

AMERICAN UNIVERSITY OF BEIRUT

SYSTEMATIC REVIEW OF EMPRICAL EVIDENCE ON THE  
EFFECTIVENESS OF AUGEMNTATIVE & ALTERNATIVE  
COMMUNICATION INTERVENTION (AAC) ON STUDENTS  
WITH DISABILITIES

by  
AMINEH ZAKARIA ABOU HOUSSE

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# ABSTRACT OF THE THESIS OF

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Title: Systematic Review of Empirical Evidence on the Effectiveness of Augmentative and Alternative Communication Intervention (AAC) on Students with Disabilities

Children with disabilities (e.g., Down Syndrome, Autism, Intellectual Disability, Apraxia of Speech, Cerebral Palsy, etc...) are at increased risk of various deficits, including speech and language development. Thus, they face challenges with their social communication and interactions, behaviors, academic achievement, and most importantly being independent. Currently, there is a rapid growing body of evidence and research-based studies on “Augmentative and Alternative Communication” intervention approach on non-verbal children with disabilities to facilitate their functional communication skills using manual signs, communication boards with symbols, and computerized devices (ranging from low-tech to high-tech). The use of this intervention has become an essential part of speech production for children with disabilities to experience the power of communication, express their needs, wants, feelings and emotions, and socialize by developing the foundation for literacy skills and later language. A systematic review of literature was conducted, using different keywords and electronic searches, to explore the efficacy of AAC intervention on their social communication skills, academic literacy skills, psychological and behavioral outcomes. In addition, the study aimed at assessing the differential impact of this intervention on domain-specific outcomes (social, behavioral, academic, psychological) as it may be more effective in one domain than in another and identifying gaps in existing literature to stimulate future research efforts aimed at developing new and more effective communication intervention strategies. Initially, a total of 762 studies were identified for screening through systematic searches of databases and then 13 studies were evaluated after setting inclusion and exclusion criteria. Findings indicated that there was evidence that augmentative and alternative communication intervention (AAC) enhanced functional communication interaction, improved literacy skills, reduced challenging behaviors, and boosted the children’s motivation, confidence, self-esteem and independent life-skills.

**Keywords:** Augmentative and Alternative Communication (AAC); Communication Disorder, Speech-Generated Devices, Complex Communication Needs, Children with Communication Disorders, Communication Intervention; Aided Speech Interventions, Communication Impairment; Social Interaction Skills; Behavioral Outcomes; Psychological Outcomes; Academic Literacy Skills.

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# CHAPTER 1

## INTRODUCTION

### **Background**

Presuming that a non-verbal child with a disability (e.g., intellectual disability, autism, cerebral palsy, down syndrome) has nothing to say is like presuming an adult without a car has nowhere to go. A student's "inability" to verbalize isn't a "disability" that will limit/restrict them to participate and function in their daily functional life and communicate with others (International Classification of Functioning, Disability, and Health, 2001). More than 1 billion people, around 15% of the global population, have some form of disability co-existing with complex communication impairment (McKenzie et al., 2016).

For instance, non-verbal individuals with intellectual and developmental disabilities represent the largest type of disability (about 200 million or 1% of the billion people who have a disability (McKenzie et al., 2016). For instance, historically, children with an intellectual and developmental disability have been given various labels including "mental retardation", "mental handicap", and "subnormal" characterized by a significant deficit in intelligence (IQ score below 70) and low levels of adaptive functioning (Bertelli et al., 2016). According to Pendzick and Demi (2009), the definition of intellectual and developmental disabilities has changed over time. Earlier intellectual impairment was described by using the terms mild, moderate, severe, and profound. However, nowadays an intellectual disability is described in relation to the significant deficits in (1) intellectual functioning (e.g., reasoning, problem-solving, planning, decision-making, abstract thinking, judgment, and

academic learning) and (2) adaptive skills (e.g., communication, social/interpersonal skills, personal independence at home or in the community settings, or work functioning, etc....) besides using the intelligence quotient (IQ) cutoffs for identifying the severity level of intellectual disability (American Psychiatric Association, 2013).

To elaborate, according to the Diagnostic & Statistical Manual of Mental Disorders (DSM-V), an intellectual disability is classified as a neurodevelopmental disorder that begins in childhood and is characterized by cognitive deficits, communication impairment, and difficulties in conceptual, social, and practical domains of living that are needed to function in everyday life (Penzick & Demi, 2009). This disability originates before the age of 18 (Schalock et al., 2010). So, ID children have lower levels of intellectual functioning and adaptive behavior which contribute to an overall lower level of intelligence in cognitive, motor, language, communication, and social abilities (Omarova, 1999). The assumptions underlying this definition emphasize that appropriate evidence-based intervention can have a significant impact on their social interaction which is the children's ability of to live independently, make interpersonal relations, communicate with peers and formulate social relationships, express emotions and feelings, work, recreate, make critical decisions, and learn successfully in community environments typical of their same-age peers.

Similarly, spoken language can also be a significant barrier to communication for students with other disabilities such as Autism, Cerebral Palsy, and Down Syndrome (Rose et al., 2016). Students with such disabilities often have difficulty with communication and interaction with other people which unable them to communicate their wants or needs, communicate refusals or agreements, or engage in social conversations through natural speech (Scott, Clark, & Brady, 2000). For these

students, severely restricted communication affects all aspects of life, including education, family, and community (Beukleman & Mirenda, 2005). In educational settings, students with communication impairments have no way to request items or activities, ask for help, ask for a break, or respond to questions (Bondy & Frost, 2001b).

According to the National Center for Education Statistics (2016), there are more than 80 million of school children (ages 3-21) globally who have some level of intellectual disability and/or developmental disabilities who receive special education services. However, this figure has likely increased along with the increasing incidence rates of autism spectrum disorder (ASD), Down Syndrome, and other disabilities (Light & McNaughton, 2012). Furthermore, the comorbidity or co-occurrence of mental disorders and neurological illness is common in children with disabilities (Flanigan et al., 2019). They tend to have at least one coexistent disability, including autism spectrum disorder (ASD), Down syndrome, Cerebral Palsy, behavioral and emotional problems, which are significantly related to the development of different domains of cognitive function that interferes with the process of social communication (Munir, 2016; Kurzius et al., 2018).

A common hallmark among the mentioned disabilities is that almost all children acquire some sort of difficulty in acquiring functional speech or communication. As described by Light (1988), their communication impairment is strongly associated with the psychological and behavioral outcomes along with social and academic literacy skills. Until the 1950s, the inability of non-verbal students with learning disabilities to express themselves using oral language was considered a natural symptom of a disorder (Glennen & Decoste, 1997). Back then, there was no

attempt to reduce symptoms of being “non-verbal”, and the goal of improving and promoting their literacy and social communication skills was not taken into consideration. As the decade progressed, more children started surviving the effects of premature birth, and more adults began surviving the results of a stroke, disease, and traumatic brain injuries (Hall & Talkington, 1970). The population of individuals with cerebral palsy, multiple sclerosis, and other motor impairments, or paralysis increased. Several of these individuals with disabilities (adults and children) and other developmental disabilities were unable to communicate using oral language (Silverman, 1980). Some years later, this had prompted public and governmental awareness of disabilities which led a number of children with multiple disabilities to begin being accommodated with some manual signs to express needs and wants (Hoffmeister & Farmer, 1972).

As children’s speech does not develop naturally or they cannot communicate effectively through speech due to pre-existing conditions, they were provided with the means to supplement (“augmentative”) or replace (“alternative”) their natural speech using the “Augmentative and Alternative Communication” (AAC) intervention (Light et al., 2003). The augmentative and alternative communication interventions had been recommended for non-verbal children with disabilities as a “communication medium” to augment spoken needs with alternative means of communication to facilitate and enhance language development, communication competence, and message intelligibility. This intervention is augmentative when used to supplement existing speech or alternative when used in place of speech that is absent or not functional (Elsahar et al., 2019). It is an evidence-based intervention approach that employs manual signs, objects, symbols, communication boards, speech-generating devices,

computerized voice-out devices, and mobile technology with AAC apps to develop receptive functional, and expressive communication abilities (Glennen, 2000).

### **Statement of the Problem**

During the first years of life, communication is a fundamental skill that is interpretive to a child's healthy development (Kasari et al., 2014). According to Hamm & Mirenda (2006), there is a strong causal correlation between the children's social development and communication impairment. When young non-verbal disabled children encounter either temporary or permanent difficulty learning to communicate via speech, they face many challenges because they are unable to meet their communicative needs, convey basic wants, and express their feelings, desires, preferences, desires, ideas, opinions, knowledge, and emotions to their families, peers, teachers, and the community-at-large. They tend to have social-communicative delays in expressive and receptive language, which are considered basic linguistic features that include a combination of phonology, morphology, syntax, pragmatics, and semantics (Salvador-Carulla et al. 2011). As a result, deficits in communication skills and receptive language put school-aged non-verbal children with disabilities at high risk of experiencing (1) academic failure, (2) psychological distress, (3) lack of social interaction, and (4) developing behavioral and emotional deficits compared to their peers without disabilities (Algozinne & Ysseldyke, 2006). In other words, non-verbal children with disabilities, who lack social and linguistic competencies, are at great risk of social and emotional isolation, depression, loneliness, dropping out of school, anxiety, self-simulating behaviors, difficulty developing interpersonal relationships, increased distress, temper tantrums, anger, reduced confidence, and social self-efficacy, etc... (Ayden & Diken, 2020). Thus, this may impact the children's ability to read,

write, speak, participate, listen, think, spell, problem-solve, organize, cooperate, collaborate, establish interpersonal relationships and warmth, engage in academic tasks and activities, express themselves, and expand their learning skills.

As a result, these children often tend to be denied the opportunity to be included in general education classrooms with students without disabilities. For instance, in the United States, over 70% of children with autism, developmental and intellectual disabilities receive most of their instruction “outside regular education classrooms,” away from their peers (National Center for Education Statistics, 2016). Thus, non-verbal children are often placed in more restrictive educational settings due to their lack of communicative ability rather than an absolute need for greater intensity of services. If these children are kept “marginalized,” they would be at significant risk in all areas of development, with implications for limited outcomes in educational achievement, adaptive behaviors, social communication and participation, and future employment opportunities (Ligh et al., 2019). Furthermore, when children with complex communication needs are placed in non-inclusive settings, they confront many peer and social interaction barriers. Considering the theory of Vygotsky (1978) of learning through social interaction which involves cooperative or collaborative dialogues, non-verbal children with disabilities will not have positive experiences with their peers, thus, this will affect their language and cognitive development, behavior, mental health, and academic success (Bukowski et al., 2009; Cohen, 2004; Hartup, 1989). In addition, the work of Vygotsky (1978) revealed that learning and development occur first in the interactions between people and then it is interiorized at the individual level. Students learn when guided by an adult or when working with other more capable peers, by discussion, joint participation, encouragement, etc. So, meaningful, and positive

interactions are needed to foster children's learning and development. Therefore, to maximize the learning potentials and social skills of children with disabilities across environments, they must be in “inclusive” environments with their general education peers accommodated with the proper evidence-based communication intervention (Wright & Wright, 2016)..

Recent evidence exists on AAC intervention that it significantly minimizes social and communication deficits and contributes to the development of communicative competence in non-verbal children with disabilities (Babb et al., 2019; Singer et al.; 2020; Von Tetzchner, 2018). However, previous research on AAC and students with disabilities hasn't evidenced the differential impact of AAC interventions on the psychological/behavioral outcomes and social communication/ academic literacy skills. Furthermore, many AAC approaches for school-aged children with disabilities lack empirical support and their effectiveness has not been well documented on the domain-specific aspects and outcomes (e.g., behavioral, social, academic, and psychological). Thus, the aim of this research study is to develop a systematic review of the existing literature on AAC approached and to assess the effectiveness of AAC intervention on non-verbal children with disabilities.

### **Purpose of this Study**

This systematic review aims to evaluate and synthesize research results of the existing literature on the effectiveness of implementing AAC intervention (aided/unaided) on disabled children taking into consideration the psychological and behavioral outcomes as well as their social communication competencies and academic literacy skills. In addition, the study aims at assessing the differential impact of this intervention on domain-specific outcomes and skills as it may be more effective in one

domain than in another and identifying gaps in existing literature to stimulate future research efforts aimed at developing new and more effective communication intervention strategies.

### **Research Questions**

After collating and studying various research studies on communication interventions, it is crucial to examine the research evidence present in the literature on the use and impact of augmentative and alternative communications on the psychological and behavioral outcomes as well as their social communication and academic skills of children with disabilities. Therefore, a systematic review study is needed to address the following research questions:

- a. According to the systematic review of the literature, what is the impact of the AAC intervention on the child's social communication skills?
- b. According to the systematic review of the literature, is there a differential impact (if any) of the AAC intervention between the child's social communication skills and behavioral, academic literacy skills, and psychological outcomes?

### **Rationale**

While many school-aged children develop their communication, language, and speech seamlessly, recent research evidence indicates that communication impairment influences the social interaction of disabled non-verbal students to meet their basic needs. (United Nations, 2006; World Health Organization, 2001). So, special needs children's additional cognitive, behavioral, social, and psychological deficits can significantly interfere with spoken language acquisition and natural speech production (Van der Schuit et al. 2010). According to Vahratian and Hoffman (2012), approximately around 34% of children between the ages of 3 to 10 years have complex

communication disorders, which put them at great risk for poor speech development due to limited communicative interactions and limited access to communication-rich learning environments in inclusive classroom settings (Drager et al., 2010). Therefore, with the increasing prevalence of school-aged children with communication deficits, there is a great demand for augmentative and alternative communication tools to enhance their abilities to communicate, socialize and form relationships, reduce maladaptive behaviors, improve academic achievement, interact with peers, enable community living, enhance literacy skills, and significantly impact the students' motivation, confidence, attitude, and resilience. Such evidence-based research effective intervention focuses on establishing functional communication to express needs and wants, exchange information, share stories, and socialize using societal norms and etiquette to promote inclusion independence, interaction, self-esteem, self-confidence, etc... (Sundqvist & Romberg, 2010).

Although non-verbal disabled students have a long history of exclusion, there had been a paradigm shift during the 1960s followed by two decades of significant legislation protecting the rights of individuals with disabilities, both the civil rights and women's rights movements which encouraged the passage of legislation increasing rights for children with disabilities (Winzer, 1993). In enacting "Individuals with Disabilities Education Act" (IDEA), the U.S congress sought to end the long history of segregation and exclusion of children with disabilities from the American public school system and requires every eligible child, regardless of the nature or severity of the child's disability, to go to school and learn alongside their peers in inclusive settings (Washington, DC: National Council on Disability, 2018).

Since 1990, research studies have demonstrated that the use of an appropriate communication intervention on students with communication impairments in inclusive settings has positive outcomes on their behavior, emotion, social communication interaction and academic achievements (Buckley et al., 2006; Guralnick, 2005). Through “acceptance” and “inclusion,” non-verbal children would learn, interact, participate, and develop diverse friendships with their non-disabled peers in the least restrictive environments (e.g., general education classrooms) (Boyd & Shaw, 2010). This is because when children with disabilities have access to a way to express themselves in social situations, they are better able to make connections and be accepted by their peers. As a result, this would enhance the students’ overall academic performance and engagement, improve social competence, communication, expressive language, and literacy skills, and reduce challenging behavior events that hamper interactive social abilities (Ligh et al., 2021; Reichle et al., 2021).

Hence, based on the above, a communication intervention is recommended to foster the acquisition of academic skills, language and communication, socialization, adaptive behavior, and other psychosocial factors (e.g., motivation, attitude, confidence, and resilience) (Light, 1997). Historically, communication interventions were concerned with remediating isolated skills (Lyon, 1998). For example, in previous years, speech and language pathologists used to provide speech intervention services for students with disabilities in sessions that are often located in isolated settings outside of the classroom and are generally provided in short time segments. However, the work of Light (1988) highlighted the importance of using “Augmentative and Alternative Communication” (AAC) interventions to focus on communication performance more holistically within natural inclusive settings. The concentration of this intervention

today shifted to functional communication for inclusion and increased social participation of children with complex communication needs. Therefore, the communication and alternative communication intervention could create equitable communication opportunities for students with communication challenges by giving them a voice to “social inequality” and most importantly expanding, maintaining, and strengthening their social networks across home, work, school, and community settings (Beukleman & Mirenda, 2013).

### **Significance of the Study**

“The silence of speechlessness is never golden. We all need to communicate and connect with each other – not just in one way but in as many ways as possible. It is a basic human need, a basic human right. And more than this, it is a basic human power” (B. Williams, 2000; p. 248). In this quote, Williams (2000) highlights the importance of verbal communication as an essential human function when advocating for needs and rights, expressing needs and wants, connecting with others, maintaining conversations, and developing relationships (Blackstone et al., 2007).

The National Joint Committee for the Communication Needs of Persons with Severe Disabilities (NJC) recently updated the 1992 Communication Bill of Rights, with a fundamental statement, “All people with a disability of any extent or severity have a basic right to affect, through communication, the conditions of their existence” (Brady et al., 2016, p. 123). So, children with disabilities and complex communication needs are entitled to the full enjoyment of all human rights, including participation in activities at home, at school, and in their inclusive community environments (United Nations, 2006). Acknowledged as a human right (United Nations, 2006), there has been an international commitment to ensuring Education for All (EFA) children, regardless

of individual or social determinants that can lead to educational inequalities (UNESCO, 2015).

According to UNESCO, educational inclusion is the “process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures, and communities, and reducing exclusion within and from education” (UNICEF, 2012, p. 8). Unfortunately, inclusive education remains elusive for children with extensive support needs, including those with disabilities, whose speech does not meet daily functional needs. Thus, many non-verbal children with disabilities, globally, miss out on education altogether or are restricted to segregated settings (Inclusion International, 2009), not only in middle and low income (Hui et al., 2018; Sharma et al., 2019) but also in high-income countries (Iacono et al., 2019; Wehmeyer et al., 2020).

Nowadays, with the passing of the “No Child Left Behind” Act (NCLB, 2002), reauthorization of the Individuals with Disabilities Education Improvement Act (IDEA, 2004), and “Mandates the use of assistive technology (AT)” support that all students with complex communications needs should have access to the general curriculum to the maximum extent possible to reach their full potential and enhance their functional communication. So, assistive technology tools like AAC should be considered when planning the individualized education program (IEP) as addressed by the Individuals with Disabilities Education Act (IDEA) amended in 2004. According to IDEA (2004), an assistive technology device (ATD) is defined as “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of a child with a disability.” Similarly, according to the United Nations (2020), assistive technology, devices, and mobility aids are external adaptive products (devices, equipment,

instruments, software), specially produced or generally available, that maintain or improve an individual's functioning in society, independence, and participation.

Examples of assistive devices and technologies include wheelchairs, prostheses, hearing aids, visual aids, and specialized computer software and hardware that improve mobility, hearing vision, or the capacity to communicate.

According to Mautone (2013), the technological tools provide access to facilitated language to increase social skills, play skills, academic skills and engagement, independence, lifestyle, leisure activities, self-worth, and productivity. Therefore, AAC can be considered as a form of assistive technology that encompasses the communication methods used to supplement or replace speech, thus maximizing community inclusion in our society.

In addition to the above, in the current society where mobile phones and the Internet are central to daily life and with the rapid increase of advanced technological devices that play an influential role in promoting inclusion, the opportunity to use AAC intervention software and applications for children with complex communication needs can be viewed as a gateway to connect with this global world for their development and efficiency in life (Shane et al., 2012). Having access to alternative and augmentative communication systems and support allows children with complex communication needs to advocate for themselves and actively participate in social exchanges, enhancing their quality of life and independence and ensuring higher autonomy (Chan & Zoellick, 2011). Based on several studies, this intervention aims to support the development of communicative competence of children to have the power of interaction and communication with others, project their authentic selves, control their own affairs, and participate in meaningful societal roles using the AAC intervention systems.

Many qualitative and quantitative studies in nature have been conducted on AAC strategies and methods that show their significant contribution to the development of communicative competence. However, previous research on AAC and school-aged children with disabilities and complex communication needs have not documented the relative effectiveness of this intervention on their social communication competencies, behavioral and psychological outcomes, and academic literacy skills (Mirenda, 2001; Prizant & Rubin, 1999). Therefore, the existing body of evidence-based results would be synthesized systematically to assess the effectiveness of the AAC intervention disabled children with complex communication needs (Cooper & Hedges, 1994). Only then can we draw more definitive interpretations and conclusions relative to the efficacy of AAC interventions for children with disabilities, which has become a major concern nowadays concerning evidence-based practice (EBP) interventions. Evidence-based practice (EBP) is an essential approach to clinical practice that highlights the importance of integrating and evaluating the comprehensive research evidence into the educational decisions process (Lloyd, 2001; Schlosser, 2003). In times of increased accountability and dwindling resources, funding agencies for clinical and educational services increasingly require documentation that AAC interventions produce a significant effect on disabled children with communication impairment. Similarly, many parents of children with disabilities are seeking evidence from education professionals that AAC works before they are willing to consider using AAC for their child. Furthermore, the federal government promoted evidence-based practice in education by calling for a U.S. education system based on solid scientific evidence.

The revised Elementary and Secondary Education Act, also known as “No Child Left Behind Act of 2001” (NCLB), mandates that “educators base school programs and

teaching practices on “scientifically based research”. This involves the application of rigorous, comprehensive, systematic, and objective procedures to obtain reliable and valid knowledge relevant to educational activities and interventions such as AAC (Murray, 2002, p. 53). In addition, there is also another theoretical reason why a comprehensive synthesis of AAC intervention research in the field of children with complex communication needs is needed. Intervention studies can test conceptual models or frameworks for understanding how inclusive intervention practices may be used to promote alternative language development in children with disabilities.

As an area of practice, AAC has a growing evidence base that demonstrates the effectiveness of AAC technologies and strategies across a broad spectrum of students with complex communication needs who are widely diverse in age, disability type, socio-economic status, ethnicity, culture, language, etc... (Blackstone et al, 2007). This is because AAC systems are not seen as synonymous with speech-generating devices (SGDs) or even with AAC technologies, but rather are a broad, integrated group of strategies, tools, and techniques from which a child with intellectual disability may choose when communicating anywhere, any time, and with anyone. Therefore, considering research and practice behind AAC, the end goal is not just the design and recommendation of AAC devices, access methods, or outputs. Instead, AAC requires concomitant attention to communication goals, content, social participation and networks, communicative self-management and self-determination, technological education, and instructional strategies.

Currently, AAC interventions for children with disabilities are either based on a social-pragmatic paradigm or derived from principles of Applied Behavior Analysis (ABA). A research synthesis study comparing AAC interventions across paradigms can

clarify the relative strengths and weaknesses of the different theoretical orientations. Therefore, through conducting a systematic review of the extant research literature, this study strives toward a clarification of unresolved effectiveness questions by considering the child's entire ecological systems such as cognitive aspects, growth, and learning process associated with psychological, behavioral, social, and environmental factors. Further, the advantages of this systematic review study are that it reduces bias, resolves the controversy between conflicting findings, and provides a reliable basis for decision-making in the field of communication intervention, communication impairment, and inclusive education.

## CHAPTER 2

### LITERATURE REVIEW

#### **Overview**

To gain a better understanding of augmentative and alternative communication (AAC) intervention and its current use by students with disabilities, this chapter critically reviews the theoretical frameworks for understanding the relationship between the impact of communication intervention on speech along with the characteristics of AAC intervention with its historical background.

#### **Theoretical Framework for Understanding the Relationship between Communication Intervention and Social Competence**

Communication is the process of transmitting and receiving ideas, information, and messages (Cohen, 2004). In the past 150 years, and the past two decades specifically, the rapid transmission of information over long distances and ready access to information have become conspicuous and important features of human society (Microsoft Encarta, 2005). In other words, communication forms the foundation of human social interaction, connections, and achievements (Hneine & Browning, 2002). So, the ability to communicate is considered nowadays essential for all human functioning. According to the Joint Commission (2010) successful interpersonal communication has been defined as the “successful joint establishment of meaning” that occurs as a result of “a two-way process (expressive and receptive) in which messages are negotiated until the information is correctly understood by both parties”. Further, as described by Lubinski & Welland (1997), communication is central to living independently, pursuing personal goals and interests, performing

social roles and functions, maintaining personal and familial relationships, making decisions, and exercising control over the quality of life and care. So, communication in all its many forms is implicit in most activities, including those associated with activities of daily living, educational and vocational performance, and the ability to participate in community and civic life.

The importance of communication for social interaction is reinforced by the fact that it is one of the key domains in the World Health Organization's conceptual model of the International Classification of Functioning, Disability, and Health (ICF) (2001). Drawn from the literature, "functioning" is the human experience related to body functions, body structures, activities, and participation. According to the WHO's ICF model (2001), a student's social, academic, behavioral, and psychological outcomes can be described not only by both body functions and structures, but also in terms of the activities and participation that the individual participates in. The term "activities" usually refers to specific behaviors that the individual may undertake, while "participation" refers to the social roles that are gained through performing those activities. This framework model is viewed in terms of its dynamic interaction with the with personal and environmental factors of the child with complex communication needs (Dalemans et al., 2008). So, based on the ICF framework model, a "disability" is the human experience of impaired body functions and structures, activity limitations, and participation restrictions in interaction with a health condition, and personal and environmental factors (WHO, 2001).

Considering the above, to better explain the relationship between social competence and complex communication needs of children with disabilities, the ICF model of disability has increasingly gained currency (Eadie, 2003; Putnam, 2002). This

model conceptualizes the student's level of functioning as a dynamic interaction between his/her health conditions, personal factors, and environmental factors. It views social, psychological, behavioral, and academic domains and their consequences in daily life and presents a framework to determine factors that could be modified to improve the communication and participation of those who experience them (Zerbeto et al., 2020). It's a biopsychosocial model of disability which considers not only the contribution of biological factors but also the psychological and social outcomes of the child (Wright, 2015). In structural terms, the ICF is composed of three main classifications: (1) Body functions, which are defined as the physiological functions of body systems, including psychological functions; (2) body structures, which include the anatomical parts of the body (e.g., mental, voice, and speech functions and structures); and (3) activities and participation, which include executive of tasks or actions by students themselves and the relationship of these actions to the rest of the student's life (e.g., communication, interpersonal interactions, self-care, learning and applying knowledge) (Zerbeto et al., 2020). These are also contextual factors, which include both environmental factors and personal factors for understanding and studying communication and behavioral, psychological, social, and academic outcomes (WHO, 2001). The environmental factors are those which are generally outside the student's control but have an impact on all components of functioning and disability, such as the social and political environment, family, school, cultural beliefs, legal context, and the attitudes of others. Such domain includes code that can document the hindering or facilitating role of the environment on the performance of the child and includes the provision of communication aids (e.g., AAC) and the communication skills of interaction partners (Rowland et al., 2012). The personal factors include student

characteristics independent of a particular health condition, such as race, gender, age, educational level, coping styles, upbringing, personality traits, and lifestyle. Personal factors are not specifically coded in the ICF because of their wide variability among students and cultures, but they are anticipated to have an impact on function as well as on the outcomes of different interventions.

All the mentioned components and factors interact with each other so the disability can be understood as an interaction between the physiological problems and the social environment (WHO, 2001). According to Worrall & Hickson (2008), communication functions are represented at all levels of the ICF, including body function, body structures, and activity and participation considering their social outcomes. Communication is one of the nine domains at the level of both activity and participation and, in addition, communication is implicit in many of the other types of activities and functions, including “learning and applying knowledge,” “interpersonal interactions and relationships,” “major life areas,” and “community, social and civic life.” The relevance of communication to so many aspects of the model clearly reinforces the notion that communication is central to many of the everyday activities of life and their behavioral, psychological, academic, and social outcomes (Rowland et al., 2012). So, this framework model promotes the importance of communication throughout the entire classification system for describing the complex interactions of the child with the environment. Furthermore, according to Threats (2006), the ICF has many potential advantages for understanding communication impairments, including its utility as a framework for studying the epidemiology of communication disability as well as its application for guiding clinical practice, research, education, and social policy. For instance, the ICF model can be used as guide research to fill several

important needs in the field, including the relationship between body function/body structure and activity/participation behaviors and an increased focus on the role of personal factors in the process of rehabilitation and adaptation.

### **The Impact of Communication Impairment on Students with Disabilities**

According to the American Speech-Language-Hearing Association (1991), communication impairment is a neurodevelopmental disorder characterized by impairments in sending, receiving, processing, or comprehending verbal, nonverbal, or graphic language, speech, and/or communication. A communication disorder may range in severity from mild to profound and it may be developmental or acquired (Cohen, 2004). Communication disorders are characterized by fluency disorder, articulation disorder, and voice disorder (Hardman et al., 2002). Perhaps the most crucial factor that influences the child's psychological, social, behavior, and academic outcomes is their severely impaired ability to communicate, in terms of having a limited understanding of others, the world around them, and having problems expressing themselves, concerns, symptoms, thoughts, or feelings (Coiffait & Leedham, 2016; Einfeld et al., 2011). The inability to articulate speech sounds correctly could be caused by biological factors, such as brain damage, damage to the nerves controlling the muscles used in speech, or gross abnormalities of the oral structures like a cleft palate (Hardman et al., 2002). Other possible conditions that might contribute to communication impairments are environmental factors such as the quality of parent-child communication, emotional disturbances, and hearing loss (Cleaver et al., 2010).

The most common conditions affecting children's communication include language-based learning disabilities, autism spectrum disorders, down syndrome, cerebral palsy and other intellectual disabilities. According to the Health and Human

Services Administration (2019), autism spectrum disorder, for example, constitutes 2.9% of children between 3 and 17 with approximately half either failing to develop speech or experiencing limited speech and communication impairments. They often demonstrate continued difficulties and barriers with speech production (Bray & Grad, 2003; van der Meer, et al., 2011). So, significant expressive language deficits can be the result of a number of different developmental and/or acquired etiologies. A survey conducted by the Australian researchers, Bloomberg and Johnson (1990), revealed that for individuals under the age of 21 with severe communication impairments, the majority of causes were related to developmental delays (100%), autism (88%), and cerebral palsy (65). According to the National Institute of Neurological Disorders and Stroke (1988), it was estimated that around 90% of school-aged children with ID have communication difficulties and limited speech abilities. Similarly, Smith et al. (2020) identified communication skills in a sample of 601 students with ID, finding that around 60% experienced communication deficits and, in 23.5% of cases, the difficulties were severe to profound (almost non-verbal).

### ***The Impact of Communication Impairment on the Academic & Behavioral Outcomes of Students with Disabilities***

The communication difficulties that children with disabilities and complex communication needs encounter vary from the intelligibility or fluency of speech, through to the understanding and comprehension of language, to the pragmatic use of language in social situations (Coppens-Hofman et al., 2016; Marrus et al., 2017; Tuffrey-Wijne et al., 2008). Thus, they tend to have difficulties in pronouncing single words, comprehending several words and phrases, and labeling objects in their environment (American Psychiatric Association, 2013). For example, a study done by Kumin (2006) found that 95% of students with Down Syndrome have speech sound

production difficulties and fluency, and 58% are often not understood. So, they show specific weaknesses in the areas of language acquisition, and the intelligibility of their speech (Roberts et al., 2007). Also, research has shown that children with intellectual disabilities and developmental disabilities exhibit deficits in multiple aspects of communication, including written, expressive, and receptive modes (Belva et al., 2012; Berry, 1972; Merrill & Mar 1987). This may be because they have reduced cognitive resources compared to typical peers which may substantially interfere with participation in social, educational, and vocational activities (Kail, 1992; Koul & Clapsaddle, 2006). Thus, they face cognitive challenges in conveying ideas consistently, developing vocabulary words, reading, understanding, and remembering information or questions, learning the alphabet, and repeating spoken language (Brice, 2001; Okoli, 2018). As a result, many of them rely on non-verbal cues to express their wants and needs including facial expressions, reaching gestures, body language, physical expression, eye gaze, and leading gestures (Casella 2005). However, Mehrabian (1981) found out that only a very small percentage of the 70-90% of children who use non-symbolic cues comprise the actual words spoken.

Furthermore, Rojahn et al. (2012) stated that other children with disabilities and complex communication needs may employ maladaptive behaviors (e.g., scratching, crying, screaming, throwing, kicking, hand banging, biting, breaking objects, tantrums, meltdowns, etc..) as a form of communication. In other words, they tend to communicate using socially unacceptable manners such as aggressiveness, impulsivity, production of sounds or noises that are destructive, ingestion of inappropriate objectives or substances, and in particular, self-injuries, or self-stimulating behaviors (e.g., repetitive body movements or repetitive movements of objects) (Hogg et al., 2001). As

described by Carr et al. (1978) “problem behavior functions as a primitive form of communication for students who do not yet possess or use more sophisticated forms of communication” (p. 22). For example, according to Dominick et al. (2007), results show that around 32.7% of children with autism spectrum disorder displayed aggressive behaviors including hitting, kicking, biting, and pinching others. More than three-quarters of these children showed aggressive behaviors both at home and outside the home, and aggression was directed toward more than one person in 92% of cases. Self-injurious behavior, including head banging, hitting oneself, and biting oneself, was present in almost one-third of children with ASD (Dominick et al., 2007). Furthermore, 70.9% of children with ASD had experienced a period of severe temper tantrums and, for 60% of these children, tantrums occurred daily and were a constant (rather than episodic) problem during the period in which they were present (Dominick et al., 2007). So, as reported by Bowring et al. (2019), a high prevalence of disabled children with severe speech impairments exhibits unwanted behaviors as a form of expressive communication in their school environments, particularly when their needs are met in response to those behaviors.

According to Chiang & Lin (2008), when these unwanted behaviors become so intense and frequent, they impact the child's safety or ability to learn, and it is necessary to intervene in them. In other words, since communication problems are strongly associated with challenging behavior, any support or interventions that enhance the communication of the students with disabilities are likely to facilitate their social interactions with others (Hancock & Foster, 2002). According to Hastings (2016), maladaptive behaviors cause a high level of psychological distress for parents and teachers as they can be disruptive to the learning program; and may consequently

impact their (1) academic success, (2) social connections, (3) psychological outcomes (4) and other daily living skills. This is because once maladaptive behaviors become an established part of a child's behavioral repertoire, they are unlikely to decrease and, according to Defonte & Boeseh (2016), will typically remain or worsen without intervention. If left untreated, these behaviors can significantly reduce a child's social and educational opportunities by limiting their access to available treatments, learning activities, interactions with others, community experiences, and, in particular, their ability to transition to, and participate in, school programs. Therefore, communication interventions should incorporate the management of maladaptive behaviors (Koegel & Koegel, 2019). So, given the relationship between maladaptive behaviors and deficits in communication and social skills, it is important that intervention approaches target these core deficits.

According to Reichle et al (2008), a variety of interventional strategies had been used in the past to manage and control the improper social behavior of intellectually disabled school-aged children such as "functional behavioral analysis" or "positive behavioral support". However, such behavior modification techniques will not prevent the unwanted side effects related to communication disabilities but rather replace the target behaviors with appropriate behaviors. This is because ABA interventional techniques can be used only to reinforce appropriate behaviors, allow the individual to learn new skills, and gradually adapt to certain environments in a structured and task-focused way without targeting the ID student's communication deficits (Langarika-Rocafort et al., 2021). Similarly, Myers and Johnson (2007) argue that the primary goals of any intervention for children with intellectual disabilities should target their "communication and social skills" to maximize their functional independence and

quality of life, facilitate development and learning, promote socialization, and reduce maladaptive behaviors using empirically evidence-based strategies. In other words, traditional interventions have addressed the challenging behaviors as an isolated issue, not accounting for the far-reaching effects that children may experience. Therefore, interventions should be shifted to the use of proactive, ecological strategies to prevent problem behaviors, as well as numerous strategies for teaching functional communication skills as “alternatives” and/or “augmentative” (Sigafos et al., 2006).

Considering that maladaptive behaviors are amongst the most commonly identified barriers to the “inclusion” of children with disabilities and complex communication needs in group settings, they are at great risk of social exclusion in different environments such as school and community (Brady et al., 2016; Grace et al., 2008). According to the U.S Department of Education (2016), around 61% of children with autism spectrum disorder, 84% of children with other intellectual developmental disabilities, and 87% of children with multiple disabilities are excluded from attending general education classrooms and learning academic content with/without accommodations. Similarly, Mirenda (2014), in reflecting on progress from 1992 to 2012 and citing data and/or reports from Canada, the United States, and the United Kingdom (UK), noted that relatively few of these students with disabilities were likely to spend their days in general education classrooms. For those students who were along with peers without disabilities, it was evident that simple presence in a general education classroom “does not ensure that a student’s academic needs will be met” (Mirenda, 2014, p. 21).

According to Plante and Beeson (2013), children with complex communication needs are denied the opportunity to participate in general education because they don’t

perform as expected to their current grade level (score below average) and don't meet the same academic standards as their peers. They may struggle with reading fluency, decoding, and accuracy; have difficulties in understanding and expressing language, spelling, and linguistically complex materials; writing sentences; producing sounds properly and oral expression; maintaining an appropriate flow or rhythm in speech; understanding mathematical reasoning; and solving numerical operations (Hardman et al., 2002). Similarly, as described by Tambyraja et al. (2020), students with such deficits are more likely to have difficulties in developing and/or understanding words, phonological representations and awareness skills, letter-sound correspondence, vocabulary, and blending of sounds than typically developing children. Thus, those students with tend to be at higher risk for delayed or no acquisition of functional literacy skills, meaning no acquisition of generative communication abilities to develop social closeness, exchange information with teachers/peers, and fulfill social routines (Light, 1997). Research demonstrates the relationship between speech and/or language impairment and literacy acquisition (Zascavage & Keefe, 2004; Weigel et al., 2006).

Several studies have reported that between 50% and 80% of children with disabilities and complex communication needs face literacy difficulties which affect their educational status as they exit full-time education (Snowling et al., 2000). Furthermore, according to Foley & Wolter (2010), up to 90% of students with complex communication needs enter adulthood without acquiring functional literacy skills undermining their participation in all aspects of life - education, future employment, healthcare, personal connections, and community living. Thus, without literacy skills, children with complex communication needs will not have the acquisition of generative communication abilities and will remain entirely dependent on others (e.g. caregivers,

parents, other siblings) to provide and teach them picture symbols to represent various vocabulary concepts. However, the vocabulary selected for the children, as opposed to that selected by them, may never truly represent their own internal lexicon (Light et al., 2021). In addition, Wu et al. (2020) identified the relationship between literacy skills, and quality of life (psychological outcomes) of students with complex communication needs. The results of this study demonstrated that the acquisition of literacy skills could increase the sense of belonging and social inclusion in addition to increased self-esteem and improved access to social networks for students with disabilities and complex communication needs.

### ***The Impact of Communication Impairment on the Social & Psychological Outcomes of Students with Disabilities***

According to Light et al. (2021), the development of literacy skills would offer children with disabilities a tremendous potential to enhance their communication and support their full social participation in various inclusive settings. However, due to the absence of functional literacy skills, those children tend to receive less support from the environment in the society (are less involved) and have restricted participation in everyday life activities and social engagements as often as other children (Bedell et al., 2013). Drawn from the literature, studies have shown a heightened risk of social exclusion in children with disabilities, because of fewer opportunities to establish meaningful social connections and to participate in fulfilling social activities (Clegg & Ginsborg, 2006).

Social participation or social engagement refers to the ability of the student to participate in social roles, relationships, activities, and functions. These activities and functions typically involve two or more individuals during which social exchanges occur (Berkman et al., 2000). According to Smith et al. (2020), communication

impairments hinder the students' social participation and increase the risks of social isolation and withdrawal which greatly impacts the students' social relationships and interactions with others. Further confirmed in McNaughton and Bryen's (2007) systematic review on participation in meaningful societal roles, students with complex communication needs may be unable to obtain a future job simply due to their low or absence of literacy skills. So, communicating one's own ideas through generative communication contributes to social inclusion in the school with peers and in the future workplace with supervisors (Lysaght et al., 2017). This is because having students with disabilities and complex communication needs engaged in intentional and meaningful interactions with their peers would add to their sense of belonging; expand their social networks, social integration, social participation and employment opportunities; and increase socio-emotional safety (Light & McNaughton, 2020). So, by acquiring literacy skills, disabled children with complex communication needs can independently generate any message to express themselves as they're improving their communicative competence (Caron et al., 2020). A large body of historical research has developed to demonstrate that social participation or social engagement directly impacts the students' psychological state of being (e.g., distress, isolation, etc.).

According to Yorkston et al. (2010), students with communication impairments may be at risk for poorer psychological state of being, with higher levels of loneliness, psychological distress, social isolation, depression, and reduced life satisfaction because of having very limited control over their environment. A study done by Kashani & Simonds (1979) shows that students with complex communications needs have depression symptoms much higher than the 2% found in the general population. This is because an inability to correctly form speech sounds might create stress,

embarrassment, and frustration as disabled students with complex communication needs are unable to report and understand their emotions and feelings, express their needs and wants, form and maintain social friendships, bond with peers, and interact with others in school, social, and even home environments (Light et al., 2021). As a result, they tend to “avoid” or “isolate” social participation and activities. As for students who decide to participate in social activities by relying on others to communicate for them, and/or ask for accommodations from their communication partners, a study conducted by Baylor et al. (2011) found that such strategies or accommodations were not effective and resulted in withdrawal from a variety of social situations. Baylor’s participants (students with autism, down syndrome, and intellectual disabilities) described feelings of isolation and marginalization, “like a bystander,” “out of the loop,” and “ignored” and as though they had lost their “sense of self” when they depend on others for communication (pp.275-276).

Similarly, in a qualitative study by Bute et al. (2007) on the impact of communication impairments on maintaining social relationships, friends and family members of students with a variety of different types of impairments were interviewed. They reported that the students with disabilities and complex communication needs made a wide variety of accommodations and adjustments to continue their social relationships. These include changes in the nature, content, and mechanics of communication, managing topics, using a third party as an intermediary, and inferring meaning from a wide variety of cues. Based on the results, it appears that the cumulative impact of these changes frequently includes a feeling of increased work to maintain a relationship, decreased feelings of closeness and intimacy, and changes in the ability to perform familial and social roles. These changes, in turn, are often

associated with feelings of a change in personality or a perception of a loss of the former sense of self (Bute et al., 2007). Thus, this would suggest a decline in the quality of personal relationships for students which leads to increased “emotional loneliness” (Yorkston et al., 2010). In addition, a loss of companionship and friendship may occur due to a reduction of the presence of friends in the social network leading to increased feelings of “social loneliness”. This might also be associated with increased social isolation due to social withdrawal, as is often reported (Hétu et al., 1993).

### **The Communication Intervention (Augmentative & Alternative Communication)**

Having said the above, a large body of literature reported a strong correlation between communication/speech impediments and the social competence of students with complex communication needs (Hamm & Mirenda, 2006). The possibility of a causal relationship is supported by improvements in their speech and social interactions through an appropriate communication intervention by having an enhanced expressive and receptive communication without restoring challenging behaviors and being limited in their involvement and social inclusion in daily life activities (Grunland et al., 2012). Therefore, a “multi-faceted” communication intervention is recommended to address the social, behavioral, academic, and psychological factors for promoting the students’ communication, interaction, and independence (Davey, 2008).

In the 1950s and 1960s, the augmentative and alternative communication intervention (AAC) was proposed as an avenue for communication that aims at developing the child's language functions and encouraging the transition to intentional and symbolic communication, so that a recovery or compensation of language function is achieved. Such evidence-based research effective intervention focuses on establishing functional communication skills, enhancing communicative competence, acquiring prelinguistic

and cognitive skills essential for language development, and facilitating the emergence of speech and language (Beukelman & Ray, 2010). This intervention is thought of as a system that has evolved to support the communication of children with complex communication needs across home, work, school, and community settings (Mirenda, 2014).

### ***The Definition of Augmentative & Alternative Communication (AAC)***

The term AAC has been defined in professional literature since the early 1980s (Glennen & DeCoste, 1997; Lloyd, 1985). The American Speech-Language-Hearing Association Special Interest Division 12 defines AAC as follows:

“Augmentative and alternative communication (AAC) refers to an area of research, as well as clinical and educational practice. AAC involves attempts to study and when necessary, compensate for temporary or permanent impairments, activity limitations, and participation restrictions of individuals with severe disorders of speech-language production and/or comprehension, including spoken and written modes of communication” (ASHA, 2005).

In addition, according to the American Speech-Language-Hearing Association Leader (2016), the Individuals with Disabilities Education Act (IDEA) defines AAC as:

“Any item, piece of equipment or product system, whether acquired commercially off the shelf, modified or customized, used to increase, maintain, or improve the functional capabilities of a child with a disability”. IDEA also recognizes AAC as “any service that directly assists a child with a disability in the selection, acquisition or use of an assistive technology device” (p. 1)

On the other hand, the definition of the International Society of Augmentative and Alternative Communication (ISAAC) focuses on forms of communication and defined AAC as:

“... a set of tools and strategies that an individual uses to solve everyday communicative challenges. The mode in which communication occurs is secondary, as long as the intent and meaning are understood by the communication partners. The mode of communication can be speech, text, gestures, body language, touch, sign language, symbols, pictures, speech-generating devices, etc. Everyone uses multiple forms of communication, depending on the context and our communication partner” (ISAAC, 2016).

### ***The Historical Development of Augmentative & Alternative Communication (AAC)***

In 1963, Maling and Clarkson developed the first assistive technological communication tool known as “POSSUM” for individuals with severe physical disabilities. POSSUM incorporated a typewriter with a switch-controlled scanning device. A variety of POSSUM adaptations were developed over the years and were available for purchase up until the late 1970s (Vanderheiden & Grilley, 1976). From this point on, rehabilitation specialists began developing other Augmentative & Alternative Communication (AAC) systems. In 1969, Garder and Garder began a revolutionary experiment to raise chimpanzees as human children and teach them to communicate using the American Sign Language. This led to a new area of primate research which concentrated on teaching sign languages, and graphic visual languages to apes (Gardner & Gardner, 1979; Premack & Premack, 1974). This research established the idea of using alternative methods for communication purposes among

individuals with severe cognitive disabilities. Thus, based on this experiment, manual signs and graphic symbol systems were taught by means of highly structured behavioral teaching programs to individuals with an autism spectrum disorder and various cognitive disabilities. (Alpert, 1980; Carrier, 1976; Kopchick & Lloyd, 1976; Premack & Premack, 1974; Woolman, 1980). While ideas that technology could bypass communicative disability and those adapted typewriters used for communication were more widespread, more other aids were developed but only accessed by non-verbal students who had literacy skills only.

In the 1970s, such heavy-equipped devices started relying on the “Blissymbol” communication board which was the first graphic symbol system to be implemented for extensive use in AAC (Shane & Bashir, 1980). Then, the “Blissymbolics Communication Institute” started providing training in using AAC methods for numerous professionals at a time when knowledge in the field was minimal. With the development of graphic picture symbols, such electronic letter board includes symbols based on their meaning rather than phonetics to be easily learned even by those who couldn’t acquire the alphabetical code for communication (Beryy,1972). For many years, the Bliss symbols were spread throughout the world and used as the main graphic system amongst individuals who were incapable of communicating verbally. Then, considering the development of graphic symbols and researchers’ study focus on the function of language rather than on the form of language, towards the end of the 1970s, AAC systems started to emerge as an area of professional specialization and be viewed as a permissible method of communication (Zangari et al., 1994). This change in recognition was due in part to legislation in 1975 that administered the right to education for “all” children with disabilities, and the Rehabilitation Act of 1973

which prohibited discrimination against individuals with disabilities within any program that was issued federal money. Then, Congress amended the Rehabilitation Act to require that all federal agencies remove barriers to making electronic and information technology accessible to people with disabilities by putting AAC into practice.

Then, in 1978, Purdue University was considered among the initial universities to deliver course subjects on “Augmentative & Alternative Communication”. Years later, the researchers Ratcliff and Beukelman (1995) conducted a study on 204 university programs that offer graduate training courses for “Communication Disorders”. Results revealed that, of 119 university programs across the United States that replied, 68% of them offer and deliver at least one course in Augmentative & Alternative Communication in their program (Ratcliff & Beukelman, 1995). Today, in the 21<sup>st</sup> century, around 76 universities provide training courses in AAC, and it’s been utilized by millions of individuals around the world with communication and speech impairment. Nowadays more conferences are being held on the applications of AAC (e.g., Conference and the Communication Aids Manufacturers Association, Closing the Gap, the California State University Northridge) to keep professionals up to date on the latest technological advancements for enhancing communication and speech production (Ronski & Sevcik, 2018).

### ***The Uses & Effectiveness of Augmentative & Alternative Communication (AAC)***

A variety of individuals can use augmentative and alternative communication systems, including individuals of all ages, ethnic backgrounds, and disorders (Beukelman & Mirinda, 2005). Ogletree (2013) stated that there are no prerequisites for the use of AAC. It may be justified at any age or cognitive level and AAC usage does not interfere with a child’s acquisition of vocal/verbal communication (Cress and

Marvin 2003). Findings from over three decades of research demonstrate that AAC improves outcomes for disabled children with complex communication needs. These outcomes include enhancing their ability to be understood, transferring information, assisting with conversation maintenance, increasing social interactions, and conducting an internal dialogue with themselves (Beukelman & Mirenda, 2013; McNaughton & Light, 2015). Also, the use of AAC supports has risen over the last three decades (Light & McNaughton, 2012), possibly due to the portability, affordability, and social acceptability of these devices (Still et al., 2014). So, it has become an essential part of language intervention for children with disabilities who experience significant difficulties with communication and social skills as it serves as a supplement to functional speech abilities for many users (Flores et al., 2012). For instance, students with moderate speech intelligibility might use AAC as a cue when a spoken message is not understood, or they might bring an AAC aid when they anticipate meeting strangers who would have difficulty understanding them, such as at a restaurant or sporting event.

The AAC intervention includes evidence-based techniques that have become a common everyday practice among students with disabilities to interact with others (Beukelman & Mirenda, 2005). Such intervention techniques involve a wide range of activities that include direct interventions working with the child who uses an AAC or indirect interventions working within the environment to effect change (e.g., instructing parents to manage the demands in the child's environment that may exceed his/her capacities for fluent speech production) (Beukelman & Light, 2020; Beukelman & Mirenda, 2013; Granlund et al., 2008).

Regardless of the type of AAC intervention adopted, each of the techniques can remediate some of the communication difficulties experienced by students who have

incomprehensible speech, have difficulty comprehending speech, and/or have limited semantic or syntactic skills (Iacono et al., 2019). For school students with complex communication needs, which are often associated with high support needs, according to Beukleman & Mirenda (2012), augmentative and alternative communication (AAC) has offered a potential means to support both their academic and social inclusion in school education.

There is a paucity of studies that investigate the potential for AAC to support inclusive education of students with complex communication needs through enhanced opportunities for shared experiences and interactions with peers without disabilities and the development of language and social skills. For example, Simacek et al. (2018) conducted a systematic review of AAC interventions for school-aged children with multiple disabilities and found that the use of switches with voice output, picture exchange, and speech-generating devices have increased the linguistic communication of students. Likewise, Xin and Leonard (2014) aimed to examine the effects of using the AAC system intervention from an iPad to support students with autism in learning communication skills. The results showed that students with ASD can use the iPad AAC application as an effective form of communication when responding to the teachers' questions during class instruction and peers during class activities. Likewise, Katz et al. (2002) found that students with intellectual disabilities who use AAC in inclusive classrooms were more likely to be actively engaged with their peers when they were involved during instruction than when they were involved in one-to-one classroom instruction in pull-out sessions. They tend to interact and communicate with them in various group class activities to achieve the learning target. Similarly, Wickenden (2011) used an ethnographic approach and observed 15 students over a two-

year period in a variety of settings. Her data were triangulated with interviews of the parents, participants themselves, and the school personnel (e.g., speech therapists and teachers). Results of this research indicated that nearly all participants described themselves positively related to peers without disabilities and were encouraged and motivated to discuss topics similar to that of same-aged peers. A majority of participants found their speech-generating devices to be a vital part of their lives and would become frustrated when they did not function properly.

According to the usage-based theory of Tomasello (2003), the competence of the social environment will be important for children's language development. Based on this theory, inclusive educational settings promote alternative language development of children who use alternative means of communication when all or most adults and children in these settings have at least basic competence in the alternative communication form. So, facilitating the development of alternative communication skills will, therefore, be a natural part of inclusive interventions for children with disabilities who have complex communication needs. Beukleman & Mirenda (2005) found that AAC intervention systems made a great contribution to inclusion and social interaction functions between peers in "least restrictive classroom" environments rather than being used only for information-sharing functions. Researchers found that using AAC intervention in general classroom settings had enhanced the participation of students with disabilities in formal and informal activities such as sports and leisure activities with peers without disabilities. According to Dundon et al. (2013), peers of students who use AAC for communicating with them were able to accommodate these differences through the repetition of messages delivered through the AAC system devices. Still, differences were also found in the nature of friendships or how they were

formed, but Biggs and Snodgrass (2020) argued that these friendships were of no lesser quality than those between speaking peers. So, this intervention can be considered the primary mode of communication for students with disabilities and complex communication needs to build social communication competence, increase peer interaction, enhance inclusion, and participate fully in all aspects of life (education, social relationships, employment). (Beukelman & Mirenda, 2013; Light & McNaughton, 2014).

AAC further supports a range of language and communication outcomes, for a diverse range of students with disabilities, using unaided modalities (communication systems that don't require the use of an external device such as eye gaze, facial expressions, vocalizations, gestural cueing systems, and the use of manual signs), and multiple aided modalities (communication systems with an external device that stores or displays symbols such as graphics symbols, communication boards, and computer-based technology with voice output) (Lynch et al., 2018; Murray & Goldbart, 2009; Sennott et al., 2016). These modalities are designed to support the communication of students who are unable to reliably achieve functional communication using verbal speech alone. So, they offer temporary or permanent solutions across communication partners and environments using multi-symbol messages (Beukelman & Mirenda, 2013). Children using AAC modalities are supported by a variety of AAC stakeholders, including direct caregivers, extended family, case managers, therapists, medical professionals, educators, and AAC vendors (Binger & Kent-Walsh, 2009).

Historically, the choice of the communication system (either aided or unaided) often was based on the belief that children with severe cognitive disabilities would benefit most from aided systems, whereas children with mild cognitive disabilities use

unaided systems (Musselwhite & St. Louis, 1982). However, this principle changed with the recognition that the combination of aided and unaided communication systems yielded substantially enhanced communicative power and speech skills. For example, according to Sigafos & Drasgow (2001), the multimodal AAC (using both aided and unaided communication systems) was found to support language learning in children with developmental and intellectual disabilities than using unaided systems only. However, Miller & Allaire (1987) added that unaided communication modes should remain the most frequently used methods because persons with high-tech devices often used these unaided AAC strategies to supplement voice-output devices.

Today, on the other hand, with the emergence and continuous developments of technology, clinical practices incorporate complex devices (both aided and unaided) into therapy to enhance students' learning and communication. According to Kagohara et al. (2013), using greatly advanced technological AAC devices that output speech (e.g., Voice Output Communication Aids in Apple iPads) along with unaided symbols (e.g., manual signs and gestures) doesn't only enhances the students' valuable skills in academics and social communication, but also allow them to establish meaningful interactions and connectedness via visual and pictorial support of multimodal approaches (Kagohara et al., 2013). However, this requires AAC candidates to effectively learn how to use AAC symbols, sign language, the meaning of words/symbols (receptive language), and how to produce them (expressive language) in communicative contexts (Beukelman & Mirenda, 2013) along with other unaided symbols (eye gaze, sign language, etc...). In a systematic review of 17 studies on AAC different modalities, Morin et al. (2018) found that a range of high- and low-tech aided AAC used with unaided symbols proved to be effective in improving communication

skills and speech production (increase verbal input) for children with complex communication needs. Also, according to Ronski et al. (1998), through a multimodal approach, more recently researchers have been looking at the effects of learning style, social interactions, specific cognitive/memory skills, and the role of speech feedback (e.g., Voice Output Communication Aids) in successful AAC outcomes and the development of literacy skills and generative communication (Foley & Wolter, 2010; Ronski et al., 1988).

### **Concluding Summary**

The communication impairment of students with disabilities is often troubled by disordered speech production, resulting in miscommunication, and consequently impairing social interactions, possibly behavioral problems, psychological drawbacks, and social isolation. An effective communication intervention, like AAC, is recommended to facilitate positive outcomes in the domains of education, social skills, and other daily living skills. Therefore, to examine the efficacy of augmentative and alternative communication interventions, the present paper provides a systematic review of alternative and communicative communication interventions conducted for children with disabilities. In other words, a comprehensive systematic review study was conducted to synthesize relevant studies on AAC and broaden the understanding of its effectiveness on the students' social competence as well as their psychological, behavioral, and academic outcomes.

# CHAPTER 3

## METHODOLOGY

### **Overview**

This chapter outlines the research purpose, questions, research design, method, and procedure. Next, it will discuss the inclusion and exclusion criteria needed for the selection of literature. Lastly, it will present the selected studies based on the Preferred Reporting Items for Systematic Review & Meta-Analysis guidelines (PRISMA) and the guidelines of Cochrane Handbook for Systematic Reviews of Interventions (Cochrane Collaboration, 2008).

### **Purpose and Questions**

The purpose of the study is to gather, study, evaluate and synthesize the available research evidence and results of the existing literature on the effectiveness of implementing AAC intervention on disabled children, specifically with complex communication needs, in inclusive classrooms taking into consideration their social competence skills, academic literacy skills, and behavioral and psychological outcomes. In addition, the study aims at assessing the differential impact of this intervention on domain-specific skills as it may be more effective in one domain than in another. So, a systematic review study will be conducted to address the following research questions:

- a. According to the systematic review of the literature, what is the impact of AAC intervention on the child's social communication skills?
- b. According to the systematic review of the literature, is there a differential impact (if any) of the AAC intervention between the child's social communication skills and behavioral, academic literacy skills, and psychological outcomes?

## **Research Design: Systematic Review Study**

This study is designed and conducted in accordance with the Cochrane Collaboration Manual for Systematic Reviews as it informs decisions social care through (a) defining the research question clearly, (b) performing a comprehensive literature search, (c) evaluating the certainty of evidence, (d) extracting relevant data, and (e) performing a qualitative analysis of the best evidence (Patticrew & Roberts, 2006). This evidence-based approach was used to extensively collate, extract, and synthesize studies published on the subject (impact of implementing AAC interventions) and to find answers to the above research questions. Therefore, this method is adopted to use a more comprehensive range of databases to search the literature and provide more reliable findings from which subjective conclusions can be drawn to support decision making for policy and evidence-based practices on the effect of AAC interventions (Petticrew & Roberts, 2006). In addition, this systematic review provides syntheses of the state of knowledge in the field, from which future research priorities can be identified; it addresses the research questions that otherwise could not be answered by individual studies; may identify problems in primary research that should be rectified in future studies; and may generate or evaluate theories about how or why phenomena occur.

### **Inclusion Criteria**

Whereas the research questions are meant to serve as an advanced organizer for the reader, the eligibility criteria provide the operational characteristics of the studies that will be included and excluded. Studies included in this systematic review only if they were are (a) published between 2008 (the year of the formation of Augmentative and Alternative Communication as Software applications) and 2021; (b) published in

English or translated into English; (c) published in peer-reviewed journals; (d) included participants reported to have disabilities (e.g., autism, intellectual disability, cerebral palsy, etc..) with co-occurring complex communication needs (across all levels of severity cases); (e) reported school-aged students (age-5—13), (f) included implementation of interventions with aided and/or unaided AAC; (g) reported the outcome of the effectiveness of augmentative and alternative communication (AAC) intervention, and (h) included research studies (quantitative, qualitative or mixed-method design (including single case studies or group design research methodologies). Studies that did not meet the specified inclusionary criteria were excluded from the review.

### **Search Procedures**

Once the eligibility criteria have been established, the systematic review process moves away from conceptual development toward implementation. The purpose of the search is to identify the universe of eligible studies that meet the eligibility criteria. This systematic study attempts to review all existing evidence on the effectiveness of AAC intervention on the social and communication competence of disabled students with complex communication needs by using a variety of online databases as a search process. Keywords, synonyms, and subject headings relating to augmentative and alternative communication and disabilities were applied to these electronic databases (Education Research Complete, JSTOR, Education Research Complete, SAGE Journals, ProQuest Central, EBSCOhost, Academic Search Ultimate, PsycINFO, and ERIC). Different key words search terms was used for this study which were:

- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”

OR “Aided Interventions” AND “Communication Impairment”.

- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”  
OR “Aided Interventions” AND “Disabled Children”.
- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”  
OR “Aided Interventions” AND “Behavioral Outcomes”.
- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”  
OR “Aided Interventions” AND “Psychological Outcomes-  
Independence”.
- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”  
OR “Aided Interventions” AND “Social Communication”.
- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”  
OR “Aided Interventions” AND “Academic Literacy Skills”.
- “Augmentative and Alternative Communication” OR  
“Augmentative Communication” OR “Alternative Communication”  
OR “Aided Interventions” AND “Communication Competence”.

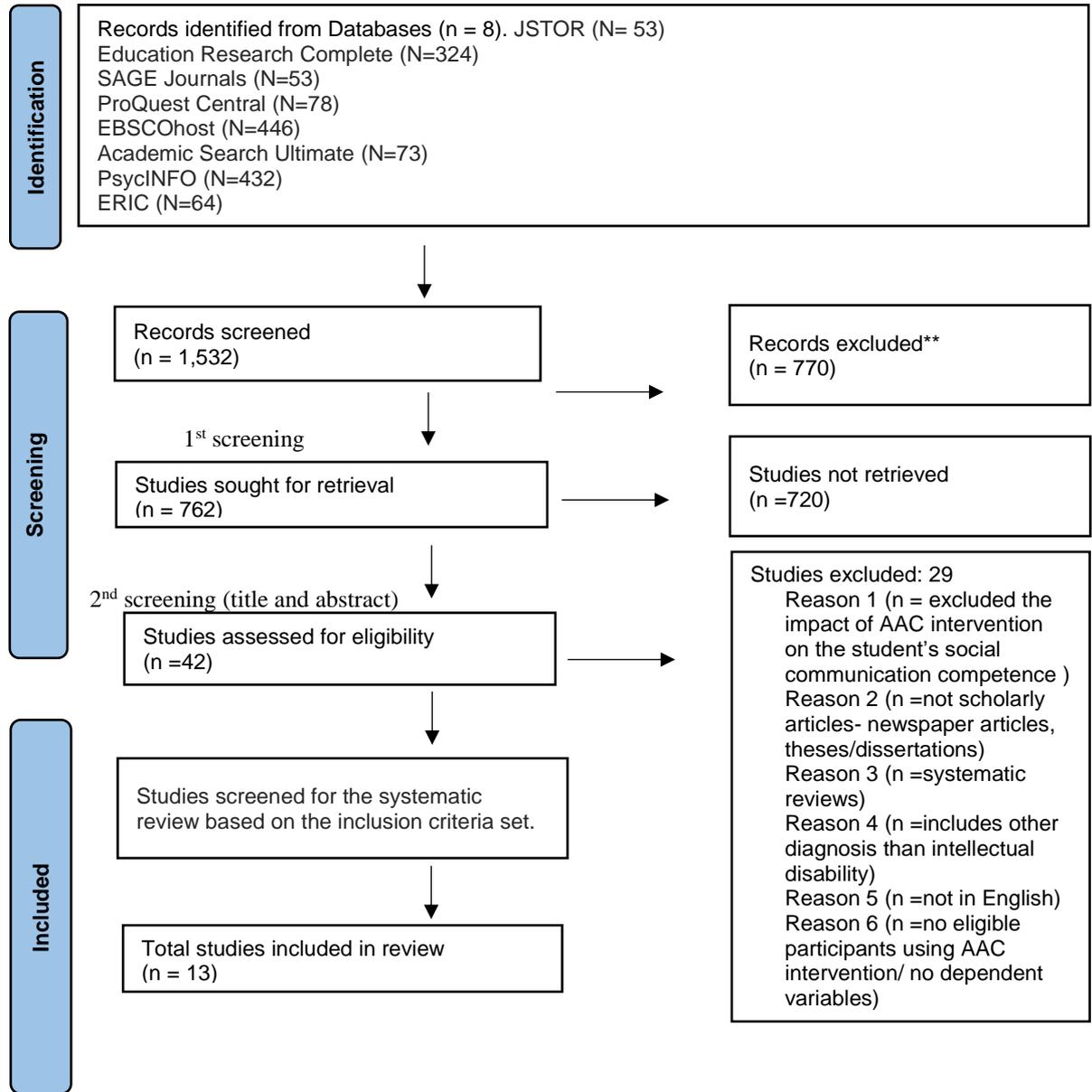
Initially, the terms “AAC” and “Disabilities” was mainly used the most, but if these terms did not elicit enough articles to warrant a review, more keywords were also been used for the search, and more databases was looked at to ensure enough relevant articles

on the effectiveness of AAC interventions on the students' social and communication competency skills. Also, the articles found were submitted to the Mendeley website, a bibliographic reference manager, and duplicates were removed.

For relevance to the current review, the search strategy followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and adhered to PRISMA guidelines/methodology which is an evidence-based minimum set of items to search, identify, select, screen, synthesize the abstracts and full-text peer-reviewed articles for reporting in systematic reviews (Moher et al., 2009). In addition, PRISMA is an international initiative developed by relevant experts to address the ongoing issue of a lack of well documented and transparent review methods reported in published review papers (Page et al., 2021) With this flow diagram (see **table 3.1**) as shown below, PRISMA items serve as a guide to determine if each document meets the inclusion criteria set. Also, the below diagram depicts the flow of information through the different phases of a systematic review. It maps out the number of records identified, included and excluded, and the reasons for exclusions (Page et al., 2021). Education Research Complete, JSTOR, Education Research Complete, SAGE Journals, ProQuest Central, EBSCOhost, Academic Search Ultimate, PsycINFO, and ERIC database searches resulted in 1,532 articles. After filtering articles by reading titles and abstracts, we selected 42 articles for full-text reading. Of these, 13 articles fulfilled the inclusion criteria for this review.

Table 1

*PRISMA Flow Diagram of Systematic Review Query*



## Data Extraction

Systematic reviews require investigators to identify studies of sufficient quality to include in the analysis for minimizing subjectivity and maximizing transparency and reliability (Borenstein et al., 2009). This is because of the variability in the quality of included studies and diversity in samples and methods which may account for as much variability in the results of a systematic review as intervention characteristics. Thus, study quality assessment will be used in this systematic review to examine the variation in the quality of included studies (Wilson & Lipsey, 2001). As such, a criterion was set to consider the studies of this review based on the guidelines of Cochrane Handbook for Systematic Reviews of Interventions (Cochrane Collaboration, 2008).

- Types of Studies: All studies that compared two or more groups (i.e., intervention A vs. intervention B, or intervention vs. no intervention) was included in this systematic review. This includes randomized controlled trials, experimental designs, and pre-post intervention studies (including single case studies or group design research methodologies)
- Types of Participants: School-aged children at the elementary and the intermediate level diagnosed with disability co-occurred with complex communication needs (e.g., autism, intellectual disability, cerebral palsy, down syndrome), regardless of gender, race/ethnicity, and socioeconomic status. The study must describe the student's disability along with his/her specific risk status (e.g., specific learning disability, language disorder, communication impairment, autism spectrum disorder, behavior problem, at risk of academic failure).
- Type of the Intervention: The studies need to describe the role of a specific intervention agent (e.g., technological device/computer "Augmentative &

Alternative Communication”) and, as relevant to the review, background variables (e.g., race/ethnicity, educational background/licensure). Also, the studies need to describe the implementation of the communication intervention experimental group considering the monitored control group. So, studies need to provide sufficient information regarding the critical features of the practice (intervention), such that the practice is clearly understood and can be reasonably replicated by describing its components, procedures, and effectiveness. As for the follow-up period after implementing the intervention, studies need to show the comparisons made between the groups on outcome variables (e.g., social, behavioral, psychological, and/or academic).

- Types of Outcome Measures: Outcome measures of the studies need to be applied appropriately to gauge the effect of the communication intervention practice on study outcomes “effectiveness of AAC interventions on the students’ academic, behavioral, social, psychological outcome measures”. Outcome measures should be socially important (e.g., they constitute or are theoretically or empirically linked to improved quality of life and social communication competence skills).

Data from the included studies was extracted using Microsoft Excel 2010. This included fields to be completed by a reviewer in the following order: (1) study identification (main author’s name, year, and country), (2) study method (type of study, blinding, and secret allocation), (3) target population aspects (age, sex, and type of disability), (4) aspects of the intervention performed (sample size, presence of supervision, instrument used, frequency, session length, and follow-up), (5) studied outcomes, and (6) presented results.

## **Data Analysis- Assessment of Study Quality**

To assess the quality of the included studies for the systematic review, we utilized the standards developed by the Council for Exceptional Children (CEC) to evaluate indicators of quality research studies (Cook et al., 2014). The Council for Exceptional Children is an international community of professionals who are the voice and vision of special education. CEC's mission is to improve, through excellence and advocacy, the education and quality of life for children and youth with exceptionalities and to enhance engagement of their families (Gersten et al., 2005).

The quality indicators were originally developed by group of education scholars with expertise across disability and research design (Cook et al., 2014). In addition, quality indicators have been field-tested and demonstrated adequate inter-rater reliability, they collectively consider findings from group comparison and single-subject studies when classifying the evidence base of practices, and they can be applied independently by special education researchers to identify evidence-based practices. The CEC tool evaluates research at the article (manuscript) level—for example, an article including three A-B-A-B designs is evaluated as a single unit. The presence of at least three demonstrations of effect is assessed, but it is not used as a gating criterion (i.e., all studies are evaluated for all indicators). Eight general indicators are evaluated as present or absent (yes/no): context and setting, participants, intervention agent, practice description, implementation fidelity, internal validity, outcome measures/dependent variables, and data analysis (Gersten et al., 2005).

In this systematic review, the quality indicators were presented and used for categorizing the evidence based of practices in the field of special education (Cook et al., 2014). Such quality indicators and criteria are used with studies that examine the

effect of practice or intervention and programs on the outcome (Cook et al., 2014). Thus, reviews should have clear indicators and studies should meet the indicators relevant to the research design. The studies were classified as being strong (all quality indicators were met), moderate (study meets all relevant quality indicators except those related to social validity, treatment fidelity, and effect size) or unacceptable methodological quality. The practices are classified as evidence-based, potentially evidence-based, mixed-effects, insufficient evidence or negative effects based on the number of single subjects, and group comparison studies of strong and moderate methodological quality with positive, neutral, and negative effects (Cook et al., 2014). To further elaborate, evidence-based practice must be supported by at least with two to four comparison studies, five single-subject studies, meet 50 % of criteria for two or more the study design described and one comparison study and three single-subject studies (Cook et al., 2014). For this item, CEC considers group experimental, non-randomly assigned group comparison, and single-subject design studies collectively (Cook et al., 2014).

The potentially evidence-based practices must be supported by one group comparison study with random assignment to groups and positive effects; two or three group comparison studies with nonrandomly assigned groups and positive effects; or two or four single-subject studies with positive effects. For this item, CEC considers group experimental, non-randomly assigned group comparison, and single-subject design studies collectively (Cook et al., 2014). Mixed evidence must meet criteria for evidence-based practice or potentially evidence-based practice and the ratio of studies with positive effects to studies with neutral /mixed-effects is less than 2:1 or one or

more studies with negative effects if these studies do not outweigh studies with positive effects (Cook et al., 2014).

Insufficient Evidence exists to meet the criteria for any of the other evidence-based (Cook et al., 2014). Practice with Negative Effects should include more than one study conducted with negative effects and the studies conducted with negative effects outweigh the studies with positive effects (Cook et al., 2014). Last but not least, the CEC standards include 28 quality indicators. From the total number of quality indicators, eighteen (18) of them apply to group comparison and single-subject studies, 6 apply only to comparison studies and 4 are specific to single-subject studies (Cook et al., 2014). In the following sections, we will provide a brief description of the set of quality indicators for each topic area: context and setting, participants, intervention agents, description of practice, implementation fidelity, internal validity, outcome measures/dependent variables, data analysis, and social validity (Cook et al., 2014). Studies received a score of 0, 1, or partial credit if some of the indicator components are met but not all (Royer et al. 2017).

Finally, the study should provide sufficient information regarding the critical features of the context and setting (the type of school—public, private, charter, pre-school), type of program or classroom, geographic location, community setting). In order to understand the population that will benefit from the intervention, it is important to describe clearly the participants' demographics (age, gender, ethnicity, socioeconomic status, language status) and define clearly the difficulty of focus, disability, or risk status of the participants—disability, autism spectrum disorder—and criteria for determining the disability or the difficulty (Gersten et al., 2005). Researchers also need to clearly examine the role of the intervention agent (teacher, researcher,

professional) and background variables (race, ethnicity, educational background, license).

The study should also describe detailed intervention procedures (description of practice) which includes the intervention components, instructional behaviors, critical or active elements, manualized or scripted procedures, dosage and intervention agents' actions (e.g., prompts, verbalizations, physical behaviors, proximity), or cites one or more accessible sources that provide this information (Gersten et al., 2005). The practice also needs to be implemented with fidelity by using direct reliable measures (e.g., checklist, observations, self-report of the duration and or frequency) before, during, and after intervention (Cook et al., 2014). With respect to internal validity, the study should describe the baseline and provide a clear description of the assignment to groups (which involves participants (or classrooms, schools, or other unit of analysis). Researchers should include detailed information on the comparison/control group and how participants are assigned to insure the comparison conditions are meaningful. The researcher also considers the outcome as an indicator by examining how the study clearly defines and describes the measurement of variables and how the effects are reported on all measures of the outcome (Cook et al., 2014). Outcomes are socially important (e.g., they constitute or are theoretically or empirically linked to improved quality of life, an important developmental/learning outcome, or both). Additionally, the researcher examines the appropriateness of frequency and timing of outcome measures. It is crucial to measure outcomes appropriately to ensure the validity of outcomes and make sure that the independent variable affected the dependent variable (outcome). The last indicator used includes data analysis and how a study reports information on effect size statistic. The data analysis should be conducted appropriately by examining the

data analysis techniques and by providing effect size calculations to determine the amount of the effect of an intervention on the participants or the group (Gersten et al., 2005).

Table 2

*Quality Indicators for Group Comparison and Single-Subject Studies.*

| Quality indicator   | Research design(s) |
|---|--------------------|
| <b>1.0. Context and setting.</b> The study provides sufficient information regarding the critical features of the context or setting.   |                    |
| <b>1.1.</b> The study describes critical features of the context or setting relevant to the review; for example, type of program or classroom, type of school (e.g., public, private, charter, preschool), curriculum, geographic location, community setting, socioeconomic status, and physical layout.   | Both               |
| <b>2.0. Participants.</b> The study provides sufficient information to identify the population of participants to which results may be generalized and to determine or confirm whether the participants demonstrated the disability or difficulty of focus.   |                    |
| <b>2.1.</b> The study describes participant demographics relevant to the review (e.g., gender, age/grade, race/ethnicity, socioeconomic status, language status).   | Both               |
| <b>2.2.</b> The study describes disability or risk status of the participants (e.g., specific learning disability, autism spectrum disorder, behavior problem, at risk of reading failure) and method for determining status (e.g., identified by school using state Individuals With Disabilities Education Improvement Act [IDEA] criteria, teacher nomination, standardized intelligence test, curriculum-based measurement probes, rating scale). | Both               |
| <b>3.0. Intervention agent.</b> The study provides sufficient information regarding the critical features of the intervention agent.  |                    |
| <b>3.1.</b> The study describes the role of the intervention agent (e.g., teacher, researcher, paraprofessional, parent, volunteer, peer tutor, sibling, technological device/computer) and, as relevant to the review, background variables (e.g., race/ethnicity, educational background/licensure).  | Both               |
| <b>3.2.</b> The study describes any specific training (e.g., amount of training, training to a criterion) or qualifications (e.g., professional credential) required to implement the intervention, and indicates that the interventionist has achieved them.   | Both               |
| <b>4.0. Description of practice.</b> The study provides sufficient information regarding the critical features of the practice (intervention), such that the practice is clearly understood and can be reasonably replicated.   |                    |
| <b>4.1.</b> The study describes detailed intervention procedures (e.g., intervention components, instructional behaviors, critical or active elements, manualized or scripted procedures, dosage) and intervention agents' actions (e.g., prompts, verbalizations, physical behaviors, proximity), or cites one or more accessible sources that provide this information.   | Both               |
| <b>4.2.</b> When relevant, the study describes materials (e.g., manipulatives, worksheets, timers, cues, toys), or cites one or more accessible sources providing this information.   | Both               |
| <b>5.0. Implementation fidelity.</b> The practice is implemented with fidelity.   |                    |

|  |                    |
|--|--------------------|
| 5.1. The study assesses and reports implementation fidelity related to adherence using direct, reliable measures (e.g., observations using a checklist of critical elements of the practice).  | Both               |
| Quality Indicator  | Research design(s) |
| 5.2. The study assesses and reports implementation fidelity related to dosage or exposure using direct, reliable measures (e.g., observations or self-report of the duration, frequency, curriculum coverage of implementation).   | Both               |
| 5.3. As appropriate, the study assesses and reports implementation fidelity (a) regularly throughout implementation of the intervention (e.g., beginning, middle, end of the intervention period), and (b) for each interventionist, each setting, and each participant or other unit of analysis. If either adherence or dosage is assessed and reported, this item applies to the type of fidelity assessed. If neither adherence nor dosage is assessed and reported, this item is not applicable.  | Both               |
| <b>6.0. Internal validity.</b> The independent variable is under the control of experimenter. The study describes the services provided in control and comparison conditions and phases. The research design provides sufficient evidence that the independent variable causes change in the dependent variable or variables. Participants stayed with the study, so attrition is not a significant threat to internal validity.   |                    |
| 6.1. The researcher controls and systematically manipulates the independent variable.  | Both               |
| 6.2. The study describes baseline (single-subject studies) or control/comparison (group comparison studies) conditions, such as the curriculum, instruction, and interventions (e.g., definition, duration, length, frequency, learner: instructor ratio).   | Both               |
| 6.3. Control/comparison-condition or baseline-condition participants have no or extremely limited access to the treatment intervention.  | Both               |
| 6.4. The study clearly describes assignment to groups, which involves participants (or classrooms, schools, or other unit of analysis) being assigned to groups in one of the following ways:<br>a) randomly;<br>b) non-randomly, but the comparison groups are matched very closely to the intervention group (e.g., matched on prior test scores, demographics, a propensity score; see Song & Herman, 2010);<br>c) non-randomly, but techniques are used to measure differences and, if meaningful differences are identified—for example, statistically significant difference, difference greater than 5% of a standard deviation (What Works Clearinghouse [WWC], 2011)—to statistically control for any differences between groups on relevant pretest scores or demographic characteristics (e.g., statistically adjust for confounding variable through techniques such as ANCOVA or propensity score analysis); or<br>d) non-randomly on the basis of a reasonable cutoff point (regression discontinuity design | Group comparison   |
| 6.5. The design provides at least three demonstrations of experimental effects at three different times.   | Single-subject     |
| 6.6. For single-subject research designs with a baseline phase (alternating treatment designs do not require a baseline), all baseline phases include at least three data points (except when fewer are justified by study author due to reasons such as measuring severe or dangerous problem behaviors and zero baseline behaviors with no likelihood of improvement without intervention) and establish a pattern that predicts undesirable future performance (e.g., increasing trend in problem behavior, consistently infrequent exhibition of appropriate behavior, highly variable behavior)   | Single-subject     |
| Quality Indicator  | Research design(s) |
| 6.7. Overall attrition is low across groups (e.g., < 30% in a 1-year study).   | Group comparison   |
| 6.8. Differential attrition (between groups) is low (e.g., ≤10%) or is controlled for by adjusting for non-completers (e.g., conducting intent-to-treat analysis)  | Group comparison   |

|  |                  |
|--|------------------|
| <b>7.0. Outcome measures/dependent variables.</b> Outcome measures are applied appropriately to gauge the effect of the practice on study outcomes. Outcome measures demonstrate adequate psychometrics.   |                  |
| <b>7.1.</b> Outcomes are socially important (e.g., they constitute or are theoretically or empirically linked to improved quality of life, an important developmental/learning outcome, or both).  | Both             |
| <b>7.2.</b> The study clearly defines and describes measurement of the dependent variables.  | Both             |
| <b>7.3.</b> The study reports the effects of the intervention on all measures of the outcome targeted by the review (p levels and effect sizes [ES] or data from which ESs can be calculated for group comparison studies; graphed data for single-subject studies), not just those for which a positive effect is found. Both   | Both             |
| <b>7.4.</b> Frequency and timing of outcome measures are appropriate. For most single-subject studies, a minimum of three data points per phase is necessary if a given phase is to be considered as part of a possible demonstration of experimental effect (except when fewer are justified by study author due to reasons such as measuring severe or dangerous problem behaviors and zero baseline behaviors with no likelihood of improvement without intervention). For alternating treatment designs, at least four repetitions of the alternating sequence are required (e.g., ABABABAB; see Kratochwill et al., 2013).                            | Both             |
| <b>7.5.</b> The study provides evidence of adequate internal reliability, inter-observer reliability, test-retest reliability, or parallel form reliability, as relevant (e.g., score reliability coefficient $\geq .80$ , inter-observer agreement $\geq 80\%$ , $\kappa \geq 60\%$ ).  | Both             |
| <b>7.6.</b> The study provides adequate evidence of validity, such as content, construct, criterion (concurrent or predictive), or social validity   | Group comparison |
| <b>8.0. Data Analysis.</b> Data analysis is conducted appropriately. The study reports information on ES.  |                  |
| <b>8.1.</b> Data analysis techniques are appropriate for comparing change in performance of two or more groups (e.g., t tests, ANOVAs/MANOVAs, ANCOVAs/MANCOVAs, hierarchical linear modeling, structural equation modeling). If atypical procedures are used, the study provides a rationale justifying the data analysis techniques.   | Group comparison |
| <b>8.2.</b> The study provides a single-subject graph clearly representing outcome data across all study phases for each unit of analysis (e.g., individual, classroom, other group of individuals) to enable determination of the effects of the practice. Regardless of whether the study report includes visual or other analyses of data, graphs depicting all relevant dependent variables targeted by the review should be clear enough for reviewers to draw basic conclusions about experimental control using traditional visual analysis techniques (i.e., analysis of mean, level, trend, overlap, consistency of data patterns across phases). | Single-subject   |
| <b>8.3.</b> The study reports one or more appropriate effect-size statistic (e.g., Cohen's d, Hedge's G, Glass's $\Delta$ , $\eta^2$ ) for all outcomes relevant to the review being conducted, even if the outcome is not statistically significant, or provides data from which appropriate ESs can be calculated.   | Group comparison |

(Cook et al., 2015, p. 5-6)

## CHAPTER 4

### FINDINGS

Considering that most children with disabilities and complex communication needs encounter various problem in social communication (e.g., expressing their needs, conveying basic wants, and express their feelings, desires, preferences), this systematic review study represents the analysis and evaluation of thirteen studies that show effectiveness of AAC interventions on the child's communication competence (from 2008-2021). The below content-coding **table 4.1** is divided into 8 areas presenting the quality indicators: (a) context and setting; (b) participants; (c) intervention agent; (d) description of practice; (e) implementation fidelity; (f) internal validity; (g) outcome measures/independent variable; and (h) data analysis. Percentages determining quality indicators met were calculated after coding the elements across the studies.

After reading the article and identifying the elements in each article, we coded the element as 1 if there is sufficient information regarding the indicator element and 0 if there is insufficient information for the indicator element by referring to the coding sheet based on the CEC (2014). So, the quality indicator for each element was calculated individually as well to determine the percentage % met for each indicator across each study. Subsequently, to ensure reliability of the coding, the included 13 studies were reviewed and coded independently by two reviewers to confirm the identified results and the information provided in the below table based on each CEC indicator.

## Study Selection Results

Across the initial search, a total of 1,532 publications were identified for screening from the included databases. By excluding 770 repeated titles, 762 articles were kept for further screening. Only forty-two studies met the first stage inclusion criteria after just reviewing the title and abstract. Then, a second screening was done for the studies based on the inclusion criteria set and 29 studies were excluded from the review based on (a) experimental design (included pre- and post-tests, reviews, (b) participant diagnoses (all or more than half needed to meet participant inclusion criteria), and (c) dependent variables (speech variables were not graphed or measured), (d) not scholarly based articles, (e) and the impact of AAC intervention on communication competence. Therefore, a total of 13 intervention studies were ultimately included in the current review and were qualified for the data extraction. The quantitative results are reported in **table 4.1** and explained below based on each CEC indicator with each indicator holdings equal weight (Cook et al., 2014). Table 4.2 presents the selected studies, based on the inclusion criteria, as a summary result for the participant characteristics (age/disability), goals of the AAC intervention, outcome of the implemented intervention and its impact on the students' communication competence.

Table 3

*Methodological Rigor by Quality Indicator*

| <b>Quality Indicator</b>                         | <b>Ahlgrim-<br/>Delzell et al.<br/>(2014)</b> | <b>Biggs<br/>et al.<br/>(2018)</b> | <b>Binger<br/>et al.<br/>(2011)</b> | <b>Bishop<br/>et al.<br/>(2020)</b> | <b>Carnett &amp;<br/>Ingvarsson<br/>(2016)</b> | <b>Chavers<br/>et al.<br/>(2021)</b> | <b>Franco<br/>(2009)</b> | <b>Holyfield<br/>(2021)</b> | <b>Kent-<br/>Walsh<br/>(2015)</b> | <b>Muhrarib<br/>et al.<br/>(2019)</b> | <b>Soto et<br/>al.<br/>(2008)</b> | <b>Sreeku<br/>mar et<br/>al.<br/>(2020)</b> | <b>Wu et<br/>al.<br/>(2020)</b> | <b>Quality<br/>indicator<br/>Met %</b> |
|--|---|------------------------------------|-------------------------------------|-------------------------------------|--|--------------------------------------|--------------------------|-----------------------------|-----------------------------------|---------------------------------------|-----------------------------------|---|---------------------------------|--|
| <b>Context and Setting</b>                       | 1/1   | 1/1                                | 1/1                                 | 1/1                                 | 1/1  | 1/1                                  | 1/1                      | 1/1                         | 1/1                               | 1/1                                   | 1/1                               | 1/1   | 1/1                             | <b>100%</b>                            |
| <b>Participants</b>                              | 2/2   | 2/2                                | 2/2                                 | 2/2                                 | 2/2  | 2/2                                  | 2/2                      | 2/2                         | 2/2                               | 2/2                                   | 2/2                               | 2/2   | 2/2                             | <b>100%</b>                            |
| <b>Intervention Agent</b>                        | 2/2   | 1/2                                | 2/2                                 | 2/2                                 | 2/2  | 2/2                                  | 2/2                      | 2/2                         | 2/2                               | 2/2                                   | 2/2                               | 2/2   | 2/2                             | <b>92%</b>                             |
| <b>Description of<br/>practice</b>               | 2/2   | 2/2                                | 2/2                                 | 2/2                                 | 2/2  | 2/2                                  | 2/2                      | 2/2                         | 2/2                               | 2/2                                   | 2/2                               | 2/2   | 2/2                             | <b>100%</b>                            |
| <b>Implementation<br/>fidelity</b>               | 3/3   | 3/3                                | 3/3                                 | 3/3                                 | 3/3  | 3/3                                  | 3/3                      | 3/3                         | 3/3                               | 3/3                                   | 3/3                               | 0/3   | 3/3                             | <b>92%</b>                             |
| <b>Internal validity</b>                         | 6/6   | 6/6                                | 6/6                                 | 6/6                                 | 6/6  | 3/6                                  | 6/6                      | 6/6                         | 6/6                               | 6/6                                   | 6/6                               | 2/6   | 6/6                             | <b>93 %</b>                            |
| <b>Outcome measures/<br/>dependent variables</b> | 5/5   | 4/5                                | 5/5                                 | 5/5                                 | 4/5  | 3/5                                  | 4/5                      | 4/5                         | 4/5                               | 5/5                                   | 5/5                               | 3/5   | 5/5                             | <b>86%</b>                             |
| <b>Data analysis</b>                             | 1/1   | 1/1                                | 1/1                                 | 1/1                                 | 1/1  | 1/1                                  | 1/1                      | 1/1                         | 1/1                               | 1/1                                   | 1/1                               | 1/1   | 1/1                             | <b>100%</b>                            |
| <b>Quality indicators<br/>met %</b>              | 100%  | 90%                                | 100%                                | 100%                                | 95%  | 77%                                  | 95%                      | 95%                         | 95%                               | 100%                                  | 100%                              | 68%   | 100%                            |  |
| <b>Design of the study</b>                       | S   | S                                  | S                                   | S                                   | S  | S                                    | S                        | S                           | S                                 | S                                     | S                                 | S   | S                               |  |

*Summary of the Identified Articles*

| <b>Journal Article</b>   | <b>Author(s)</b>           | <b>Participants (Age/Disability)</b>  | <b>Goals of the AAC Intervention</b>   | <b>Outcome of the Implemented Intervention</b>   | <b>Impact on Domain</b> |
|--|----------------------------|---|--|--|-------------------------|
| Effects of Systematic Instruction and an Augmentative Communication Device on Phonics Skills for Students with Moderate Intellectual Disability Who Are Nonverbal. | Ahlgrim-Delzell al. (2014) | 3 participants<br>(3 boys, 7—10 years old)<br>2 Autism<br>1 Intellectual Disability         | Teach students to identify letter sounds, segment and blend CVC words, sight words, read connected text, and answer comprehension questions related to the stories using GoTalk 32 Express on an AAC device. | Using the AAC device, students produced target phonemes and words, as well as blended phonemes to form words and were able to blend CVC & non-CVC words. | Academics               |
| Enhancing Peer Network Interventions for Students with Complex Communication Needs.  | Biggs et al. (2018)        | 3 participants<br>(2 girls, 1 boy, 9-10 years old)<br>3 Autism<br>1 Intellectual Disability | Participants & peers used AAC devices to communicate & interact during peer network sessions.  | The AAC device enhanced the role of peers as communicative partners and it increase the student interaction and symbolic communication with peers.       | Social                  |
| Using Aided AAC Models, Recasts, and Contrastive Targets to  | Binger et al. (2011)       | 3 participants<br>(1 girl, 2boys—6, 9, and 11 years old)                                    | Three children used aided AAC recasting intentions of target   | The aided AAC models helped children acquire and increase the production of grammatical  | Academics               |

|   |                             |  |  |   |        |
|---|-----------------------------|--|--|---|--------|
| Teach Grammatical Morphemes to Children Who Use AAC.  |                             | 2 Cerebral Palsy and 1 Childhood Apraxia of Speech.    | grammatical morphologic structure.   | morphemes/morphology forms (e.g., Aux+ main, past tense –ed vs. possessive ’s)  |        |
| Further Investigation of Increasing Vocalizations of Children with Autism with a Speech-Generating Device                     | Bishop et al. (2019)        | 3 participants (3 boys, 5-10 years) Autism             | Use of speech generated devices (AAC) to produce increase vocal speech between three young children with autism.   | SGD-based interventions (AAC models) led to increase vocal output for children with ASD and increase independent vocal requests for all three participants.   | Social |
| Teaching a Child with Autism to Mand for Answers to Questions Using a Speech-Generating Device                                | Carnett & Ingvarsson (2016) | 1 participant (boy—11 years old) Autism                | Use of Speech Generated Devices (AAC) to communicate and mand for answers to unknown questions.  | The AAC interventions led to the acquisition of new intraverbals (i.e., answers to questions) and increase vocal responses by the participant.  | Social |
| Effects of a Systematic Augmentative and Alternative Communication Intervention Using a Speech-Generating Device on Multistep | Chavers et al. (2021)       | 5 participants (2 girls, 3 boys—7-13 years old) Autism | Use of AAC intervention (speech-generating device) to teach students “multistep requests” and generic small talk, using visual and verbal cues, to facilitate social communication interactions. | All participants acquired the ability to use an SGD to make multistep requests such as asking for their preferred snacks or activities they want to be engaged. With the use of AAC intervention, students were engaged in social interactions using symbol identification and iconicity. | Social |

Requesting and  
Generic Small Talk  
for Children with  
Severe Autism  
Spectrum Disorder

|  |                             |   |  |   |           |
|--|-----------------------------|---|--|---|-----------|
| Functional Analysis<br>and Treatment of<br>Inappropriate<br>Vocalizations Using a<br>Speech-Generating<br>Device for a Child<br>With Autism  | Franco et al.<br>2009       | 1 participant (boy—7<br>years old)<br>Autism            | Use of AAC intervention<br>(speech generating device) to<br>reduce inappropriate<br>vocalizations and behaviors<br>which limited the student’s<br>ability to produce intelligible<br>speech.   | Challenging behaviours (e.g., escaping from<br>activities and being off-task) were reduced by<br>using SGD devices to request attention and break<br>from the task.   | Behaviour |
| Comparative Effects<br>of Picture Symbol<br>With Paired Text and<br>Text-Only<br>Augmentative and<br>Alternative<br>Communication<br>Representations on<br>Communication From<br>Children With Autism<br>Spectrum Disorder | Holyfield<br>(2021)         | 4 participants (4<br>boys, 9—11 years<br>old)<br>Autism | Use of AAC technology and<br>instruction to enhance social<br>communication by using high<br>imageability words “nouns”<br>from objects, nonidentical<br>objects, miniature objects, color<br>photos, written words, and<br>multiple picture symbol types. | In response to AAC intervention, all participants<br>demonstrated increase in effective<br>communication behaviours using “nouns”<br>specifically from picture symbols with paired<br>texts during book reading activities. | Academics |
| Teaching Children<br>Who Use   | Kent-Walsh<br>et al. (2015) | 3 participants (1 girl,<br>2boys, 5—6 years<br>old)     | Use of aided Models (AAC<br>intervention) to produce novel<br>sentences (using correct order of<br>words) and yes/no questions.  | All 3 participants showed a direct treatment<br>effect, producing a greater number of inverted  | Social    |

|  |                         |  |  |   |               |
|--|-------------------------|--|--|---|---------------|
| Augmentative and Alternative Communication to Ask Inverted Yes/No Questions Using Aided Modeling   |                         | 2 Childhood Apraxia of Speech<br>1 Down Syndrome         |  | yes/no questions and sentences after the implementation of AAC intervention.  |               |
| Effects of Functional Communication Training Using GoTalk Now™ iPad® Application on Challenging Behavior of Children with Autism Spectrum Disorder | Muhraib et al. (2019)   | 2 participants (1 girl, 1 boy, 5—6 years old)<br>Autism) | Use of GoTalk Now™ AAC application on an iPad® for children with challenging behaviors and no functional speech to communicate using picture cards and signs as a way to express their needs and wants.                      | The iPad-based SGD (AAC intervention) reduced/ mitigated the children’s challenging behaviours as they were taught to access symbol icons to express their needs, feelings, and wants, etc... through different pictures and signs. | Behavior      |
| Effectiveness of Multifaceted Narrative Intervention on the Stories Told by a 12-Year-Old Girl who uses AAC  | Soto et al. (2008)      | 1 participant (1 girl, 12 years old)<br>Cerebral Palsy   | Use of AAC device to increase the numbers of different words, clauses, and story elements used by the child  | The participant’s use of different words, clauses, and story elements increased during the creation of both personal and fictional narratives.  | Academics     |
| Advancement to Higher Communicative Functions with Transition to iPad App  | Sreekumar et al. (2020) | 1 participant (1 girl, 7 years old)<br>Cerebral Palsy    | Use of high voice quality synthesis and picture symbols (part of AAC) to enable the girl in expressing herself and creating her own messages and using the speech synthesizer to speak the intended message; all of which to | The use of AAC iPad app had a significant benefit in improving the girl’s confidence, motivation, independence of daily living by building effective communication skills.  | Psychological |

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enhance her confidence,  
motivation, and independence.

|   |                  |  |   |  |        |
|---|------------------|--|---|--|--------|
| Effects of Peer-Mediated Instruction With AAC on Science Learning and Communitive Responses of Students With Significant Cognitive Disabilities in Taiwan | Wu et al. (2020) | 3 participants (1 girl, 2 boys<br>8—9 years )<br>Intellectual Disability | Use of AAC device with peer instruction to increased the communicative interactions between peers and students with intellectual disabilities and autism. | The iPad-SGD intervention (AAC) was effective in improving participants' targeted science knowledge through peer instruction. Also, participants increased their communicative interactions with peers and increased the use of different communication modes during the science experiment activities | Social |
|---|------------------|--|---|--|--------|

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## **Context and Setting**

Describing the context and setting of studies is primarily important for evidence-based reviews to determine whether a study falls within the parameters of the review. According to the CEC standards, the articles must provide adequate information regarding context and setting (Cook et al, 2014). The authors need to describe the relevant setting and context in a clear and detailed manner such as mentioning the type of school, curriculum, geographic location, and community setting (Cook et al., 2014). The interventions were conducted in a variety of settings. Of the 13 studies, 10 studies (76%) were conducted in school settings and the other studies were implemented either in clinical settings or home. For the school-related settings, three studies (23%) were conducted in special education classrooms (Binger et al. 2011; Carnett & Ingvarsson, 2016; Holyfield, 2021), four studies (30%) were conducted in general education classrooms (Ahlgrim- Delzell et al., 2014; Biggs et al., 2018; Bishop et al., 2019; Soto et al., 2008), one study (8%) was conducted in special education and general education classrooms (Muhraib et al., 2019), two studies (15%) were conducted in an empty classrooms or observation rooms (Franco et al., 2009; Wu et al., 2020), two other studies (15%) were conducted in a clinical room (Kent-Walsh et al. , 2015; Sreekumar et al. (2020), and another study (8%) delivered intervention procedures in at home, school, and ABA clinical settings (Chavers et al., 2021).

Considering the above, findings show that all studies met the criteria regarding describing the context and the setting explicitly with a percentage accuracy of 100%. However, one study conducted by Franco et al. (2009), described the geographical location in a detailed and clear way to describe how participants are allocated to the area covered by resettlement services. For example, according to Franco et al. (2009), the specific locations for instruction within the school included the classroom, playground, and gymnasium.

Functional analysis and initial SGD training took place in the classroom setting in the participant's "work space" area, containing a child-sized desk. The area was separated from the rest of the room with partitions. Following training and analysis of SGD use across target functions, the participant was given access to the device in two generalization settings, the playground and the gymnasium. The playground was a large, fenced-in outdoor area containing a playscape, swings, hanging bars, and picnic tables. The gymnasium was a large indoor room with designated space for swings, crash mats, a trampoline, a trapeze, and a track for tricycles and scooter boards.

As for time, the individual instructional sessions lasted between 10 min and 50 min, with a number of studies (n=11) reporting individual instructional times of 25 min or less. Instruction was delivered between one and five times each week. The total amount of instruction provided to a participant ranged from 30 min to 2 h. Most studies (n=12) reported total instruction time to be 2 hours or less, but one study reported total instruction time to be more around 3 hours (Franco et al., 2009). All studies included information regarding the frequency of intervention sessions and the rate of aided AAC input during intervention sessions.

## **Participants**

### ***Age, Gender, and Disability***

Each of the 13 studies included in this review reported the age, diagnosis (from psychoeducational assessment report), and gender of the participants. All the elements regarding participants' criteria were met by providing sufficient information on participants' demographics. Although the number of participants included in each study varied from one participant to five participants, the majority of studies (n=11) included either one or three participants and (n=2) included 4 or 5 participants. Across the 13 studies, a total of 33

participants were involved who range in age from 5 years to 13 years and all were reported as having significant support needs. Of these participants, 70% (n=23) were boys, and 30% (n=10) were girls, who received to use Augmentative and Alternative Communication “AAC” intervention. In terms of diagnosis, more than half of the participants were classified with Autism Spectrum Disorder (ASD) 63% (n=21), and the remaining participants were 12% (n=4) with Intellectual Disability, 12% (n=4) as having Cerebral Palsy (CP), 9% (n=3) as having Childhood Apraxia of Speech, and 3% (n=1) as having Down Syndrome (DS).

### ***Communication Modes***

Studies reported that the participants communicated using a variety of modalities prior to intervention, but most (n=29) were reported to communicate using a variety of different communication modalities (e.g., non-symbolic communication such as vocalizations, limited repertoire of intelligible words, gestures, imitation of expressive communication, sign language, speech generating device, picture communication board) to request attention, show affection, and direct attention. Other participants (n=3) were reported to primarily communicate using a picture communication symbol which doesn't include audio or any aids of voice output or handwriting where they write a word or a phrase to request for items (Carnett & Ingvarsson, 2016). One participant primarily communicated verbally using 10 one-syllable words only (e.g., snack, no, go, in, out, up, etc...) (Muharib et al., 2019). Having said the above, none of the participants have any experience or history of using an augmentative and alternative communication tool or speech-generating device for communication purposes.

Participant descriptions suggest that the majority of participants demonstrated intentional communication behaviors. However, three participants with severe-profound autism reported to demonstrate a restricted repertoire of communication behaviors (e.g.,

eating inedible items), self-injurious behavior (e.g., biting their wrists), and escapism (running away, covering ears) when agitated, tired, or frustrated (Chavers et al., 2021).

Similarly, participants with autism and limited speech communicated primarily using idiosyncratic vocalizations and gestures (Holyfield, 2021). Such communication behaviors had suggested prelinguistic communication prior to the implementation of the AAC intervention.

Additionally, the majority of studies (n=10) reported the pre-baseline literacy and social skills of participants. A few participants were unresponsive during storybook reading (n=4 participants) or demonstrated limited to no basic print awareness (n = 3 participant). However, the majority of participants demonstrated basic literacy and social skills such as the ability to: (a) used line-drawn symbols to communicate with peers (n=4 participants), (b) mand for approximately 15 missing items (n=6 participants), (c) speak less than 10 functional words (n=4 participants), (d) identify five letters or sight words (n=3 participants), (e) listen to stories and answer basic comprehension questions (n=4 participants), (f) identify basic vocabulary (n=3 participants), (g) demonstrate letter sound correspondences (n=2 participants) (Ahlgrim- Delzell al., 2014; Biggs et al., 2018; Binger et al., 2011; Bishop et al. , 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Holyfield, 2021; Kent-Walsh et al., 2015; Soto et al., 2008; Wu et al. , 2020).

### **Research Designs**

All the reviewed studies utilized single-subject research designs. The majority (85%) of studies reported using multiple baseline design across participants research designs to evaluate the effectiveness of intervention on the communication competence of students. The most commonly utilized research design was the AB design baseline followed by treatment to increase methodological rigor when evaluating the effectiveness of the

intervention (n=10 studies) (Ahlgrim- Delzell et al., 2014; Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Holyfield, 2021; Kent-Walsh et al., 2015; Soto et al., 2008; Sreekumar et al., 2020; Wu et al. , 2020). This particular design was chosen because the intervention plan was expected to produce relatively permanent performance changes. For this reason, neither true withdrawal nor a reversal of treatment was considered practical or appropriate. Furthermore, other researchers used a multiple-probe-across-participants design with a baseline and two intervention phases (i.e., A-B-BC) to sequentially evaluate the effects of the peer network intervention (B) and an added aided AAC modeling component (BC) on students' overall interaction and non-prompted symbolic communication with peers (Binger et al., 2011).

Moreover, another study (n=1) utilized a variation of the multiple-baseline design as well but across two settings not participants (playground and gymnasium). Baseline, intervention, and follow-up sessions were conducted in each setting. For instance, the playground and gymnasium settings were chosen as targets on the basis of teacher reports that challenging behavior occurred most frequently in these settings (this was done to test the effectiveness of intervention on the participants' behavior in these settings). Instruction in social skills, self-help skills, and receptive identification of objects occurred in these environments. Therefore, in both settings, multiple functions were probable given the presence of demands and preferred activities (Franco et al., 2009). Additionally, another study implemented the reveal design to determine the effects of the intervention on the children's requesting and challenging behaviors using the AAC intervention (Muharib et al., 2019). For instance, in this study, both children began the first baseline phase at the same time. They remained in the first baseline phase until a stable baseline data path was achieved. Next, both children were introduced to the intervention on the same day. Children

were moved to Baseline 2 after achieving two criteria in intervention: (a) requiring no prompts to touch the corresponding icon on the iPad for three consecutive sessions and (b) achieving a data path that was different in level compared to the previous baseline phase. The same procedures were followed in the second baseline and second intervention phases. Considering the above designs, based on the data analysis of quality indicators, all single design studies (n=13) provided a graph to represent the outcome data across the phases of the study (Cook et al, 2014).

### **Intervention Agent and Description of Practice**

Based on the CEC standards, the role of the intervention agents or interventionists should be noted or can be reasonably inferred in the study (Cook et al., 2014). Eleven studies involving a practitioner delivering the intervention or strategies included varying detail about the training provided to the practitioner (Ahlgrim- Delzell et al., 2014; Binger et al., 2011; Bishop et al. , 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Franco et al., 2009; Holyfield, 2021; Kent-Walsh et al., 2015; Muharib et al., 2019; Soto et al., 2008; Wu et al. , 2020). The content of practitioner training focused on increasing the use of AAC through direct teaching, providing opportunities, and/or ensuring device accessibility. Common training elements included discussions and demonstrations of the intervention components or procedures, followed by practices (e.g., role play with practitioners and researchers) and corrective feedback. Therefore, the findings of this indicator show that almost all studies (n=11) 85% met the element for the intervention agent description or the criteria for the quality indicators' elements except for two studies (n=2) where the role of the interventionists wasn't explicitly mentioned clearly during the intervention procedure and method (Biggs et al. , 2018; Sreekumar et al., 2020). On other hand, a study done by Wu et al. (2020) described the role of the interventionist not only during the intervention process

but also at the beginning and end. For example, according to Wu et al. (2020), at the beginning of each instructional session, the interventionist showed some “buoyancy pictures” and asked questions to pique students’ interests. The interventionist then conducted a buoyancy demonstration to show something can float or sink in a small aquarium tank and explained the buoyancy concepts to students. After the demonstration, the interventionist gave the target participant and peers a buoyancy experiment task with 12 materials for them to complete the task independently. An iPad-SGD was available on the desk but no prompting of how to use the iPad-SGD was provided to the participants. The interventionists then asked the peers to use explicit instruction and aided language stimulation to teach the participant science concepts with use of iPad-SGD (using visual stimulus and audios). Then, the interventionists collected the target participant’s communication responses directed to peers during the experiment. While completing the experiment, students were asked to classify things by floating or non-floating properties and report their findings. The interventionist then explained the core concept (i.e., what is buoyancy, buoyancy application, or treasuring water resources) based on findings from the students’ experiment and summarized the key points through re-emphasizing, summarizing, answering questions, and at the end providing feedback for the participants (Wu et al., 2020).

Based on the CEC standards, in order to meet the standard related to the description of practice, two elements must be included in a study. First, authors need to provide detailed and sufficient information regarding the critical features of the practice (intervention), such that the practice is clearly understood and can be reasonably replicated. Also, authors need to describe the intervention procedures in terms of dosage and content. Secondly, authors need to describe materials (manipulatives, times, cues, or toys used) or access to the materials used

in the intervention (Cook et al, 2014). All studies (n=13) 100% provided details about the implemented AAC intervention along with the materials used such as Using a GoTalk 32 Express application, various speech-generated devices (SGD), LAMP Words for Life., communication matrix aided boards, etc... These apps were chosen due to their layout (i.e., grid displays) and visual cues. Also, the apps contained picture symbols that appeared to be designed with an effort for transparency through the use of color (Holyfield, 2021) and the use of literal, high iconicity depictions when possible (e.g., objects, places, and animals were represented with drawings of the referents). Based on the study results, Proloquo2Go served as the primary app in the four studies (n=4) (Ahlgrim- Delzell al., 2014; Biggs et al., 2018; Binger et al., 2011; Bishop et al., 2019). Based on the results, the apps also allowed for the creation of customized pages. Across apps, the default picture symbol representations for all high imageability words from the High Imageability Study used iconic picture drawings of the animal being represented (e.g., the picture symbol for duck on both apps was a color drawing of a duck) (Soto et al., 2008). Another study (n=1) used a specific AAC assessment tool during the intervention which is called “Test of Aided Communication Symbol Performance (TASP)” to establish a starting point for designing and selecting an appropriate AAC system and to establish intervention goals for symbolic and syntactic development (Sreekumar et al., 2020). Other intervention strategies, often used in conjunction with the aforementioned procedures, included computer assisted fast mapping vocabulary instruction, picture card prompts, story mapping, picture communication symbols, introduction of a package of AAC devices and accessories, using universal design principles to modify instructional procedures (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015).

## **Goals of the “Augmentative and Alternative Communication”- AAC Intervention**

Of the 13 selected studies, 6 studies (46%) targeted social communication skills to increase peer interaction of students, support their interactions with peers using symbolic aided communications, speech-generated devices, and other communication books with voice output, to mand answers for unknown questions, increase independent vocal requests, make multistep requests for preferred snacks or activities and engage in generic small talk, and vocalize/produce greater number of inverted yes/no questions (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015). Additionally, 4 studies (30%) targeted the use of augmented and alternative communication intervention (e.g., GoTalk 32 Express and picture symbols with paired texts) to enable participants to produce three phoneme blends and morphemes, identify letter sounds, nouns, segment and blend CVC words, sight words, read connected text, develop their narrative skills after reading a story. Hence, according to the results, four studies targeted single literacy skills (i.e., sight word vocabulary, participation during book reading, narrative skills) and aimed to increase the frequency, variety, or complexity of AAC messages during literacy activities (Ahlgrim- Delzell et al., 2014; Binger et al., 2021; Holyfield, 2021; Soto et al., 2008).

Based on the results, two studies (15%) from the selected 13 studies targeted the use of speech-generated devices (AAC) to reduce the child’s inappropriate vocalizations and challenging behaviors across all settings (e.g., escaping from demands, attention from others, or by sensory consequences, grabbing, protesting, and/or head banging) which were used as a form of expression communication (Franco et al., 2009; Muharib et al., 2019).

Based on the studies, the treatment of inappropriate vocalizations is often difficult because participants who engage in such behaviors may have little to no ability to produce

intelligible speech. This limits their ability to make alternative verbal responses; thus, the use of AAC device had allowed them to produce recorded spoken messages and were able to express their needs and wants. The corresponding AAC replacement involved requesting attention, preferred items, or a break from the task which in fact also reduced the occurrence of inappropriate vocalizations and challenging behaviors. Hence, according to the study results, when the participants were taught a more appropriate way of communication (e.g., use of speech generated device: GoTalk Now application) that serves the same function as the problem behavior, the challenging behavior will be ineffective, and hence, stop occurring (Franco et al., 2009; Muharib et al., 2019). Lastly, only one study (8%) from the selected studies targeted the use of “AVAZ—speech generating iPad application”—type of augmentative and alternative communication to improve the motivation and confidence (psychological aspect) of the students who have very limited or no spoken language (Sreekumar et al., 2020). As the student was learning communicative functions such as greeting, requesting, answering questions, labeling through pointing the appropriate picture communication symbols (PCS) on a communication book, he was confident and motivated to respond to many questions independently as he was able to express his needs using words like “more”, “stop”, “finish” and “I need help” (Sreekumar et al., 2020).

### **Effects of the Communication Intervention (Outcome Measures)**

The outcome measures across studies were mostly positive as a result of the implementation of AAC intervention. Effectiveness of these interventions can be considered as very high, because the all PND were 100% for all participants. Most of the studies reviewed reflected at least some gain in speech development (social communication) than improvement in literacy skills (academic efficacy) and other skills to reduce challenging behaviors and enhancement of motivation and confidence only.

Synthesized across the body of 13 studies, children took increased communication turns, gained vocabulary knowledge, communicated increased multi-symbol utterances, and demonstrated knowledge of early morphological forms. Positive results were obtained across a range of communication partners and contexts such as play, shared reading (storybook reading) and mealtimes. Based on the study results, four types of outcome variables for AAC interventions were detected in this systematic review technique (a) enhanced social communication and building of social relationships, (b) improved literacy and linguistic skills (e.g., pragmatic and semantic skills), (c) reduced challenging behaviors, and (d) increase levels of motivation and confidence.

### ***The Impact of AAC on the Students' Social Communication***

According to the study results, six studies highlighted the use of aided AAC modeling through brief training and coaching which resulted in increasing students' use of symbolic communication within interactions with peers. The researchers trained students to identify symbols on a communication board, provided peer training, and introduced interactive activities across settings (e.g., language arts, lunch, recess). The intervention increased social interaction and AAC use for students (n=9). This was done by creating social groups with elementary students which involved shared play activities and direct instruction on social-communicative skills; in each study, peer networks increased students' communication and initiations with their peers (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015; Wu et al., 2020). Based on the results, when students build skills to use symbols expressively—whether through spoken words, signs, or graphic symbols with aided AAC—they can communicate about abstract concepts and express their thoughts about the future, the past, and things not present in their current setting. Hence, teaching students with communication impairment to

use aided AAC as a shared means of communication could demonstrate the device is a useful mode of communication which would help them to build connections between the meaning of spoken words, graphic symbols, and their referents (Biggs et al.,2018).

In addition, students learned to answer questions which enhanced their back and forth conversations with any adult asking them a question (e.g., what do you do with a bike? He answered: ride a bike, what do you do with an apple? He answered: eat an apple, what do you do with a book? He answered: read a book, what do you do with a hat? He answered: wear a hat); all of this were responded through the use of symbolic communication boards and visual cues which prompted them in understanding the question to respond (Carnett & Ingvarsson, 2016). Also, the use of AAC showed an impact on improving the students' multipstep requests and engaging in generic small talk with peers (Chavers et al., 2021). For instance, based on the study done by Chavers et al., (2021), students with intellectual disabilities were able to perform three-step sequences to request and produce a social communication response (i.e., "thank you") using Proloquo2Go3 on an iPad. Intervention included systematic instruction involving least to most prompting, time delay, error correction, and reinforcement. All participants acquired the skill to combine two symbols to make general requests (e.g., "I want a toy") and specific requests (e.g., "I want the doll") using an iPad and engage in social interactions.

### ***The Impact of AAC on the Students' Academic Efficacy***

Based on the study results, AAC intervention research has yielded positive outcomes on various expressive linguistic measures for children. Using techniques originally used with children with communication impairment/intellectual disabilities who communicate through natural speech, such as modeling and recasting, researchers have demonstrated rapid improvements in productions of multi-symbol messages with young school-age children

using AAC who have a range of underlying disabilities (Ahlgrim- Delzell et al., 2014; Binger et al., 2021; Holyfield, 2021; Soto et al., 2008). These investigations involved the use of aided modeling as a central intervention component; in other words, the interventionists provided both spoken models, as well as models using the children’s communication devices, during intervention activities.

Through the use of AAC interventions, children were taught how to compose yes/no questions. Based on a study done by Kent-Walsh (2015), teaching children to use simple inverted forms, especially when contrasted with declarative forms (e.g., IS JESSIE LAUGHING? vs. JESSIE IS LAUGHING), highlights two essential properties of rule-based language learning. First, each word in a sentence is important to clearly convey a particular message; leaving one or more words out of these types of sentences is likely to result in a misunderstanding of the child’s meaning. Second, word order is important when constructing sentences; for example, if the child says JESSIE IS LAUGHING to indicate IS JESSIE LAUGHING?, the meaning of the child’s intended message will be misinterpreted by communication partners. Both the sentence length and word order can be problematic for children using AAC, so teaching these children to ask yes/no questions will highlight both properties of language simultaneously which will facilitate the development of generative language. Furthermore, Binger et al. (2011) provided evidence of gains in morphology development with the participants by studying the acquisition of morphemes such as “plural -S,” “present progressive -ING,” “past tense -ED,” and “possessive ’S through the use of speech-generated devices (SGD). The intervention included AAC models and recasts with the target forms (e.g., modeling on the SGD: HE IS GO + ING). All of participants quickly improved their performance in the probes of each of the target forms with overall robust changes in level from baseline to intervention. Through the use of speech-generated devices,

students learned the concept of regular past tenses and possessive 'S and increase literacy knowledge. Such that for the regular past tense –ED, the following scenario was used: First, the researcher said, “The [character] is going to [verb]” (e.g., “The grandma is going to jog”) and then performed the action with the figures (e.g., made grandma jog). The researcher then said, “He/she/they is/are all done [verb–ing ]. What did [character] do? He/she/they... ” (e.g., “She is all done jogging. What did grandma do? She ....” Child: JOG + –ED). A correct response included both the verb and the –ED “Jogged”. For possessive 'S, the researcher said, “Here is [character], and here is/are his/her/its [object(s)]” while placing the appropriate figures on the felt board. The researcher then said, “This/these [object(s)] belong to [character]. The [object(s)] is/are the....”. For example, “Here is a horse, and here is his hay. The hay belongs to the horse. The hay is the ....” with a correct response being HORSE + 'S. A correct response included both the noun and 'S (Binger et al., 2011). All four research studies result in improvement in the expressive vocabulary productivity, sentence complexity, use of relevant story elements, and morphology/linguistic skills (Ahlgrim-Delzell et al., 2014; Binger et al., 2021; Holyfield, 2021; Soto et al., 2008).

### ***The Impact of AAC on the Students' Behavioral Outcomes***

The study results also indicate that the use of speech-generated devices by students enhanced their ability to convey their needs and wants while reducing their inappropriate vocalizations and behaviors (Franco et al., 2009; Muharib et al., 2019). Before the implementation of the AAC intervention, based on the identified studies, students with disabilities used only signs for “movie,” “candy,” “swing,” and “music.” However, these signs were not easily understandable to anyone who was not specifically trained in their meaning (Franco et al., 2009; Muharib et al., 2019).

Based on the identified studies, due to deficits in oral communication and language skills, communication patterns in children with disabilities can appear more frequently as challenging behaviors such as aggression, property destruction, and self-injury. Researchers found lower levels of communication skills were associated with more severe challenging behaviors in young children with disabilities because such behaviors (e.g., hitting, pushing, self-injurious, head banging, or crying) are used as a form of expressive communication (Franco et al., 2009; Muharib et al., 2019). However, when the SGD—speech generated devices, part of AAC intervention, were available, the child reduced his inappropriate vocalizations across all settings and increased his engagement with peers and teacher by selecting the message from the communication board (e.g., I need a break from task or access to a preferred tangible) and other requests via an iPad-based SGD. Hence, both results of the study suggest that the use of an SGD may be an effective treatment for inappropriate vocalizations and challenging behaviors for students with disabilities. The occurrence of inappropriate vocalizations was substantially reduced during each of the conditions in which the participants used an SGD. Additionally, the participants were able to generalize the use of the device to two different settings (school and home), resulting in a subsequent reduction of inappropriate vocalizations and challenging behaviors across environments (Franco et al., 2009; Muharib et al., 2019)

### ***The Impact of AAC on the Students' Psychological Outcomes***

One study done by Sreekumar et al. (2020), showed the impact of implementing Augmentative and Alternative Communication intervention by enhancing the students' motivation and confidence by having the ability to express his needs and wants, convey certain messages, request items, greet, and/or answer questions using the AVAZ speech generating iPad app. Based on the study, Sreekumar et al. (2020) found that the use of the

core vocabulary on the communication board (e.g., more, I need help, thank you, stop, finish, less, move, eat, drink) had been used to cater the child's need which in turn enhanced his confidence and motivation, after 10 training sessions, as he started to communicate more using AVAZ communication board.

### **Implementation Fidelity**

Considering the above, Cook et al. (2014) stated three elements needed to ensure that the augmentative and alternative communication (AAC) intervention is effective and was implemented with fidelity: (a) implementation fidelity regarding adherence using measures such as observation checklists (b) dosage and exposure using direct measures, and (c) reporting implementation fidelity throughout the intervention and by the unit of analysis.

Almost all study results were consistently positive with high level changes in communication performance from baseline using direct/indirect observations and checklists to ensure consistency in the implementation of the intervention procedures. From the 13 studies, 11 studies (85%) included fidelity checklists across the intervention phases which were used by two observers to ensure that the intervention procedures were implemented appropriately and to have higher interobserver reliability(Ahlgrim- Delzell al., 2014; Biggs et al., 2018; Binger et al., 2011; Bishop et al. , 2019; Carnett & Ingvarsson, 2016; Franco et al., 2009; Holyfield, 2021; Kent-Walsh et al., 2015; Muharib et al., 2019; Soto et al., 2008; Wu et al. , 2020). Additionally, based on the results, one study conducted by Chavers et al. (2021) included three separate procedural/treatment checklists—one for baseline procedures, one for intervention procedures, and one for generalization procedures. On other hand, only one study done by Sreekumar et al. (2020) which did not include measures or observation checklists to determine fidelity implementation but the study provided information regarding

analyzing sessions (10 total training sessions) by the team and refining sessions by adding recommendations and tracking changes to the following session or week.

### **Internal Validity**

To identify the internal validity of the identified studies based on the results, 9 internal validity items per design type are considered (Cook et al., 2014) (a) For both types of design studies, the researcher needs to control and manipulate the independent variable (b) describe baseline or control conditions (c) control or baseline condition must have no or limited access to intervention (d) for group design type, the researcher must describe the assignment to groups (e) the overall attrition must be low (f) the differential attrition must be low (g) for single-subject design, the design must include three different times of three demonstrations of experimental effects (h) all baseline phases must include three at least three data points (i) design controls threats to internal validity (Cook et al., 2014).

The majority of the study results (n=11) reported the pre-baseline literacy, social, behavioral level of the participants prior to implementing the intervention. In 11 of the 13 studies (85%), participants had access to pictures (visual cues) on aided communication boards to request for items, answer questions, convey a certain message, express his/her needs and wants during baseline (Ahlgren-Dezell et al., 2014; Biggs et al., 2018; Binger et al., 2011; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Franco et al., 2009; Holyfield, 2021; Kent-Walsh et al., 2015; Muharib et al., 2019; Soto et al., 2008; Wu et al., 2020). So, across the 11 studies, all independent variables were controlled, the baseline (prior to the intervention) was described using checklists and direct observations, and the baseline conditions were specified. On the other hand, the other two studies (30%) done by Chavers et al. (2021) and Sreekumar et al. (2020) didn't clarify if the control group had limited access to the intervention, didn't not make pictures available (use of visual cues or communication boards) during baseline, and

it wasn't clearly reported how study participants were gathered and matched based on variables (dependent and independent). Hence, the two studies (30%) didn't indicate common threats to internal validity (Chavers et al., 2021; Sreekumar et al. (2020) Additionally, three studies reported assessing the social validity of intervention procedures. Social validity was assessed by evaluating the results of questionnaires completed by a variety of educational staff (i.e., general and special educators, SLPs), and parents of participating children (Holyfield, 2021; Kent-Walsh et al., 2015; Soto et al. 2008). Two studies conducted pre-intervention focus groups with various stakeholders to identify relevant themes regarding the acceptability of intervention procedures (Binger et al. 2008; Chavers et al., 2021).

### **Concluding Summary**

Based on the study findings and the inclusion criteria set in this systematic review, research has proven that integrating assistive technology such as Augmentative and Alternative Communication into the education setting, improves and maximizes the school environment by promoting greater independence and enhancing functional performance and success of students with disabilities. Augmentative and alternative communication (AAC) interventions had shown a great impact on the students' social communication competency and skills specifically than on any other domain specific outcomes (e.g., psychological, behavioral, academic) where they had increased social interaction and communication more efficiently not only between peers but also adults, teachers and parents (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015; Wu et al., 2020). In fact, through the students' enhanced level of social communication and interaction using the AAC communication board symbols and signs, they were able to express their needs, wants, desires, thoughts, emotions, and formulate

sentences which has also reduced their challenging behaviors (e.g., crying, self-harming, etc.)—which hampered their interactive social abilities.

## CHAPTER 5

### DISCUSSION & CONCLUSION

Communication is one of the fundamental human rights, and its impairment results in significant consequences in various areas of child development and the outcomes of everyday life especially among children with disabilities and complex communication needs. As the prevalence of children with disabilities and communication impairment increases, it is important for the general population, as well as clinicians to have a greater general understanding of the difficulties and needs these children may need. Thus, having access to communication systems and support allows children with disabilities and with complex communication needs to advocate for themselves, to connect with loved ones, and to participate and interact with members in the community. The results of this systematic review provide evidence that children with disabilities and complex communication needs associated with various ages, and language skills can derive benefits in communication as a result of interventions that include aided AAC input.

In this chapter, the findings of the systematic review are discussed as per the identified 13 studies that assessed the effectiveness of AAC-based interventions on communication skills in children aged from 5 to 13 years. The findings of the AAC interventions were focused on (1) developing the narrative skills, vocabulary, requesting, or improving phonological awareness, (2) enhancing social communication interactions between peers and adults, (3) boosting the children's confidence and motivation, and (4) reducing their challenging behaviors. Overall, the intervention studies included in this best-evidence synthesis investigated the impact of AAC modeling-based interventions and reported consistently positive and large main effects

for pragmatic, semantic, syntactic, and morphological development for young children who are beginning communicators and social communication skills. This was done to determine the impact of AAC intervention on the overall and domain-specific outcomes (social, emotional, behavioral, and psychological) of children with disabilities and to examine if there is any differential impact of the AAC intervention between its impact on their social communication skills, academic literacy skills, as well as behavioral and psychological outcomes.

### **Augmentative and Alternative Communication- AAC Intervention**

Augmentative and alternative communication (AAC) interventions can benefit students with disabilities who have significant speech and language impairments by enhancing their communicative competence and facilitating the development of language skills. Based on the study results, AAC intervention may reduce the pressure on the individual for speech production, thereby reducing stress and indirectly facilitating speech and communication interaction. Furthermore, AAC intervention may allow students with significant speech impairments to bypass the motor and cognitive demands of speech production and focus on the goal of communication instead; after they establish basic communication and language skills, they may then be better able to reallocate resources to improve their speech productions. So, this research showed aided AAC had a positive impact on communication skills for children with disabilities. They also found these forms of AAC also promoted social skills and help to decrease the occurrence of troublesome behaviors (Franco et al., 2009).

The findings of the systematic review show that the implementation of AAC interventions may be considered as an evidence-based practice for use with this population (children) which, in fact, has a great impact on their social communication

competence and social interaction with peers and teachers specifically than its impact on their behavioral, psychological, and academic outcomes. In other words, the results of the study reveal that there is a differential effect on the implementation of AAC intervention on the social communication interaction of students as the augmentative and alternative communication phrase and communication symbol board encompass a wide range of adapted communication methods that can be used to assist in speech and most importantly improve the transmission of direct messages and conversations between students and their peers, teachers, and parents. This is encouraging, particularly considering the rapid increase in the availability of AAC apps for mobile devices which allow them to achieve an increasingly better level of functional and social communication.

In addition, in order for students with disabilities to use symbols effectively to facilitate “social” communication and interaction, they may need to learn the meaning of words/symbols (receptive language) and how to produce them (expressive language) in communicative contexts. This is done when the key elements of intervention are the instructional strategies or procedures used within interventions to achieve the various intervention goals. Various intervention techniques including explicit instruction, incidental teaching, modelling of AAC use in naturalistic interactions, conversational coaching, and strategy instruction can be utilized to expand communication competence for individuals who use AAC.

Furthermore, based on the study results, AAC provides a visual representation of language to better help them communicate with others. Most forms of AAC have visual words or pictures on display to aid in communication (Wu et al., 2020). When the students with complex communication needs and disabilities are able to see the visual

of the word or concept they want to communicate, they have more support from the device than they would otherwise (Soto et al., 2008). AAC helps to facilitate language by providing visuals (such as signs, pictures and visual icons representing specific communication units) for the individuals. Thus, the visual information, which is predictable, static or less dynamic than words, enables the children to improve recognition of language input or generation of language output (Eadie, 2003). To support, PECS—Picture Exchange Communication System which is a type of AAC intervention, for instance, had been found to be an effective tool to teach functional communication to individuals with autism because key features of PECS, such as concrete visuals and preferred reinforcers, build on the strengths of individuals with autism (Chavers et al., 2021). Similarly, Charlop-Christy et al. (2002) concluded that the success of PECS was because of its structured, concrete format and the use of picture cards as visual prompts. It is evident from the literature that individuals with autism learn better when information is concrete and presented visually which might contribute to a greater retention of skills over time.

### ***The Use of AAC Intervention by Students with Disabilities and Complex Communication Needs***

All of the identified studies reported the participants' detailed characteristics, especially for communicative imitation skills and communication functions prior to the implementation of AAC intervention. The expressive communication related skills are the essential baseline for determining the effect of AAC intervention on the individuals with specific capabilities.

Enrolled populations vary widely in functional profiles such as movement, cognition, communication, receptive and expressive language, learning characteristics, and age. They also vary in their educational setting (mainstream schools or special

education), previous and concurrent interventions, and concurrent medical conditions. However, one of the most important conclusions that can be drawn from this research is that although participants in the studies varied considerably in age and severity of communication impairment and the interventions were also very heterogeneous, etc... all of them reported positive effects in children from 5 to 13 years of age with disabilities. To elaborate, regarding the intervention target, it is observable that most of the interventions are based on working directly with children. None of the studies included in the review mentioned a minimum age for the introduction of AAC, even though the youngest children identified in the articles reviewed were 5 years old. Nevertheless, Bishop et al. (2019) indicated that the developmental age of participants affects their receptive and expressive vocabulary and language development. They found that the developmental rate of speaking children was higher than nonspeaking children both before and after the intervention. Having already acquired certain language skills, speaking children obtained a greater benefit from the intervention with AAC systems.

In general, findings indicate that instruction can be very effective across a wide range of participants, with very large effects within the diagnoses of Intellectual and Developmental Disabilities (e.g., autism spectrum disorder, cerebral palsy, Down syndrome, apraxia speech delay). However, given the small number of participants in each diagnostic category, as well as the number of participants that were the only person representing a given diagnosis, it is difficult to draw generalizations about the effectiveness of interventions with specific diagnoses.

### *Enhancing the Students' Social Communication using AAC Modes*

Prior to the implementation of AAC intervention, the majority of participants did not have a consistent or sufficient symbolic communication mode that allowed meaningful participation. For example, among the total 33 participants, n=22 of them (66%) had no reported prior use of AAC, others n=5 (15%) used limited (few words) or unintelligible speech, whereas others n=6 (18%) relied on non-symbolic modes only (e.g., gestures) to interact with others. This is vital to see the effectiveness of the implementation of the AAC intervention on the students' social communication and interaction.

The studies included in this review have gathered evidence of the positive impact of various types of AAC on the development of basic communication skills in children. In the 13 identified studies, a variety of AAC types were used to address the communicative needs of the participants—either simultaneously or sequentially—including low-tech aided systems (communication boards and Picture Exchange Communication System [PECS]), and high-tech aided systems (speech generating devices, AVAZ-ACC, and other various Voice output communication aids-VOCAs). With reference to the different types of communication boards used, all of them had shown an improvement in communication and social interaction skills, including phonological awareness, vocabulary, requesting, and developing narrative skills. To support, Binger et al. (2021) analyzed the effect of modeling play and vocabulary across three play contexts on the child's symbolic communication. They found that improvements in communication were more evident when a multimodal AAC approach interventions were used in modeling than when the sign language was used alone.

The aided communication interventions, e.g., using augmentative and alternative communication boards for socialization can be used as the primary means of expression throughout life due to language disabilities or defects. So, during AAC interventions, students with disabilities and complex communication needs will be encouraged to use various methods and appropriate means in various situations and with different communication partners. This follows the principles of total communication strategies, and it implies that AAC users will use multiple methods of communication (e.g., use of visual signs, pictures and visual icons) to achieve the most effective communication possible while enhancing their socialization skills.

Considering the study findings, none of the studies included in the review have focused only on unaided systems (e.g., eye gaze, gestures and the use of manual sign). In fact, 3 studies used both aided and unaided systems, and the remaining 10 studies made use of a variety of low-tech and high-tech AAC systems. With aided low tech, the participants have additional visuals to help easier facilitate language (Franco et al., 2009). In order to use aided low-tech however, the participants must bring it with them at all times when they want to communicate (Muharib et al., 2019). With aided high tech AAC, the individual can have a vocal output as well as visual concepts with their device (Carnett & Ingvarsson, 2016). Therefore, this finding suggests a clear tendency toward using aided AAC in intervention studies with children from 5 to 13 years old and that the use of aided interventions (e.g., PECS, Voice output communication aids-etc...) can be a successful communication method in interventions with children with little to no functional speech as a way to increase communication and social interactions with others (Wu et al., 2020). This shows that the AAC intervention has a greater impact on the child's social communication interactions specifically than his/her

behavioral, psychological, and academics literacy outcomes which was also positively affected later as a result of his/her enhanced communication and social interaction.

### ***Independent and Dependent Variable Characteristics of the Intervention***

Instructional approaches and the number of different skills taught in the intervention appeared to be important factors in intervention effectiveness. Instructional approaches which more closely utilized direct instruction methods (e.g., introduction, model, guided practice, independent practice (Ahlgrim- Delzell et al., 2014; Biggs et al., 2018; Binger et al., 202; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Franco et al., 2009; Holyfield, 2021; Kent-Walsh et al., 2015; Muharib et al., 2019; Soto et al., 2008; Wu et al., 2020) yielded very large effect sizes. These methods, as well as the guiding principle of direct instruction – the belief that every child can learn if carefully taught (Soto et al., 2008) should be factors for consideration by clinicians. It is important that interventions provide explicit practice with the skills we want participants to learn (e.g., teaching letter-sounds and later assessing growth in letter-sound knowledge or teaching decoding and later assessing decoding growth). One of the 13 interventional studies which did not include explicit practice for skills which were assessed (e.g., enhancing the children’s motivation and confidence) had low gains and moderate effect sizes.

### ***Enhancing Communication and Social Interaction***

In practice, the assumption that the early introduction of AAC systems might prevent natural speech development is still ingrained among parents and some practitioners, and its use with young children is often considered a last resort. The results of the studies included in this review run counter to this assumption and instead provide evidence of improvement in communication and language skills following the

implementation of AAC interventions. This was evident by six studies who showed PECS and VOCAs (Voice output communication aids) which promoted an increase in communication and was beneficial for children with limited joint attention skills, a desire to explore and understand objects, and poor motor imitation skills (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015; Wu et al., 2020). Therefore, based on the study results, the best evidence indicates that AAC interventions do not have a negative impact on speech production. All participants in our systematic review demonstrated increased speech production during or following at least one of the AAC interventions investigated and specifically 6 intervention studies of the 13 total studies showed increase communication interaction among children with disabilities and their peers with a consequent influence on their quality of life, in addition to improvements in spoken communication and an increased number of different words after the implementation of intervention (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015; Wu et al., 2020). The improved communication and social skills by using AAC intervention is as a result of implementing and integrating its use during ongoing activities. For instance, professionals, such as speech therapists, special educators, and early interventionists, experienced in using AAC (well-trained), would collaborate with child care providers to determine ways the child can use the system within routines and play activities. Teachers can help the other children in the group to understand the AAC system and use it to communicate with the child. Adults should continue to talk with and encourage the child to make sounds or speak by pressing on the different communication board

symbols to express their needs, wants, desires, thoughts, answer a question, ask for a request, etc...

To further elaborate, the communication boards and/ or computerized speech synthesizers have a display of communicative messages using photographs, line drawings, phrases, words, or letters. The message is activated by touch or laser beam to produce a printout or synthesized/digitized speech (synthesized speech is computer-generated; digitized speech is recorded using a human voice). Hence, as the student with complex communication needs use different symbols and icons to socialize and communicate with another student, teacher, or his/her parents, using the visual picture and at the same time the audio, he/she was encouraged to interact and socialize more than before by building social relationships with peers. This is because a new set of vocabulary is introduced, taught, and programmed onto the device to reflect the ever-changing needs of them and meet the demands of the environment. By time, the student was able to attain independency and have an enhanced communication interaction by combining words to make phrases and sentences, and learning the multiple functions of language that include requesting, social etiquette, information sharing and seeking, answering questions, commenting and protesting (Light, 2019). Therefore, the use of AAC systems can increase children's independence as well as support their inclusion in activities with other children and with family members as a result of enhancing their social and communication skills. Hence, considering the study results and AAC interventions of the studies, the AAC intervention enhances the communication competence and its effectiveness increase social interaction, quality of life, independence and participation in everyday life.

## **The Impact of AAC Intervention on the Child's Behavioral and Psychological Outcomes and Academic Efficacy**

Lack of functional communication is generally a life-long condition that severely impacts the social communication of subjects and their families, and is highly correlated with subsequent behavioral problems and psychological distress. This review presents preliminary evidence suggesting effective instruction may improve student performance in skills that can be especially challenging for nonverbal children (1) letter-sound correspondence, tasks that require phonemic awareness and grammatical competence such as word segmentation for spelling, and word reading tasks, (2) building social relationships and engage in social communication interactions, (3) use of communication symbolic cues to convey a message; thus, managing one's own behaviors and reducing challenging behaviors and inappropriate vocalizations (4) independent skills which, in turn, enhances, their motivation and confidence for communication using speech-generated devices. All of the listed positive participant outcomes are closely related to the use of evidence-based systematic instructional procedures such as direct instruction, least to most prompting, and scaffolding of child communication. This is not surprising given that previous research has indicated that more explicit and systematic instruction, particularly in phonemic awareness, phonics, fluency, comprehension strategy instruction, and producing novel sentences tends to improve reading and social communicative outcomes (Wanzek and Vaughn, 2007).

### ***The Impact of AAC Intervention on Academics Efficacy***

In four studies (n=4) of the 13 identified interventional studies, participants who use AAC have been reported to be at risk of experiencing deficits in syntax and morphology skills (Ahlgrim- Delzell al., 2014; Binger et al., 2021; Holyfield, 2021;

Soto et al., 2008). The impact of being able to combine words and parts of words is important, as it provides access to the generative, flexible, and combinatorial power of language. Research suggests that children with disabilities, especially beginning communicators, often produce short utterances (Holyfield, 2021; Soto et al., 2008).

The evidence found in this review indicates that in response to AAC modeling-based interventions, children with disabilities who require AAC were able to increase their use of multi-symbol utterances, identifying phonemes, blending words to sounds in a meaningful way within the contexts of play (Binger et al., 2021) and shared storybook reading (Soto et al., 2008). Also, although only across 11 participants and 4 interventions, researchers demonstrated children acquiring the use of morphology structures in response to AAC modeling and AAC recasts during shared storybook reading. Taken together, this emerging evidence in the syntax and morphology domains is an encouraging sign that when provided the right interventions, children with disabilities can develop these generative, flexible, and combinatorial skills.

Furthermore, some studies teaching letter-sound correspondences included children with limited or no literacy experience; there were no literacy prerequisites required prior to participation in letter-sound correspondence intervention. Some authors use basic language testing as a method of determining if the individual has the skills to participate in the intervention (e.g., Peabody Picture Vocabulary Test) and conducted a pre-literacy baseline (as mentioned previously) (Ahlgrim- Delzell et al., 2014; Binger et al., 2021).

Most of the studies, focusing on the academic literacy outcomes, included in the current review focused on the expression of wants and needs as well (enhancing social interaction and communication). This focus of communicative function was reflected in

the target vocabulary, which comprised largely preferred items and particularly preferred edible items. It was also reflected in “snack” serving as the most frequent context in included interventions. It may also have played a role in the small number of vocabulary items targeted in most studies – it requires a far smaller corpus of messages (in fact, just one) to request a favorite snack than to converse with a peer about a favorite television show. So, the use of identifying and listing vocabulary words using the AAC intervention symbolic communication boards were used to teach students “multistep requests” and generic small talk, using visual and verbal cues, to facilitate social communication interactions (Chavers et al., 2021).

### ***The Impact of AAC Intervention on Social Communication***

According to the study results, AAC intervention increases the complexity of human interaction and acts on several specific domains. The effects of intervention may therefore have an impact on the students’ social communication and interaction (in one domain) which may influence the outcomes in other domains (e.g., behavioral, psychological, and/or academics). This was evident in all the studies where the impact of AAC intervention was not only on the child’s social communication and interaction but also on their domain-specific outcomes which was also impacted as a result of their enhanced social communication. Based on the study results, the improved social communicative behaviors and enhancement in speech and function communication had a direct impact on the students’ behavior, acquisition of literacy skills, and psychological outcomes (e.g., confidence, motivation, self-esteem, etc...) (Biggs et al., 2018; Bishop et al., 2019; Carnett & Ingvarsson, 2016; Chavers et al., 2021; Kent-Walsh et al., 2015; Wu et al., 2020).

Based on the results of the systematic review, the social and functional communication was promoted and enhanced by (i) selecting words/ forms concepts functionally relevant to the child's environment (ii) teaching the child to use the words/forms in functional manner and (iii) preparing people in the environment to respond to words/forms used by the child in functional manner (Bishop et al., 2019). The augmentative and alternative communication intervention tool was used to facilitate production of social communicative functions such as initiating conversation, answering questions, requesting, commenting, engaging in generic small talks, etc... which in turn increased the independence, vocalizations, and reduced inappropriate behaviors in children (Franco et al., 2009; Muharib et al., 2019).

Therefore, the study findings of this review extend the research literature by demonstrating that aided AAC modeling can be effective to improve the symbolic communication of students with disabilities and complex communication needs while enhancing their social experiences with peers and adults within school and home settings. These findings provide initial evidence that aided AAC modeling can be effective to help students acquire the expressive use of new graphic symbols within the context of natural interactions without relying on decontextualized, one-to-one teaching sessions. Additionally, the visual supports (graphic symbols on the aided communication boards) are reported to be useful in educational program for children who do not acquire functional speech or have difficulty in processing and comprehending spoken language and social communication (Holyfield, 2021). The visual information, which is predictable, static or less dynamic than words, enables children to improve recognition of language input or generation of language output which, in turn, also improve their literacy skills.

Based on the above, the social communication aspect as a result of implementing AAC intervention with children was the most impacted domain on than other domain-specific outcomes (behavioral, psychological, or/and academics), simply because by enabling them to communicate and socialize effectively with peers, parents, and teachers, all other domains specific were impacted after the social interaction aspect was enhanced. In other words, as the students were able to use the communication symbolic boards and have improved social communication with others, they were able to read words (improving their literacy skills and fostering learning), express their desires and needs (reducing in appropriate behaviors), and most importantly feel more independent which boosted their motivation, self-esteem, and confidence (impact on their psychological outcomes). Hence, the social communication domain aspect can be considered as the core central domain which has a direct relational impact on the other domain-specific (e.g., psychological, behavioral, and academics).

### ***The Impact of AAC on Behavioral Outcomes***

Based on this study's results, two (n=2) of the 13 studies indicated that PECS (Picture Exchange Communication System), which is a kind of AAC intervention, didn't only increase communication behaviors (e.g., increase in prompting, increase in responses to requests), but also decreased problem behaviors (Franco et al., 2009; Muharib et al., 2019). These findings support assertions that problem behaviors are often attempts to communicate and that functional communication can replace less acceptable modes of communication. Furthermore, according to the study results, the use of "Speech-Generated Devices"—SGDs can successfully be used across multiple functions to replace challenging behaviors. To elaborate, behaviors that are maintained by multiple functions are common; treatment of such behaviors often requires multiple

intervention components and may be complicated by conflicting functions. For example, an intervention for challenging behavior maintained by both attention and escape might contain opposing intervention components: If attention is denied, the child escapes; if escape is denied, the child may have access to adult attention. Hence, it was evident that the use of an SGD to address both functions may be more efficient to mitigate challenging behaviors of children (e.g., a child requests continuation of toy plays via an iPad).

### ***The Impact of AAC on Psychological Outcomes***

Of all the included studies in this review, only one study (n=1) conducted by Sreekumar et al. (2020) indicated the impact of using AVAS (speech generating iPad app), which uses high-quality voice synthesis and picture symbols or text to help children in creating intended messages and develop their language skills. AVAZ enables the individuals to express themselves by creating their own messages and uses the speech synthesizer to speak the intended message. Through this intervention, the child in the study improved in syntactic knowledge by combining symbols for communicating her needs and desires. Progress in communicative functions led to further improving her linguistic knowledge as she was able to overcome the communication limitation she faced. This, in turn, build her confidence, motivation, and willingness to communicate, ultimately resulting in increased language use (e.g., responding to others, participating in conversations, requesting items, etc.).

In a nutshell, AAC interventions have the potential to provide an effective communication method to augment the use of speech by students with disabilities and thereby enable higher levels of community participation and social interaction. This, in return, would reduce the occurrence of challenging behaviors, enhance literacy skills,

increase their independence as well as boost their self-esteem and motivation as they'll be able to express their ideas, needs, wants, desires, feelings, opinions, etc...

### **Implications**

There are several broad clinical implications that emerge from this systematic review. First, the findings suggest that there is evidence to support the use of aided AAC input can be considered as an evidence-based practice to enhance a wide range of communication outcomes for children who use AAC of various ages, diagnoses, and language abilities. Second, these interventions can be effective when implemented by everyday communication partners in naturally occurring environments over relatively short periods. Instruction for parents, school employees, and other communication partners should result in improved outcomes for individuals who use AAC. Thirdly, the review demonstrated that aided AAC input can be effective by itself as it could be accommodated to best meet the needs of children who require AAC within the demands of busy real-world environments. Therefore, speech ability, including limited or no speech, should not factor in access to foundational reading interventions (Franco et al., 2009). Adapting instruction to meet the needs of individuals who use AAC is important as it contributes to overall effectiveness of intervention, resulting in positive literacy gains. Interventions in this current review successfully utilized a range of instructional strategies, including the use of multi-modal and low-high tech AAC response strategies.

Moreover, results of the best evidence analysis also suggest that clinicians and parents should not be concerned if increases in speech production does not occur immediately after initiation of the AAC intervention; in 21% of the cases reviewed, speech gains were observed after a lag of 6–25 sessions. In keeping with evidence-based practices and outcomes measurement, clinicians should carefully monitor the

effectiveness of AAC interventions with individual clients to determine the effects on communicative competence, social interaction, language skills, and speech production.

### **Limitations**

Despite the research and clinical implications discussed previously, the current review has some limitations that affect the interpretation and application of the results. Initially, the search is limited to peer-reviewed journal articles and thus excluding dissertations or other types of studies may be a limitation. In addition to that, including peer-reviewed journal articles that are in the English language only may also be considered as one of the limitations in the study. Accordingly, it can be noted that the low number of articles may limit generalizing the findings. Moreover, the number of studies located may be insufficient to present a statistical measurement or meta-analysis.

In addition to the above, an important limitation is that the data set represented a restricted population. Most notably, there are limited participant profiles related to age range, disability, and language ability. This limitation is an important gap because we do not have conclusive data documenting the impact of AAC modeling interventions on adolescents and adults with disabilities and complex communication needs. Another limitation in this systematic review was the lack of inclusion of information about the generalization and maintenance of any observed intervention effects in one (n=1) of the 13 included studies. This limitation is particularly important when considering the value such information has in intervention decision-making and the overall value of interventions; if the effects of an intervention only appear within the context of that intervention and disappear immediately following the end of intervention, there is limited value in any observed effects. As more research becomes

available, differences in generalization and maintenance across differing AAC intervention features should be weighed heavily when comparing effectiveness.

Lastly, an additional limitation is that some researchers in three studies already had the application, “Proloquo2Go,” already opened up on each of the student participant’s iPad to request and use the symbol communication board. However, the researchers could have taught a more explicit training to the student participants, by having them navigate through the iPad and application (i.e. turning on the device, unlocking the screen, choosing the correct application, touching the back button, etc.). Despite the limitations of this study, the results can be considered positive. The teacher and researcher felt that the iPad was a great success for the students to facilitate communication by independently requesting their desired wants and needs.

### **Future Research**

Reviewing the literature base on the effectiveness of AAC intervention on the social communication of students with disabilities and complex communication needs revealed several areas that would benefit from additional research. Future research should consider the possibility of when to begin phasing out AAC if speech reaches a certain level to determine if speech will surpass AAC usage. This does not suggest that AAC is an inadequate means of communication but that for some individuals at a certain point the systematic phasing out of AAC could result in increased speech production. Development and testing of clear strategies to increase vocalizations during AAC use and training may influence family decisions to adopt AAC. Secondly, future research could differentiate between high-tech apps and older speech-generating devices. Given the speed at which technology is expanding, it would be beneficial to determine whether there are differential effects between the different types of AAC

technologies on the social communication of students with disabilities. Lastly, future systematic reviews may also need to improve search procedures by examining more databases or including additional resources to improve search procedures yielding more accurate results. It is also essential to examine these practices with other participants (e.g., children with hearing impairment—who may also have complex communication need) or participants suffering from other types of disorders or symptoms to compare the effectiveness of these practices.

## **Conclusion**

To conclude, verbal communication is essential for an individual's daily interactions with others, as it is the first tie to the world, we live in. Children with speech and language difficulties often experience barriers in understanding and using verbal language in communication. Without access to functional communication, children with disabilities are left with limited opportunities for communication, language development, literacy learning, and socialization. In order to overcome these challenges and give access to the power of communication, augmentative alternative communication (AAC) can be introduced as an intervention to help them in carrying out conversations in daily activities and improve their social communication abilities by the supplementation or replacement of natural speech.

Based on the study results, AAC intervention offers the potential to enhance communication, language, and learning for children with disabilities and communication impairment. This is because it increases functional communication goals such as the expression of needs and wants, the development of social closeness, and the exchange of information between students and their peers. Such interventions can also promote social closeness interactions (e.g., play activities, social routines). In

other words, the AAC intervention enhances the (1) pragmatic language (social uses of communication, such as turn taking), (2) semantic meanings (the meanings of words and sentences, such as vocabulary acquisition), (3) syntactic language/morphological markers (the order and combination of words to form sentences, such as increases in the length and/or complexity of messages, and the construction of word forms such as plurals or tenses). Hence, the AAC intervention would have differential effect/impact on the social communication and interaction than other domain specific outcomes (behavioral, academics, and psychological). This is because greater functional skills had contributed to increased independence in many activities of daily living, allowing for the ability to make choices and decisions that affect self-determination skills and self-esteem. At the same time, by building appropriate channels of functional communication to express needs and wants or establish social attention, AAC interventions had also reduced challenging behavior such as aggression, self-injury, etc... Thus, as students are using visual language support on communication boards to answer, request, and express their ideas and opinions, it will also help them to facilitate comprehension of spoken language and most importantly enhance their literacy skills further. However, due to the few numbers of studies in understanding the effect of augmentative and alternative communication intervention on behavioral and psychological outcomes, our results cannot be generalized to the general population.

The evidence from this systematic review indicates that interventional studies, with strong quality indicators, utilize AAC approaches which allow children to develop social and functional communication skills. This would, in return, further promotes the students' cognitive/conceptual development, provide the foundation for literacy learning skills (e.g., sight word recognition, decoding, letter-sound correspondences,

blending and segmentation), reduce challenging behaviors, improve social participation, and allows for increased independence in activities of daily living.

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