DESIGN, DEVELOPMENT AND EVALUATION OF MYSUARA APPS ON TEACHER-STUDENT INTERACTION FOR STUDENT WITH COMPLEX COMMUNICATION NEEDS

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by

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LIST OF ABBREVIATIONS

AAC	Augmentative and Alternative Communication
AACUQ	Augmentative and Alternative Communication Usability Questionnaire
AT	Activity Theory
CCN	Children with Complex Communication Needs
CLT	Cognitive Load Theory
DDR	Design and Development Research
DOI	Diffusion of Innovation Theory
EPRD	Educational Policy Planning and Research Division
JEPEM	Jawatankuasa Etika Penyelidikan Manusia/ Human Research Ethics Committee
MADLC	Mobile Application Development Lifecycle
PACMAD	People at Centre of Mobile Application Development
PPKI	Program Pendidikan Khas Integrasi/ Integrated Special Education Programme
SGD	Speech Generating Device

LIST OF APPENDICES

REKABENTUK, PEMBANGUNAN DAN PENILAIAN APLIKASI MYSUARA TERHADAP INTERAKSI GURU-MURID UNTUK MURID BERKEPERLUAN KOMUNIKASI KOMPLEKS

ABSTRAK

Berpandukan kerangka Penyelidikan Reka Bentuk dan Pembangunan (Design and Developmental Research, DDR) yang dicadangkan oleh Richey dan Klein (2007), kajian ini menunjangi reka bentuk, pembangunan, dan penilaian aplikasi MySuara. Kajian ini bertujuan untuk meneroka cara guru dan murid berinteraksi di bilik darjah pendidikan khas, dan menggunakan maklumat yang diperolehi ini untuk mereka bentuk, membangun aplikasi komunikasi bantuan dan gantian (AAC), MySuara, dan menilai kebolehgunaan serta kesan aplikasi tersebut terhadap interaksi dua hala antara guru pendidikan khas dan murid berkeperluan komunikasi khas. Reka bentuk kajian yang digunakan ialah kaedah campuran berturutan tiga fasa. Fasa pertama merupakan fasa kualitatif. Seramai lima orang guru pendidikan khas dari negeri Pulau Pinang dan Kedah ditemu bual menggunakan soalan temu bual secara berstruktur. Dalam fasa kedua, ciri-ciri yang dikenal pasti daripada fasa satu, digunakan dalam proses mereka bentuk dan pembangunan aplikasi MySuara. Penilaian kebolehgunaan juga dijalankan dalam fasa ini, melibatkan 12 orang guru dan 2 orang ahli terapi pertuturan yang menguji MySuara sebelum menjawab soal selidik yang disediakan. Fasa ketiga menguji kesan aplikasi MySuara terhadap interaksi antara seorang guru dan seorang murid melalui enam sesi intervensi. Temu bual ringkas diadakan pada akhir intervensi untuk mendapatkan pendapat guru tersebut mengenai keberkesanan intervensi dan aplikasi MySuara. Dapatan fasa satu menunjukkan interaksi guru-murid lebih bersifat sehala akibat perbezaan mod komunikasi. Guru turut menekankan keperluan aplikasi

AAC yang menggunakan bahasa tempatan dan kandungan kurikulum pendidikan khas. Justeru, fasa dua menyaksikan pembangunan MySuara dengan mengintegrasikan strategi sokongan (scaffolding) dan konsep ZPD berasaskan Teori Sosiobudaya, Lev Vygotsky, melalui antaramuka dua skrin dan fasa pemodelan. MySuara dibangunkan dalam Bahasa Melayu dan bahasa tempatan lain, serta memanfaatkan kosa kata daripada mata pelajaran Pengurusan Diri. Dapatan fasa tiga merangkumi dua aspek: ujian formatif menunjukkan tahap kebolehgunaan MySuara yang tinggi dari segi kepuasan dan keberkesanan; manakala ujian sumatif membuktikan peningkatan kekerapan murid memberi respons yang sesuai, hasil daripada penggunaan strategi sokongan dan pemodelan oleh guru. Kesimpulannya, MySuara berpotensi besar dalam meningkatkan interaksi bermakna antara guru dan murid.

DESIGN, DEVELOPMENT AND EVALUATION OF MYSUARA APPS ON TEACHER-STUDENT INTERACTION FOR STUDENT WITH COMPLEX COMMUNICATION NEEDS

ABSTRACT

Grounded in the Design and Developmental Research (DDR) framework proposed by Richey and Klein (2007), the present study guides the design, development, and evaluation of the MySuara app. This study aims to 1) explore teacher-student interactions, 2) use the insights gained to design and develop the MySuara application, and 3) assess the developed app's usability and its impact on reciprocal interactions involving a special education teacher and a student with complex communication needs. The research employs a three-phase sequential mixed-method approach. The first qualitative phase involves semi-structured interviews with five special education teachers from Penang and Kedah. Insights from these interviews informed the design and development of the MySuara application in the second phase. Usability testing was conducted with twelve teachers and two speech therapists, who tested the app before completing surveys. The third phase tested MySuara's impact on teacher and student interactions through six intervention sessions with an experienced special education teacher and a student diagnosed with Autism. A brief interview was conducted at the end of the intervention to gather feedback from the teacher regarding the effectiveness of the intervention and the MySuara app. Findings from the first phase revealed that teacher-student interactions in special education tend to be one-sided due to disparity in communication modes. Teachers expressed a need for augmentative and alternative communication (AAC) apps that include local languages and align with the special education curriculum. Findings from phase one indicated

that teacher-student interaction was predominantly one-way due to differences in communication modes. Teachers also highlighted the need for an AAC application that incorporates local languages and content aligned with the special education curriculum. Consequently, phase two involved the development of MySuara, which integrates scaffolding strategies and the Zone of Proximal Development (ZPD) based on Vygotsky's Sociocultural Theory, implemented through a dual-screen interface and a modelling phase. MySuara was developed in Malay and other local languages, using vocabulary drawn from the Self-Management subject. Findings from phase three were divided into two aspects: formative testing demonstrated a high level of usability, particularly in terms of user satisfaction and application effectiveness, whereas summative testing showed an increase in the frequency of appropriate student responses, attributed to the implementation of scaffolding and modelling strategies by the teacher using MySuara. In conclusion, MySuara holds significant potential to enhance meaningful teacher-student interaction.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Severe communication impairments affect approximately 33% of people with intellectual and developmental disabilities (Ganz et al., 2017). These individuals experience complex communication needs (CCN), a condition characterised by insufficient speech and language abilities for engaging in everyday communicative interactions (Sigafoos & Gevarter, 2019). Children with complex communication needs have issues with speech production, speech and language comprehension, and difficulties acquiring reading and writing skills. The term "complex communication needs" is often used for children with significant speech and language impairments, excluding those who have merely speech delays or are deaf (Sigafoos & Gevarter, 2019). In general, many children with complex communication needs exhibit deficits in cognitive, motor, sensory, language, reading, and writing skills, directly or indirectly affecting their academic performance and social integration (Erickson & Geist, 2016). For over three decades, augmentative and alternative communication (AAC) has been instrumental in serving individuals with complex communication needs in the clinical and educational field (Joginder Singh et al., 2020), using various strategies and tools to augment or replace their speech production, primarily facilitating the expression of thoughts, needs, ideas, and language development (Joginder Singh et al., 2024; Lund et al., 2017; Radici et al., 2016).

Children with complex communication needs usually have fewer social interactive opportunities than their typically developing peers, mainly due to limitations in their communicative abilities. Past research has established a correlation between young children's early communication skills and their language development (Light,

Mcnaughton, et al., 2019; Light & Drager, 2007; Light & Mcnaughton, 2014). Riad et al. (2023) emphasised the importance of early language skills for academic achievement and literacy development, highlighting the role of interactions with peers and adults in enhancing these skills during the critical developmental period from birth to age five. In essence, children with well-developed communication skills will have better opportunities to participate in education, employment, healthcare, family life, and community activities compared to those who are at risk in all aspects of development (Light, Mcnaughton, et al., 2019; Light & Drager, 2007; Light & Mcnaughton, 2014).

Therefore, it is crucial to provide communicative intervention, such as augmentative and alternative communication, to children with complex communication needs as early as possible to increase their social interactions and enhance their learning opportunities. Augmentative and alternative communication systems have proven beneficial for children with complex communication needs, improving receptive and expressive communication skills while reducing challenging behaviours (Gaba, 2014; Light, Wilkinson et al., 2019; Radici et al., 2016).

Augmentative and alternative communication (AAC) refers to a system that utilises clinical and educational practices to compensate for speech-language production and/or comprehension, including spoken and written modes of communication used for individuals with communication needs (ASHA, 2020). An AAC system is an integrated group of components that enhance communication using tools and techniques such as tangible objects, manual signs, flashcards, gestures, picture communication boards, and speech-generating devices (Tönsing et al., 2019). The use of AAC can be permanent or temporary, depending on the severity of the individual's speech impairment that resulted from congenital or acquired disabilities. Congenital

disabilities include autism spectrum disorder, cerebral palsy, developmental disabilities, intellectual disability, developmental apraxia of speech, and genetic disorders. While acquired disabilities include cerebrovascular accidents, acquired brain injuries, and neurodegenerative diseases such as amyotrophic lateral sclerosis (ALS) and other temporary conditions.

1.2 Background

Teacher-student interaction, communication, and behaviour are deeply interwoven elements that collectively shape the dynamics of any classroom. In special education settings, teacher-student interaction takes on heightened importance due to the distinct needs and challenges faced by children with disabilities. Teacher-student interaction involves continuous, reciprocal exchanges that form the basis of classroom engagement (Syting et al., 2024; Tsai, 2016). These interactions are essential for establishing and reinforcing communication patterns and behavioural expectations (Tsai, 2016). For children with communication difficulties, the quality and consistency of these interactions play a vital role in supporting the development and application of new skills (Fu et al., 2020). Ideally, all children should receive equal opportunities for communicative exchange, but research shows that children with disabilities often experience fewer and less varied interactions compared to their typically developing peers (An et al., 2017).

The use of AAC systems can significantly improve teacher-student interactions, particularly for students with complex communication needs. However, in the United States, Andzik et al. (2017) found that special educators face persistent challenges such as limited training, lack of collaboration with other professionals, time constraints, and inconsistent AAC implementation. These issues often lead to the underuse or

abandonment of AAC devices, restricting students' communication and learning. Similarly, in Malaysia, AAC adoption remains limited. Yasin et al. (2020) reported that special education teachers generally have only moderate knowledge and skills in AAC, with insufficient training contributing to its minimal classroom use. These gaps impede inclusive education efforts and restrict meaningful participation for students with communication difficulties.

Teachers play a pivotal role in facilitating communication by offering frequent and diverse opportunities for interaction. Communication in the classroom involves ongoing verbal and nonverbal exchanges between teachers and students, where teachers initiate opportunities and expect student responses. These opportunities are vital for building children's communication skills and confidence (Tsai, 2016; Sabol & Pianta, 2012). However, in special education classrooms, such opportunities are often insufficient. Tsai (2016) found that only 28.2% of observed intervals containing interactions in special education preschool classrooms included a communication opportunity initiated by the teacher, with the majority focused on naming or commenting, and far fewer devoted to requesting, answering, or imitation. This limited exposure restricts children's chances to practice and generalise their communication skills, and may contribute to reduced engagement and slower skill acquisition.

Effective teacher-student interaction sets the stage for meaningful communication, which in turn is enacted through observable behaviours. Behaviour in the classroom encompasses both the actions of teachers and students during these communicative interactions. Teachers' interaction behaviours include providing prompts, cues, and structured opportunities for communication, while students' interaction behaviours involve responding to these opportunities in various ways-

appropriately, inappropriately, with prompts, or not at all (Tsai, 2016; Sigafoos, Roberts, et al., 1994). The study by Tsai (2016) revealed that 42% of the communication opportunities provided by teachers did not receive any response from students, highlighting a significant gap in reciprocal interaction. This lack of response may be attributed to both internal factors (such as limited communication skills in the child) and external factors (such as a classroom environment that does not sufficiently encourage or scaffold communication) (Tsai, 2016; Sigafoos et al., 1994).

In sum, teacher-student interaction, communication, and behaviour are intricately linked in shaping the classroom environment, especially in special education settings. Given the foundational role of teacher-student interactions in shaping communication and behaviour, particularly for children with complex communication needs, targeted interventions such as augmentative and alternative communication (AAC) become essential in supporting their development. Therefore, the current study further examines how the presence of the MySuara app influences teacher-student interaction behaviours, particularly in relation to the frequency, quality, and types of communicative exchanges that occur within special education classrooms.

History has witnessed ongoing efforts to support individuals with complex communication needs (Light, McNaughton, et al., 2019). Augmentative and alternative communication interventions have been pivotal in fostering speech development and supporting communication skills among children with complex communication needs (Beukelman & Mirenda, 2013; McNaughton & Light, 2015). The AAC systems began facilitating individuals with communication issues more than thirty years ago.

The earliest form of AAC is manual signs dating back to the 16th and 17th centuries (Mirenda, 2014). The “manual sign” is a natural sign language such as American Sign Language (ASL) (Mirenda, 2014), and for the Malaysian context is

Bahasa Isyarat Malaysia (BIM)(Abdul & Erman, 2020). Mirenda (2001) also observed that during the 1980s, sign languages combined with speech, known as total communication, were utilised to promote literacy among individuals with hearing impairments, autism spectrum disorder, and other significant disabilities. Since the 1920s, printed arrays of letters, phrases, pictures, and symbols in communication boards representing communicative messages categorised as low-tech AAC systems have served individuals requiring speech (Griffiths et al., 2019).

The augmentative and alternative communication system has evolved since its inception, progressing from manual signing to developing more advanced technology-based AAC tools. Consequently, low-tech AAC methods, such as communication boards and picture symbols, were slowly replaced or supplemented by more sophisticated high-tech solutions like speech-generating devices (SGDs) and mobile AAC applications (apps). High-tech AAC systems emerged in the 1960s, primarily to assist literate users using adapted typewriters and keyboards (Griffiths et al., 2019; Vanderheiden, 2002; Zangari, 2019). Technological advancements such as computers and laptops in the 1980s and 1990s contributed to compact, palm-fit, and portable dedicated voice output AAC systems such as GoTalk, 32-Message Communicator, and QuickTalker. Regardless of the system used, the primary aim of augmentative and alternative communication is to give individuals a voice and support their active social participation.

According to Boster and McCarthy (2017), mobile touch-screen devices provide a sense of comfort among children due to the pervasive influence of technology in today's society. Nowadays, children are exposed to touch-screen devices at the early stages of their lives, which are becoming an integral part of their early experiences. Consequently, extensive research has been undertaken to explore the application of

touch-screen devices as augmentative and alternative communication (AAC) tools for children with complex communication needs. These studies have reported positive outcomes, exposing notable improvement in the functional communication skills and prosocial behaviours of children with complex communication needs following the implementation of touch-screen devices such as tablets equipped with AAC applications (Alzrayer & Banda, 2017; Crowe et al., 2022; Skogly Kversøy et al., 2020).

Mobile touch-screen devices such as tablets and iPads are gaining popularity as speech-generating devices after the invention of smartphones (Alzrayer & Banda, 2017; Radici et al., 2016; Waddington, 2018). A system that "speaks" for its user is known as a speech-generating device (SGD), wherein speech is produced synthetically or recorded digitally (Muharib & Alzrayer, 2018; Romski & Sevcik, 2005). In general, tablets are widely accepted to facilitate speech and language development mainly due to their social acceptability, affordability, portability, availability, and flexibility (Alzrayer & Banda, 2017; Mcnaughton & Light, 2013; Radici et al., 2016; Tommy & Minoi, 2016; Waddington, 2018). Moreover, tablet-based AAC systems can transform any existing tablet into an AAC system by simply installing a suitable AAC mobile application (Alzrayer & Banda, 2017). The advancement of AAC applications, which come with a more extensive database of symbols, pictures, and texts (Radici et al., 2016), along with larger screen sizes and increased storage capacity, has contributed to the widespread acceptance of these tablets among users.

A range of AAC applications available in the app market comes with a price, such as Tobii Dynavox, Proloquo2Go, OneVoice, My Talk Tools, and iComm. Meanwhile, some applications are available without costs, such as PECS-Phase III, Tap To Talk, and Alexicom (Alzrayer & Banda, 2017). However, not all AAC applications suit children with complex communication needs. Some AAC applications are too

expensive, some are free, some are free for a short period, and others are simple versions of the original application (Amalfitano et al., 2013).

Among the most recently trending AAC apps, Avaz AAC and CoughDrop are considered practical for Malaysian users due to their multilingual support, affordability, and cultural adaptability. For instance, Avaz offers built-in Malay Text-To-Speech (TTS) and Asian-themed symbols that resonate with local users, making it highly suitable for diverse environments. CoughDrop, though reliant on device TTS for Malay, provides collaborative features and flexible web-based access, which are valuable in educational and therapeutic contexts. LetMeTalk, while basic and ad-supported, is a free alternative with potential for customisation, especially beneficial for low-income households.

Conversely, Proloquo2Go and Grid for iPad, though feature-rich, are less viable for the Malaysian context due to their high costs, lack of Malay language integration, and limited cultural relevance. TouchChat HD offers some advantages with cross-platform availability and mid-range pricing, but still falls short in terms of native Malay support and cultural representation. Overall, AAC apps that integrate Malay language support, allow for culturally relevant customisation, and function across multiple settings are vital to ensuring inclusive and effective communication in Malaysia's diverse linguistic and cultural landscape. Even though AAC apps like Avaz and CoughDrop may align well with Malaysia's linguistic and cultural needs, their adoption remains limited due to awareness and training. Research underscores the potential of these AAC apps but highlights the urgent need for localised adaptations, affordability initiatives, and policy support to scale usage in both educational and home settings (Aldabas, 2019).

The AAC apps available in app markets are predominantly designed to serve social and functional communicational purposes, facilitating interaction with family and caregivers. It is imperative to acknowledge the limitations of these AAC applications, such as the lack of age-appropriate vocabulary and inadequate graphics and symbols relevant to the classroom context, which may hinder the effective use of AAC applications in settings other than homes. For instance, in a study, Bright and Gadgil (2023) emphasised the importance of incorporating both cultural and linguistic nuances into the design and localisation of AAC apps to ensure their effectiveness and appropriateness for assistive technology users.

Additionally, most AAC applications are developed in English, making them unsuitable for Malaysian educational settings where the Malay language serves as the primary instructional medium in Malaysia's national schools (Joginder Singh et al., 2020; Joginder Singh & Loo, 2023). Similarly, Rajagopal and Low (2021) highlighted that the scarcity of AAC apps integrating local languages and contextually relevant material hinders their classroom adoption. Teachers, however, indicated a strong willingness to integrate such AAC tools into their practice if the apps were designed to align with subject-specific curricula and accommodate local linguistic needs. Therefore, designing an AAC application that aligns with Malaysia's linguistic, cultural, and educational needs is imperative.

The Special Education curriculum for students with low functional abilities in Malaysia emphasises the development of self-management skills ('Pengurusan Diri') to help special needs students achieve greater independence and confidence in daily life. The self-management curriculum covers essential areas such as personal hygiene, safety, health, emotional regulation, social integration, daily routines, money management, and household tasks, all structured to be practical and applicable in real-

life situations. The program aims to equip students with the knowledge, skills, and values necessary to navigate home, school, and community environments, fostering positive self-identity and preparing them for meaningful participation in society (Ministry of Education, 2011). Thus, the self-management syllabus has been referred to in the design and development process of the MySuara app, where almost 60% of the symbols were added in reference to self-management topics.

1.3 Problem Statement

Teacher-student dynamics significantly influence learning experiences and outcomes, particularly in special education contexts. Teacher-student interaction involves reciprocal verbal and nonverbal communication during instruction and classroom management (Weenusk, 2023). Some studies have found that teachers devote more attention to special needs students, adapting their teaching methods to meet the students' specific requirements (Fu et al., 2020). In such cases, these students may receive more individualized attention and concern from teachers than their typically developing peers. Positive teacher-student interactions have been linked to improved academic performance, social skills, and overall well-being for students with special needs (Hamre & Pianta, 2001).

The student-teacher interaction is crucial for students' emotional, behavioural, and academic adjustment (Allen et al., 2013; Syting et al., 2024), including students with disabilities. Conflicted teacher-student interactions may adversely affect students' life satisfaction, school attachment, and communication. For instance, a study by Blacher et al. (2014) revealed that students with autism spectrum disorder (ASD) often have less close and more conflicted relationships with teachers compared to students with intellectual disabilities or typical development. There are other similar studies that

reveal that special needs students, especially those with behavioural or learning issues, often interact less with teachers (Fu et al., 2020). Teachers may perceive their disabilities as unchangeable, resulting in limited engagement. Syting et al. (2024) mentioned that teachers' biases exist in classrooms. Based on a study conducted by Sedova and Navratilova (2020), the teacher's biases prevailed when high-achieving students received higher interaction opportunities, while the low-achieving and less engaging students, often called the "silent students," did not get to engage much in classrooms with teachers. As a result, these students may miss out on valuable learning opportunities and support.

Understanding teacher-student interaction dynamics in special education is crucial. Despite this, teacher-student interactions in special education have not been extensively studied. More importantly, the existing literature does not fully address how communication tools, such as AAC systems, can directly support these interactions in local contexts, like Malaysia. Thus, the current research employs a preliminary study to explore teacher-student interactions from the teachers' perspective, focusing on students with complex communication needs in Malaysian special educational classrooms in Penang and Kedah.

Communication is a fundamental human right (Bailey & Murray-Branch, 1993) that enables full participation in society (Biggs et al., 2018). However, children with complex communication needs (CCN) often struggle to express basic wants and needs, leading to significant life limitations (Biggs et al., 2018; Bonnike et al., 2018). Lacking functional verbal speech, these children may exhibit aggressive or self-injurious behaviours (Fodstad et al., 2018; Muharib & Alzrayer, 2018) and face emotional, social, and cognitive issues (Silva et al., 2018). They are also at risk of academic failure, social

exclusion, and bullying (Conti-Ramsden & Durkin, 2012). Thus, early identification and proper interventions to improve their communication skills are crucial.

Children with complex communication needs follow a similar communication development process as their typically developing peers but require more time, support, and often achieve different functional outcomes (Kaiser et al., 2001). Suitable supports, such as aided augmentative and alternative communication (AAC) systems like speech-generating devices (SGDs), can significantly aid their communication (Biggs et al., 2018). Enhanced social interactions and functional communication through AAC systems can also reduce behavioural issues (Muharib & Alzrayer, 2018).

Technological advancements now allow individuals with disabilities, including children with complex communication needs, to use high-tech AAC systems. Mobile apps have transformed devices into speech-generating devices, making augmentative and alternative communication more accessible than ever before (Romski et al., 2015). However, many AAC apps are primarily in English, with limited options in local languages, such as Malay, which is crucial for Malaysian special education (Ahmad & Zulkharnain, 2020; Chua & Gorgon, 2019; Kraleva & Kralev, 2018). Malay language AAC apps are only available only in research studies, such as 'AutiAct' by Ahmad and Zulkharnain (2020) and ‘Suara Saya’ by Fatimah et al. (2017), and not in Google Play Store or Apple App Store. In a study, 67% of Malaysian parents wanted AAC mobile apps for their children with complex communication needs (CCN), and 50% preferred apps in the Malay language for their children (Joginder Singh et al., 2017).

Children’s speech abilities are influenced by daily language input. Those who use speech receive rich spoken language input, aiding their expressive communication skills (Sennott & Mason, 2016). Conversely, children with CCN experience an asymmetry between spoken language input and their AAC-based output (Smith &

Grove, 2003). It is essential to model language input using the AAC system to bridge this gap (Sennott & Mason, 2016).

AAC modelling involves communication partners such as parents, educators, and therapists using the AAC system to provide both aided and unaided communication modalities (Sennott et al., 2018; Walker et al., 2018). Aided AAC involves external tools like communication boards or devices, while unaided AAC includes gestures, signs, and facial expressions. Effective AAC modelling helps children with complex communication needs learn to use their devices (Muttiah et al., 2019).

While many studies have examined AAC systems from clinical or technical perspectives, there is a lack of research that begins with a clear needs assessment conducted directly with practitioners—those who will implement these systems in classrooms (Andzik et al., 2017; et al., 2020). This study responds to that gap by conducting a preliminary qualitative exploration with special education teachers in Penang and Kedah to understand their communication needs, expectations, and challenges when interacting with students with complex communication needs. Therefore, the needs analysis guides the entire study, ensuring that the MySuara app aligns with the real experiences and teaching needs of special education teachers in classrooms.

Special education teachers, who are directly involved in aiding their students with complex communication needs, have the power to make decisions for the benefit of their students. Therefore, gathering their feedback on their expectations and needs for AAC apps through a preliminary interview study is crucial. Based on this feedback, the AAC mobile application MySuara was designed and developed to address communication and interaction gaps, aiming to enhance interactions between teachers and students with complex communication needs. By focusing on the actual needs of

users, this approach enhances the relevance and suitability of the intervention, thereby increasing the likelihood of long-term use, teacher adoption, and meaningful outcomes for students.

The rapid growth and increasing complexity of mobile applications present significant challenges for developers in terms of efficient development and maintenance. There is a significant gap in existing research, as traditional software development life cycles, such as the waterfall, spiral, and prototyping models, do not adequately address the unique challenges of mobile application development (Khandelwal & Tyagi, 2015). Laudson and Gibeon (2014) identified 13 key characteristics of mobile systems, including limited energy and memory, simplified graphical and input interfaces, varying bandwidth and connectivity options, the need to adapt to changing user contexts and environments, limited performance and processing power, constant interruptions requiring offline and online synchronization, portability across devices and operating systems, optimized response time, and the choice between native and web-based application design. These are the key factors that the traditional software development lifecycle models fail to consider for developing mobile applications (A. Kaur & Kaur, 2018; Shanmugam et al., 2019; Vithani & Kumar, 2014). Therefore, a dedicated lifecycle model is needed to address these distinct challenges and ensure robust and optimised control applications.

The MADLC model consists of six stages: identifying application requirements, designing the application, developing the application using various tools and technologies, creating a prototype to test and refine the application, testing the application for functionality, performance, and usability, and maintaining the application after its release (Shanmugam et al., 2019). This study focuses on developing the MySuara mobile app prototype using the Mobile Application Development

Lifecycle (MADLC) model, as this lifecycle allows mobile developers to successfully create robust and optimized control applications (Vithani & Kumar, 2014).

Many augmentative and alternative communication (AAC) applications developed for students with complex communication needs (CCN) to help them communicate with others. However, there is still a critical need for mobile apps that effectively support teacher-student communication for those with CCN. Despite the wide availability of AAC apps designed to improve communication, many do not fully meet usability requirements, resulting in low adoption and high abandonment rates (Smidt & Pebdani, 2023; Waller, 2019).

In a study, Joginder Singh et al. (2023) found that parents abandoned AAC systems due to a lack of support from teachers, as parents felt no need to continue using it at home if teachers did not support it in school. Therefore, the MySuara mobile application was developed to be utilised by both teachers and students with complex communication needs in their classrooms for enhancing teacher-student interactions. To ensure its effectiveness, a thorough usability assessment is crucial. The PACMAD (People At the Centre of Mobile Application Development) usability model, proposed by Harrison et al. (2013), offers a comprehensive framework for this evaluation, focusing on attributes such as effectiveness, efficiency, satisfaction, learnability, memorability, error-handling, cognitive load, and timeliness. This study aims to use these attributes to rigorously assess the usability of the MySuara app and prevent future abandonment issues related to AAC applications. Formatively assessed MySuara app for its usability, was evaluated for its impact on teacher-student interaction via summative assessment.

The interaction between a special education teacher and a student with complex communication needs is crucial for effective learning outcomes. Research has

consistently shown that positive teacher-student interactions are essential for supporting the academic, social, and emotional development of students, especially those with special needs. For instance, Fu et al. (2020) and Goble et al. (2019) found that positive teacher-student interactions significantly impact the learning outcomes of students with special needs. Similarly, Murray and Pianta (2007) and Pianta et al. (2020) highlighted the importance of teacher-student interactions in promoting the academic, social, and emotional development of students with special needs.

However, the lack of suitable tools, such as augmentative and alternative communication systems, can hinder social interactions, leading to difficulties in communication and understanding (Anwar & Juliet E. Hart, 2024). Students with complex communication needs, such as those with autism, intellectual disabilities, or severe speech and language impairments, often face significant challenges in expressing their thoughts, needs, and preferences effectively (Hofmann & Müller, 2021). This can create barriers in the teacher-student relationship and limit the student's ability to fully engage in the learning process (Fu et al., 2020).

This study aims to investigate how the MySuara mobile application influences the teacher-student interaction behaviours between a special education teacher and a student with complex communication needs dyad.

1.4 Purpose of the Study

The purpose of the study is to explore teacher-student interaction behaviours in special education classrooms through interviews with teachers and use this information to design, develop and evaluate an augmentative and alternative communication (AAC) mobile application for its usability and impact of AAC application on dyadic interactions between a teacher and a student with complex communication needs. The

study is expected to provide empirical evidence and practical solutions to enhance communication and engagement in special education classrooms, contributing to assistive technology and improving educational experiences for students with complex communication needs.

1.5 Research Objectives

The objectives of this research are:

1. Based on the teachers' preliminary study reports:
    1.1. To explore the interaction behaviours of special education teachers and their students with complex communication needs.
    1.2. To examine teachers' expectations and requirements for the augmentative and alternative communication (AAC) mobile applications.
2. To design a mobile application, MySuara, based on teachers' feedback.
3. To develop a mobile application prototype, MySuara, based on the design outlined previously using the Mobile Application Development Lifecycle (MADLC) model.
4. To evaluate the usability of the developed MySuara mobile application based on eight attributes:
    4.1. To evaluate the effectiveness level of MySuara.
    4.2. To evaluate the efficiency level of MySuara.
    4.3. To evaluate the satisfaction level of MySuara.
    4.4. To evaluate the learnability level of MySuara.
    4.5. To evaluate the memorability level of MySuara.
    4.6. To evaluate the error-handling level of MySuara.

4.7. To evaluate the level of cognitive load of MySuara.

4.8. To evaluate the timeliness level of MySuara,

5. To evaluate the impact of the developed MySuara mobile application on teacher-student interaction behaviours between a special education teacher and a student with complex communication needs.

1.6 Research Questions

Based on research objectives, the following research questions were formulated:

1. Based on the preliminary study feedback from teachers:
   1.1. How do teachers and students with complex communication needs interact in their classrooms?
   1.2. What are their expectations and requirements for the augmentative and alternative communication (AAC) mobile applications they wish to implement in their classrooms?
2. How was the MySuara mobile application designed based on the feedback from Research Questions 1.1 and 1.2?
3. How was the MySuara mobile application prototype developed using the Mobile Application Development Lifecycle (MADLC) model based on the design outlined in Research Question 2?
4. What is the usability of the developed MySuara mobile application based on the PACMAD's attributes:
   4.1. What is the effectiveness level of the MySuara mobile application?
   4.2. What is the efficiency level of the MySuara mobile application?
   4.3. What is the satisfaction level of the MySuara mobile application?

4.4. What is the learnability level of the MySuara mobile application?

4.5. What is the memorability level of the MySuara mobile application?

4.6. What is the error-handling level of the MySuara mobile application?

4.7. What is the cognitive load level of the MySuara mobile application?

4.8. What is the timeliness level of the MySuara mobile application?

5. How does the MySuara mobile application impact the teacher-student interaction behaviours between a special education teacher and a student with complex communication needs dyad?

1.7 Significance of Study

The significance of this study lies in the design and development of a mobile application tailored to enhance teacher-student interactions involving students with complex communication needs. This research addresses a critical gap in special education settings, where students with complex communication needs face challenges in communication that hinder their full participation and engagement in schools.

The developed AAC application, MySuara, focuses on providing students with complex communication needs a pathway to enhance communication, literacy skills, academic engagement, social integration, and overall improved quality of life. Unlike other AAC applications, MySuara does not require the involvement of speech-language therapists to introduce AAC systems to novice users and their caregivers. The application incorporates embedded scaffolding strategies through 'AAC modelling' phases, enabling communication partners, such as teachers, to train students with complex communication needs to learn how to use AAC apps.

The inclusion of multiple languages within the MySuara application, including Malay, English, Tamil, and Mandarin, further amplifies its usability and suitability for

Malaysian students studying in national schools. This multilingual feature allows students to communicate using their preferred language, addressing the diverse linguistic needs of the target population.

Overall, this study aims to contribute to the field of assistive technology and improve the educational experiences of individuals with complex communication challenges by providing empirical evidence and a practical solution to enhance communication and engagement in special education classrooms.

1.8 Limitations of the study

The current study is subject to several limitations that warrant acknowledgement. Firstly, it is constrained geographically to two states, Kedah and Penang, which may limit the generalisability of the findings to other regions within the country. Participant selection for the preliminary stage, usability and effectiveness assessments exclusively targeted individuals from these two states. Such geographical constraints may consequently limit the generalisability of the study's findings beyond the confines of these localised regions, thereby necessitating caution in the interpretation of findings on a national scale. Secondly, the study exclusively focuses on schools offering the Special Education Integration Programme(PPKI), potentially limiting the representativeness of the participants' characteristics and experiences to the broader Malaysian educational context.

Thirdly, a significant limitation of this research is the impact of the COVID-19 pandemic, particularly the closure of schools during the lockdown period. The pandemic disrupted regular school operations, rendering the recruitment of teachers challenging, especially considering their already heightened workloads and stress due to the transition to remote teaching. Consequently, the pandemic necessitated a shift to

online data collection methods, such as virtual surveys and interviews, potentially influencing participant engagement and response rates. For example, the usability assessment of the MySuara app involving three special education teachers and two speech-language therapists was conducted via Zoom video conferencing. As a result, participants faced technical difficulties and limited access to reliable internet connections, which may have affected the quality of the interviews and surveys, thus introducing biases or data inconsistencies. Additionally, the lockdown altered the typical educational environment, making it difficult to evaluate the efficacy of mobile applications in a conventional classroom setting. Given that schools were closed, teacher-student interactions occurred in the student's home, potentially deviating from the usual dynamics of such interactions in a school setting.

Fourthly, the study's limited number of participants may impact its statistical power and the ability to draw broad conclusions. The current study involves qualified special education teachers affiliated with national schools. The population of special education teachers and students with complex communication needs is notably limited, and obtaining their consent to participate in the study proves challenging. Therefore, only a modest number of participants were selected. For example, the efficacy study of MySuara employs a single case study design, focusing on an in-depth examination of a single individual or a small group. While this approach provides a rich, contextual understanding of participants' experiences with the AAC mobile app, it inherently limits the sample size. With only one or a few participants, the statistical power may be reduced, making it difficult to detect significant effects or generalize findings to a larger population of special education teachers and students with complex communication needs. Individual differences or outliers may skew results, as the unique characteristics of the limited participants can heavily influence findings. The current study includes a

preliminary interview with five participants and a usability survey with 14 participants, which may further limit robust conclusions. Although the interview study offers valuable insights, it may not capture the full range of opinions and needs within the larger population. Therefore, the limited number of participants may impact the comprehensive evaluation of the AAC mobile app's effectiveness and satisfaction across a diverse user base.

Time constraints significantly limited this study's participant recruitment, implementation, and overall data collection process. The COVID-19 pandemic caused school closures, complicating recruitment and delaying data collection. Evaluating the MySuara mobile app's impact on teacher-student interactions was particularly challenging due to the nationwide lockdown. The duration of the intervention and evaluation period may have been insufficient to capture long-term effects and outcomes. Changes in teacher-student interactions and communication skills may require extended periods to manifest fully, and short-term studies may not provide a complete picture of the app's impact. Consequently, the results may not be fully applicable to all educational settings.

In addition to these constraints, the prolonged duration required for application development further accentuates the study's limitations. The mobile application development cycle is inherently iterative, requiring multiple phases: design, development, testing, and refinement. This iterative cycle necessitated additional time to ensure the app's functionality and usability before arriving at the final prototype. The extended development timeline delayed the start of the intervention and evaluation phases, further constraining the study period. Additionally, the iterative nature of development may have introduced variability in the app's features and usability over time, potentially affecting the consistency of the data collected.

1.9 Operational Definitions of Terms

The following terms have been operationally defined to suit this study.

1.9.1 Special Education

According to the Malaysian Education (Special Education) Regulations 2013, special education means "an education for a student with special educational needs in a special school or school which implements the special education integrated programme or Inclusive Education programme". These programmes are provided at preschool, primary, secondary, and post-secondary schools (Kementerian Pendidikan Malaysia, 2013, p9). The special education integrated programme is also commonly known as 'Program Pendidikan Khas Integrasi (PPKI)'. For this study, special education refers to special education integrated programmes where students with complex communication needs are placed among other students with learning disabilities.

1.9.2 Teacher-Student Interaction

Teacher-student interactions are the building blocks of solid teacher-student relationships associated with students' academic and behavioural outcomes, including those with special needs (Koenen et al., 2019). Effective teacher-student communication enhances learning outcomes (Li & Yang, 2021) and fosters a better classroom environment. Therefore, gaining an in-depth understanding of the teacher-student interactions and how these interactions affect communicative behaviours in classrooms is crucial.

Interactions can be observed in various forms, including online-classroom, dyadic, whole-class, or small group interactions, which vary according to the settings (Flieller et al., 2016). In special education settings, dyadic interactions are vital for supporting learning, communication, and social development. Teachers facilitate these opportunities by asking questions, providing prompts, or making comments, thereby

encouraging students to engage and develop their communication skills (Tsai, 2016). Ultimately, interaction is a mutual, dynamic process that shapes meaningful teacher-student connections and enhances the learning experience.

For the context of the current study, teacher-student interaction is formally defined as the observable verbal and nonverbal actions exchanged between teachers and students that occur within structured or spontaneous communicative events in the classroom. Thus, often termed as communicative behaviours. These communicative behaviours encompass teacher-initiated strategies such as prompts, cues, modelling, and structured communication opportunities, while student responses are appropriate, with or without support (Tsai, 2016; Sigafoos, Roberts, et al., 1994). In special education contexts, where students often present with complex communication needs, these interaction behaviours play a critical role in facilitating communication development, reinforcing behavioural norms, and promoting classroom engagement (Syting et al., 2024; Fu et al., 2020). The frequency, quality, and diversity of these interactions significantly influence students' opportunities to practise, generalise, and acquire essential communication skills (An et al., 2017; Sabol & Pianta, 2012). The frequency of each type of communication opportunity and responses are recorded as suggested by the original author, Sigafoos et al. (1994).

Teachers use five types of communicative opportunities to engage with their students: requesting, naming or commenting, answering, imitation or echoic behaviour, and no communication opportunities (Sigafoos, Roberts, et al., 1994). These types of communication opportunities that teachers provide are based on Skinner’s (1957) functional taxonomy of verbal behaviour. Requesting opportunities occurred when teachers offered items that children might want or need, waiting at least 3 seconds for the child to make a request. For example, a teacher might hold a candy and ask, "Would