

**AN EXPLORATORY CASE STUDY OF IMPLEMENTING PARTICIPATORY CO-
DESIGN OF A DIGITAL HEALTH SOLUTION FOR LIFE SKILLS DEVELOPMENT
OF LEARNERS WITH AUTISM SPECTRUM DISORDER IN LOW RESOURCE
CONTEXTS**

GENEVIEVE RUTH VILLAMIN

Thesis submitted to the University of Ottawa
in partial Fulfillment of the requirements for the
Doctor of Philosophy Digital Transformation and Innovation

Faculty of Engineering
University of Ottawa

© Genevieve Ruth Villamin, Ottawa, Canada, 2026

Abstract

This exploratory case study examined the envisioned features of a digital health solution designed to support individuals exhibiting behaviors consistent with moderate to severe autism spectrum disorder (ASD). The proposed solution sought to facilitate learning by integrating learners' interests and strengths while accommodating their challenges and support needs. The design adopted an individualized and personalized approach guided by learners' primary support systems, including parents and teachers.

Conducted over 20 months, the study engaged parents and teachers of learners with ASD in a low-resource area in Metro Manila, Philippines. A participatory and co-design approach was employed, combining qualitative surveys and interviews with design thinking, requirements engineering, and iterative development methodologies to inform the conceptualization of a digital life-skills learning solution.

To establish a foundation for design, the research first examined documented characteristics of learners with moderate-to-severe ASD through empathy mapping and persona development, informed by existing literature. Building on this foundation, direct engagement with parents and teachers provided contextualized insights into learners' lived realities. Participants described students as demonstrating notable strengths in creative domains while experiencing significant challenges in daily living skills, behavioral regulation, and communication. Parents frequently balanced caregiving with employment responsibilities amid limited financial and social support, relying on nurturing, structured, and interest-driven approaches. They reported persistent difficulties related to behavioral and sensory regulation, financial strain, limited access to specialized services, and minimal extended-family support. Educators likewise encountered constraints, including diverse learner needs, limited training,

resource scarcity, uneven workloads, insufficient institutional backing, and inconsistent parental involvement - factors that contributed to burnout and constrained educational outcomes.

These layered insights informed the subsequent synthesis and co-design process, during which findings from literature and stakeholder experiences were translated into actionable design elements. Drawing on human-centered, inclusive, and agile principles, the research team developed a digital health solution encompassing 45 integrated design themes. These features included customizable visual learning activities informed by video modeling and task analysis, gamified positive reinforcement systems, visual scheduling supports, behavior and emotion regulation tools, individualized learning plans, communication functionalities, and a platform to foster digital community-building among families and educators.

Several limitations shaped the study's trajectory. Direct participation was limited to parents and teachers, as learners themselves were not involved in data collection or co-design activities, thereby constraining the extent to which their firsthand perspectives were represented. Heavy workloads, limited participant availability, and resource constraints further reduced opportunities for collaborative workshops, necessitating greater reliance on surveys and interviews: the small, localized sample - predominantly male learners, limited generalizability, and restricted examination of gender-related differences. Infrastructure challenges, including connectivity issues and varying levels of digital literacy, affected prototype interaction, while technical constraints delayed full feature implementation. Future research should address these considerations to enhance robustness, inclusivity, usability, and scalability.

Despite these limitations, the study contributes to the fields of digital health solution and educational technology for ASD by articulating potential digital capabilities that may expand access to evidence-informed learning supports in low-resource settings. The proposed solution

offers mechanisms to reduce caregiver burden, empower parents in home-based instruction, and equip educators with tools suited to resource-constrained environments. Collectively, these contributions advance the pursuit of more equitable, sustainable, and impactful autism services, particularly in underserved communities where traditional supports remain limited.

Table of Contents

Abstract	ii
List of Abbreviations.....	xi
Chapter I: Introduction	1
Life skills development and quality of life	4
Inclusive education and the need for support tools	6
Digital health solution, assistive technology, and equity in ASD support	7
Low resource areas	8
Research gap and rationale	9
Statement of the problem	10
Purpose of the study	11
Research questions	12
Delimitations and limitations	13
Significance of the study.....	14
Thesis Organization.....	15
Chapter II: Literature Review.....	18
Low resource areas	18
Lack of universal health coverage and service fragmentation in the Philippines.....	20
Structural and economic barriers in LMICs	22
Diagnostic inequities among marginalized populations	22
Cultural and linguistic barriers	23
Social vulnerability and geographic disparities	24
Caregiver burden and quality of life in underserved contexts.....	24
Challenges and needs of parents and families.....	26
Language barriers, limited access to information, training and education.....	26
Poor parent - teacher collaboration	29
Systemic and structural barriers.....	30
Financial and resource challenges	32
Emotional, psychological stress and personal sacrifices.....	35
Cultural beliefs, discrimination, and stigma.....	40
Social challenges.....	43
Challenges and needs of individuals with ASD	45
Physical health, motor, and nutrition challenges	46
Sensory sensitivities	48

Behavioral challenges	49
Social integration and relationships	51
Emotional and psychological challenges	54
Life skills and independence	55
Communication challenges	59
Academic challenges.....	60
Financial challenges and transition to adult life	63
Challenges and needs of educators.....	64
Behavioral challenges of learners	65
Communication and social interaction.....	65
Diverse learning needs	66
Insufficient training and professional development.....	68
Limited collaboration and support networks	71
Resource constraints	72
Huge class size and workloads	74
Cultural and attitudinal barriers	76
Poor parental engagement	78
Teacher well-being and mental health	80
Systemic and policy-level barriers.....	82
Alternative solutions in low-resource settings	85
Parent-implemented interventions	85
Task-sharing and non-specialist delivery models.....	86
Barriers to implementation in LMICs and marginalized communities.....	87
Community engagement and participatory design	88
Systemic policy barriers and opportunities for reform	89
Health equity and digital technology.....	90
Digital health solution’s potential to bridge the gap	91
Characteristics of digital health solution.....	92
Industry standards for digital health solution	94
Best practices in design and development.....	97
Data privacy, PII, PHI, and regulatory frameworks	97
Digital health solution for ASD life skills development	99
Content supported.....	100
Capabilities and Features.....	102

Life skills addressed and digital interventions used	106
Digital interventions used to teach life skills	109
The TEACCH model enables structured learning.....	114
Components of TEACCH	116
Visual information.....	116
Organization of the physical environment.....	116
Task organization.....	118
Work systems.....	119
Parent-implemented intervention	120
Skills that can be taught using PII	121
Coaching parents to implement PII.....	121
Methods that parents can implement using PII	122
Designing digital health solution with individuals with ASD	123
Methodologies to design and evaluate digital health solution for ASD	125
Theoretical framework.....	131
How humans process information	132
Cognitive load theory.....	132
Dual coding theory.....	134
Cognitive theory of multimedia learning	135
Words as social tools theory.....	136
Information processing in ASD	138
Theory of mind.....	138
Executive dysfunction theory.....	140
Weak central coherence theory.....	143
Enhanced perceptual functioning theory.....	145
Vygotsky’s sociocultural theory of learning	146
Dialectical Misattunement theory.....	147
A learner-centered paradigm of education to support ASD learning	149
Theoretical framework to design a digital health solution for ASD.....	154
Summary	158
Chapter III: Methodology	161
Research design.....	164
Case study based participatory design	164
Qualitative survey and interviews.....	167

Design thinking.....	168
Requirements engineering	169
Types of requirements.	170
Iterative methodology	173
Context and boundaries of the case	174
Research questions.....	174
Sampling	175
Participants.....	176
Research team and their roles	178
Researcher’s positionality.....	179
Data sources	181
Data collection.....	181
Instrument and materials.....	184
Data analysis procedure	185
Thematic analysis.....	185
Quantitative analysis	186
Within case analysis.....	187
Document analysis	188
Pattern matching	188
Logic models	188
Participatory design focused analysis	188
Ensuring trustworthiness.....	189
Ethical considerations	190
Summary	194
Chapter IV: Findings.....	195
RQ1: What are the capabilities, interests, challenges and needs of learners with moderate to severe ASD	195
Findings from workstream 1: literature review research and design thinking	196
Empathy map of learners	196
User persona of learners	197
Findings from workstream 2: qualitative surveys and interviews	198
Demographics.	198
Capabilities of learners.	203
Interests of learners.....	206
Needs and challenges of learners.	215

Findings from workstream 3: Iterative design and development	223
Updated user persona of learners	223
RQ 2: What are the challenges and needs of parents and teachers in teaching life skills to learners with moderate to severe ASD	226
Findings from workstream 1: literature review research and design thinking	227
Empathy map of parents	227
User persona of parents	227
Empathy map of teachers.....	228
User persona of teachers.....	229
Findings from Workstream 2: qualitative surveys and interviews	230
Parent demographics.....	231
Parenting styles.	235
Pain points.....	241
Needs and goals.....	245
Teacher demographics.	250
Teaching styles.....	256
Pain points.....	258
Needs and goals.....	260
Perspective on digital education tools.	261
Findings from workstream 3: Iterative design and development	263
Updated user persona of parents and teachers.	263
RQ 3: What capabilities, features, and processes are essential for developing a digital health solution that effectively supports learners with moderate to severe ASD, parents, and educators	269
Findings from Workstream 1: literature review research and design thinking	270
Design themes derived from literature review.	270
Findings from Workstream 2: qualitative surveys and interviews	271
Integration of primary and literature review	289
Workstream 3: Iterative design and development	290
Alpha Version.	290
Beta version.....	296
Charlie version.	317
Process to design a digital health solution in low-resource areas	333
Identifying and understanding user needs, designing ideation, and building the technical foundations.	334

Ideating user requirements	336
Design, prototyping and iterative development cycle 1	337
Design and iterative development cycle 2.....	338
Fourth stage - future	339
Summary	341
Chapter V: Analysis.....	343
Learner strengths, challenges, and engagement needs	343
Caregiver challenges and support needs	346
Teacher challenges and instructional needs	349
Cross-stakeholder pattern synthesis	351
Theoretical integration and how it informed the design	352
Capability and feature prioritization for the Odyssey digital health solution	357
Analysis of the iterative design process.....	359
Identifying and understanding user needs: foundations for design ideation.	360
Envisioning user requirements through primary data collection	362
Design and development cycle 1: Prototype refinement and teacher feedback	363
Design and development cycle 2: parent-oriented expansion	365
Evaluation and refinement (future work)	366
Chapter Summary.....	366
Chapter VI: Conclusion	369
Summary of Major Findings	370
Learners with moderate to severe ASD	370
Parents of learners with moderate to severe ASD	371
Teachers and educators	373
The participatory design processes	374
Recommendations	375
Limitations	377
Future Directions	379
Conclusion	380
Appendix	382
Bibliography.....	437

List of Abbreviations

Abbreviation	Full term	Description
AAC	Augmentative and Alternative Communication	Communication supports for minimally verbal learners
ABA	Applied Behavior Analysis	Behavioral intervention approach referenced in autism education
ACL	Agile Creative Labs	Industry partner supporting Odyssey development
ADHD	Attention-Deficit/Hyperactivity Disorder	Mentioned as related neurodevelopmental condition
ADL	Activities of Daily Living	Life-skills domain targeted by the intervention
AI	Artificial Intelligence	Used for recommendations and content support
ASD	Autism Spectrum Disorder	Central population of the study
ASMR	Autonomous Sensory Meridian Response	Appears in sensory-related discussion/examples
CLT	Cognitive Load Theory	Learning theory guiding UI simplification
CTML	Cognitive Theory of Multimedia Learning	Multimedia learning foundation
CSS	Cascading Style Sheets	Part of hybrid app tech stack
DCT	Dual Coding Theory	Visual + verbal learning support theory
DLS	Daily Living Skills	Target skill category for learners
DT	Design Theme	Main qualitative synthesis output (DT#1–DT#45)
EDT	Executive Dysfunction Theory	Autism-specific cognitive framing
EF	Executive Functioning	Cognitive domain considered in design
EPF	Enhanced Perceptual Functioning Theory	Autism perceptual strengths theory
EU	European Union	GDPR regulatory context
FDA	Food and Drug Administration	Digital therapeutics regulation reference
GDPR	General Data Protection Regulation	EU privacy compliance
HCI	Human–Computer Interaction	Core disciplinary framing
HIPAA	Health Insurance Portability and Accountability Act	U.S. health privacy regulation
HTML	HyperText Markup Language	Used in Cordova hybrid development
IEP	Individualized Education Plan	Personalized learner planning feature

IMDRF	International Medical Device Regulators Forum	SaMD guidance body
ISO	International Organization for Standardization	Digital health solution standards
IoMT	Internet of Medical Things	Connected health device ecosystem
iOS	Apple Mobile Operating System	Mentioned in cross-platform development
JA	Joint Attention	Autism developmental skill referenced
LCE	Learner-Centered Education	Foundational educational paradigm
LMICs	Low- and Middle-Income Countries	Low-resource context framing
mHealth	Mobile Health	Digital health solution delivery type
MVP	Minimum Viable Product	Future product roadmap stage
MySQL	My Structured Query Language	Backend database used
PHI	Protected Health Information	Sensitive health data category
PII	Personally Identifiable Information	Privacy compliance concept
PoC	Proof of Concept	Early prototype validation stage
QMS	Quality Management System	ISO 9001 compliance framing
QoL	Quality of Life	Outcome domain for caregivers/learners
RA	Republic Act (Philippines)	Disability policy references (RA 7277, etc.)
REB	Research Ethics Board	Ethics approval process
RQ	Research Question	Dissertation structure (RQ1–RQ3)
SaMD	Software as a Medical Device	Regulatory classification
SNED	Special Needs Education	Education context in low-resource settings
TEACCH	Treatment and Education of Autistic and Communication-Handicapped Children	Structured autism education model
ToM	Theory of Mind	Autism social cognition theory
UI	User Interface	Prototype design focus
UNIDO	United Nations Industrial Development Organization	Philippines economic context reference
UX	User Experience	Evaluated via think-aloud + feedback
WCC	Weak Central Coherence Theory	Autism cognitive processing style
WHO	World Health Organization	Digital health solution definition + equity framing
XML	Extensible Markup Language	Mentioned in Android native development

Chapter I: Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder defined by persistent difficulties in social communication and social interaction across multiple contexts, together with restricted and repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2022).

Social communication challenges may involve reduced reciprocity in conversation or emotional exchange, limited or atypical use of nonverbal communication such as eye contact and gesture, and difficulty developing and sustaining relationships appropriate to one's developmental level. The behavioral domain includes characteristics such as repetitive motor movements or speech, strong adherence to routines, highly focused interests that are intense or unusual in focus, and atypical responses to sensory input, including heightened or diminished sensitivity. For a diagnosis to be made, these features must be present in the early developmental period, even if they become more evident as social demands increase, and they must result in clinically significant impairment in everyday functioning. The diagnosis is not assigned if the presentation is better explained by intellectual disability or global developmental delay, although co-occurring conditions are common (American Psychiatric Association, 2022).

The Diagnostic and Statistical Manual of Mental Disorders conceptualizes autism as a spectrum to reflect variation in presentation and support needs. Severity is specified according to the level of support required in the domains of social communication and restricted, repetitive behaviors. Individuals identified as Level 1 require support and may experience noticeable social and behavioral challenges without assistance. Level 2 indicates a need for substantial support,

with marked impairments in communication and more apparent restricted or repetitive behaviors. Level 3 reflects very substantial support needs, characterized by severe communication difficulties, limited initiation of interaction, and behaviors that significantly interfere with daily life. These levels are intended to guide understanding of current support requirements and may change over time depending on developmental progress and contextual demands (American Psychiatric Association, 2022).

As ASD exists on a spectrum, individuals who exhibit behaviors consistent with moderate to severe ASD often experience substantial challenges in communication, daily functioning, and independence. These individuals may have limited or no spoken language, rely on gestures or vocalizations to communicate, display repetitive physical behaviors, and require continuous support to manage everyday routines (Brodhead et al., 2017).

In recent years, the term profound autism has been introduced in the literature to describe individuals who are minimally verbal or have significant cognitive impairment and require high levels of supervision and lifelong support (Hughes et al., 2023; Lord et al., 2024). While autism research increasingly recognizes the diversity of the spectrum, individuals with higher support needs remain among the most underserved populations in both intervention research and service delivery systems.

Communication in severe ASD

Children with severe ASD, especially those who are minimally verbal, experience significant difficulties with communication that extend beyond the absence of speech. Their challenges affect how they initiate interaction, respond to others, use symbols, and participate in shared activities. Many preschool-aged children with ASD and severe communication

impairments produce very few spoken words and instead rely on gestures, vocalizations, physical guidance, or behavior to express needs and preferences (Koppenhaver & Erickson, 2003; Thiemann-Bourque et al., 2012). Communication in these children is often limited in range and may primarily serve instrumental purposes, such as requesting tangible items or escaping demands (Hoffman & Falcomata, 2014).

Research also shows that communication in severe autism is closely connected to play and broader cognitive development. Symbolic play, such as pretending that one object represents another, typically emerges alongside early language development. In preschoolers with severe communication delays, including those with autism, play skills are strongly related to language and cognitive levels. Children who have lower language abilities tend to demonstrate less complex symbolic play. However, when children with ASD are compared to peers with other developmental delays who have similar language levels, their play behaviors are often more similar than different (Thiemann-Bourque et al., 2012). This suggests that communication differences are closely tied to overall developmental level rather than being unique to autism.

Emergent literacy research provides additional insight into communication patterns. In young children with autism, oral language ability is strongly associated with early literacy skills. Children with more severe language impairments tend to show lower performance on measures of emergent literacy. Their skill profiles are often uneven. For example, some children may recognize letters but struggle to understand how print functions in meaningful ways (Lanter et al., 2012). In classrooms where literacy materials are limited or highly controlled, children with severe communication impairments may show little spontaneous engagement with books or writing tools (Koppenhaver & Erickson, 2003). When print materials and writing tools are made

accessible in natural contexts, children demonstrate increased interest and more sophisticated use of these materials over time (Koppenhaver & Erickson, 2003).

Behavioral research further highlights the vulnerability of communication in this population.

When children are explicitly taught functional communication responses, such as requesting with a card exchange or a switch, they can learn to use them effectively. However, if reinforcement is withdrawn, previously extinguished behaviors may reappear (Hoffman & Falcomata, 2014). This finding reveals that communication in severe autism can be highly sensitive to environmental conditions and requires consistent support.

Relational approaches such as Intensive Interaction emphasize that communication begins with foundational social skills, including shared attention, turn-taking, and emotional connection. Rather than focusing only on spoken language, this approach supports the development of early communication through responsive, reciprocal engagement. For children with severe ASD, these early social foundations are often areas of difficulty. Still, they can develop when adults intentionally adjust their pace, follow the child's lead, and create opportunities for mutual interaction (Mourière & McKim, 2018).

Life skills development and quality of life

Individuals with severe ASD often remain dependent on their caregivers well into adulthood. They often struggle to acquire and maintain essential life skills, such as managing hygiene, preparing food, or navigating their environment. Many experience significant cognitive, linguistic, and adaptive challenges, making it difficult to process and organize information. Language delays and atypical speech patterns are common, and some may never develop spoken communication (Rea et al., 2018).

Because of these limitations, many individuals with severe ASD experience a reduced quality of life compared to their neurotypical peers. This disparity is influenced by a combination of social isolation, limited access to employment and education, and heightened vulnerability to mental health conditions such as anxiety and depression (Balbin et al., 2022). Co-occurring conditions such as intellectual disability and sensory sensitivity can further intensify autism related challenges, increasing the need for individualized and sustained support (Waizbard Bartov et al., 2024). Individuals with higher support needs often face barriers to autonomy, inclusion, and self-determination, resulting in lower overall well-being (Mason et al., 2018; Morisse et al., 2013).

The consequences of these unmet needs are evident in outcomes for youth and adults with ASD, even those who are considered high functioning. For example, only 12 percent of high-functioning individuals with ASD are in paid employment, and only 15 percent of young adults with ASD work full-time. Educational attainment also remains low, with only 25 percent pursuing education or training beyond high school (Hersh, 2016). These outcomes highlight the urgent need for targeted interventions that address both the core characteristics of autism and the broader life context that shapes long-term success and well-being (Waizbard Bartov et al., 2024; Balbin et al., 2022).

To support individuals with autism in living more independent and dignified lives, sustained attention must be given to the development of life skills. According to the World Health Organization (2012), quality of life encompasses six dimensions: physical health, psychological well-being, autonomy, social relationships, environment, and spirituality. When applied to individuals with intellectual or developmental disabilities, the quality-of-life

framework is grounded in the principles of emancipation, inclusion, and self-determination (Morisse et al., 2014).

Life skills are the practical capabilities that enable individuals to care for themselves and contribute meaningfully to their community. And they are critical to enhancing autonomy and improving quality of life (Ayres et al., 2013). These skills span five core areas: self-care and domestic living, recreation and leisure, social interaction, employment, and community participation (Chiang et al., 2017). Activities such as grooming, cooking, traveling independently, managing finances, and navigating social spaces are all essential to functioning in daily life. However, due to cognitive and behavioral limitations, individuals exhibiting behaviors consistent with moderate to severe ASD often require structured and individualized interventions to acquire and retain these skills.

Inclusive education and the need for support tools

Inclusive education has become a global priority, with international frameworks such as the Salamanca Statement, the UN Convention on the Rights of Persons with Disabilities, and Sustainable Development Goal 4.5 affirming the right of individuals with disabilities, including autism, to equitable access to education (Petersson Bloom & Holmqvist, 2022). As more learners with autism enter mainstream or specialized educational settings, schools have become key environments for supporting functional learning, independence, and quality of life.

Despite these policy commitments, inclusion remains uneven in practice. Many educators report limited training in autism informed approaches, insufficient instructional resources, and difficulty implementing individualized supports for learners with higher support needs (Petersson, Bloom, & Holmqvist, 2022). Communication challenges and sensory sensitivities

further complicate classroom participation, underscoring the need for flexible learning pathways and tools to support both teachers and caregivers in daily instruction.

Digital health solution, assistive technology, and equity in ASD support

Studies on the use of mobile technologies for people with ASD and intellectual disabilities to help in life skills development are increasing, due to mobile device affordability; proliferation of applications targeting people with ASD or intellectual disabilities (Ayres et al., 2013); portability and mobility (Cabiell-Hernandez et al., 2017); and natural inclination of people with ASD to technologies, most especially children who are digital natives (Mintz, 2014, Mintz, 2013, Mintz et al., 2012). The ubiquity of mobile devices such as tablets and mobile phones makes them a viable option for educators to use as instructional or assistive technology that can help people with severe ASD build, enhance, or maintain their life skills, and, over time, enhance their capacity for self-determination (Ayres et al., 2013).

The use of digital and assistive technologies to support life skills development can enhance, retain, or improve the capabilities of people with ASD. According to the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (Public Law 100-407), an assistive technology pertains to any item, equipment, or product system, that could be acquired commercially, off-the-shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities (S.2561 - 100th Congress (1987-1988); Technology-Related Assistance for Individuals with Disabilities Act of 1988, 2019). Assistive technologies for ASD intervention involve the use of mobile phones, tablets, and websites to teach people with intellectual disabilities and autism to acquire, practice, and maintain life skills, and, in a way, function as educational technology. There are a lot of studies

that use videos and photos to execute or teach a task (such as cooking) or activity (such as travelling) to people with ASD. These solutions provide task sequences, auditory prompts, and the ability to rewind and review instructions (Ayres et al., 2013b, p. 263).

More recently, the emergence of digital health solution has expanded the scope and capabilities of these interventions. Digital health solution has emerged as a promising field, offering innovative tools to support the development of life skills for individuals with autism. It encompasses mobile health applications, telehealth services, wearable devices, and AI-supported platforms that enable personalized, adaptive, and scalable learning and intervention supports (Kuwabara et al., 2019; Lawrence, 2022; WHO, 2019).

Digital health solution interventions can extend care beyond clinical settings, reduce geographic barriers, and support collaboration between caregivers, educators, and professionals (Ji et al., 2025; Topol, 2019). These technologies can provide multimedia learning support, real-time monitoring, and individualized guidance, which is especially valuable in contexts where specialist services are limited or unaffordable.

Health equity is a state in which all individuals have a fair opportunity to attain their highest level of health. Systemic disparities linked to socioeconomic status, infrastructure, and service access contribute to unequal autism support worldwide (Richardson et al., 2022). Digital health solution, therefore, holds potential not only as a technical innovation but also as an equity-oriented approach to reducing gaps in access to autism intervention.

Low resource areas

In this study, low-resource areas refer to geographic or social contexts in which families and service systems face persistent constraints that limit access to adequate autism-related health,

educational, and developmental supports (Carr & Lord, 2016; Divan et al., 2021; Gulrud et al., 2021; Naithani et al., 2022). These constraints are shaped not only by economic hardship but also by limited infrastructure, shortages of trained professionals, and the absence of sustainable intervention pathways.

Low -resource contexts may include rural or underserved communities in low- and middle-income countries, where diagnostic services and specialized autism interventions are often unavailable or concentrated in distant urban centers (McConkey, 2022; Schlebusch et al., 2020). Importantly, low-resource settings are not confined to national income categories. Marginalized populations in high-income countries may also face resource limitations due to stigma, language barriers, and limited access to culturally responsive services (Imanpour et al., 2025; Okwara & Donald, 2024).

In such contexts, caregivers and educators often bear primary responsibility for teaching life skills with limited professional support, reinforcing the need for scalable, accessible, and family-centered digital approaches.

Research gap and rationale

Despite growing research on autism focused digital interventions, significant gaps remain. First, many technologies are designed for individuals with higher verbal and cognitive abilities, while learners exhibiting behaviors consistent with moderate to severe remain underrepresented due to communication barriers and methodological challenges (Bradbury Jones et al., 2018; Wilson et al., 2019).

Second, most existing solutions are highly individualized prototypes that are difficult to scale, making universal design approaches challenging in a heterogeneous spectrum (Reis et al.,

2021). This limitation is especially critical in low-resource settings, where families cannot afford hyper-personalized interventions.

Third, global gaps in autism care require approaches that go beyond specialist-driven models. Task sharing and non-specialist delivery models, in which caregivers, educators, and community workers deliver intervention components, are increasingly recognized as necessary in contexts where specialists are scarce (Naithani et al., 2022; Divan et al., 2021). However, these models require practical tools, culturally adaptable supports, and sustainable digital infrastructures to succeed.

Finally, there remains an unknown contribution to how participatory and proxy-mediated design processes can inform digital life skills platforms that are feasible in low-resource educational environments. This study addresses this gap by identifying design requirements grounded in stakeholder realities and exploring transferable insights rather than making generalized claims.

Statement of the problem

ASD is a growing global public health and developmental challenge that affects individuals, families, and education systems worldwide. An estimated 61.8 million individuals, or one in every 127 people, were on the autism spectrum globally in 2021 (Santomauro et al., 2024). Hughes et al. (2023) reported that approximately 26.7 percent of surveillance data from over 20,000 children aged 8 met criteria consistent with profound autism. The prevalence of ASD has increased significantly over time and varies across sociodemographic groups (Zeidan et al., 2022).

The economic burden associated with autism is substantial. The annual cost of supporting a child with ASD has been estimated at \$17,081, including education, healthcare, therapy, and related services (Trentacosta et al., 2018). Even in high-income regions, families continue to face significant out-of-pocket expenses. Rural families experience additional barriers due to travel distance and limited service availability, often resulting in fewer and shorter interventions (Meadan et al., 2016).

In low- and middle-income countries, treatment gaps are even wider due to shortages of trained specialists, weak service infrastructures, and excessive intervention costs (Rahman & Hamdani, 2018). Families also experience significant economic stress, with mothers earning approximately 35 percent less than parents of neurotypical children due to caregiving demands (Trentacosta et al., 2018). These realities highlight the urgent need for innovative and accessible approaches that support individuals with autism related needs, particularly where diagnosis and specialist-driven services may be delayed or unaffordable.

Purpose of the study

The purpose of this qualitative case study series is to identify essential requirements for designing a digital health solution that supports life skills development for learners aged 5 to 30 who exhibit behaviors consistent with moderate-to-severe ASD in low-resource contexts.

At this stage in the research, individuals exhibiting behaviors consistent with moderate to severe ASD are understood as learners who typically experience significant communication limitations and may rely on nonverbal or minimally verbal forms of expression. These learners may copy or repeat words or phrases, and frequently use gestures, vocalizations, facial

expressions, and body movements as primary means of communication (Waizbard Bartov et al., 2024; Delafield Butt et al., 2019). They may also experience co-occurring conditions such as intellectual disability and sensory sensitivity, which can further influence learning, daily functioning, and support needs (Waizbard Bartov et al., 2024; Balbin et al., 2022).

In this study, a digital health solution for life skills development refers to a combination of process and technology that provides a digital service usable by learners, parents, and teachers, either in person or remotely, to teach, improve, or maintain essential life skills (Ji et al., 2025; Kuwabara et al., 2019). Digital health solution can personalize support through learner profiles and leverage multimedia such as videos, interactive simulations, and text to adapt learning content to individual preferences.

Finally, involving individuals with moderate-to-severe ASD through their proxies in the design process empowers learners and families by fostering ownership of the technology. Proxy-mediated participation recognizes the lived expertise of caregivers and educators and supports the development of solutions grounded in everyday contexts (Colin et al., 2020; Dawe, 2007).

Research questions

This study aimed to answer the central question: What are the essential requirements for designing a digital health solution for life skills development for learners exhibiting moderate-to-severe ASD in low-resource settings?

Sub-questions included:

- What specific capabilities, interests, challenges, and needs do learners with moderate to severe ASD exhibit in relation to life skills development?

- What are the challenges and needs of parents and teachers in teaching life skills to these learners?
- What capabilities, features, and processes are essential for developing a digital health solution that effectively supports learners, caregivers, and educators in low-resource contexts?

Delimitations and limitations

This study focused on parents or caregivers of learners aged 5 to 30 who exhibit behaviors consistent with moderate to severe ASD, as well as their teachers. Participants were recruited through the Philippine Department of Education district superintendent and Paranaque Elementary School Central. Snowball sampling was also used through participant networks.

Methodological and practical constraints shaped the delimitations. The extended age range was selected to capture lifelong support needs that often continue beyond adolescence. The focus on moderate-to-severe support needs addressed an underrepresented population in digital intervention research, particularly in low-resource settings.

Participatory engagement was significantly constrained by teacher workload and resource limitations. Planned iterative workshops were not feasible and required a methodological pivot to qualitative surveys with optional follow-up interviews. As a result, most participants contributed through surveys, with only two parents and one teacher completing follow-up interviews.

This proxy-mediated approach introduced potential bias, including recall bias, contextual mismatch between home and school perspectives, social desirability bias, and possible over- or underestimation of learner abilities. To mitigate these risks, triangulation across parent and

teacher accounts was applied, multiple data sources were used, and transcript-level member checking was conducted before analysis.

The sample size was small and localized, limiting transferability. Most participating parents had male children, reducing the presentation of female learner profiles. Infrastructural constraints, such as limited connectivity and device access, also affected the quality of prototype feedback and future scalability.

Significance of the study

This study was relevant because the acquisition of a life skill for a person with moderate to severe ASD is extremely challenging. Life skills are, however, crucial to independent adult life, especially for people with moderate to severe ASD because they focus on self-care and domestic living, among others (Chiang et al., 2017). The study of Mason et al. (2018) showed that the quality of life of adults with ASD is low compared to the general population and even to younger ASD patients, and most of them experience health problems such as hypertension and sleeping disorders.

The amount of life skills acquired by adults with ASD also varies depending on the quality of education that they have received since they were diagnosed with autism. The study by Chiang et al. (2017) showed the importance of continuing life skills education even after a child has graduated from high school. However, individuals with ASD from low-income communities, such as those in the Philippines, seldom receive quality education, as there are very few public schools that offer free education to individuals with intellectual disabilities. Private schools are also very costly and often hard to afford (Autism Society PH, 2022).

Because of this, parents' role in teaching their children life skills is vital. Given the limitations in the current support structure in low-income communities, such as the government's inability to provide substantial support, quality education, and progressive policies supporting individuals with intellectual disabilities, parents need to take a more active role in teaching their children so they can achieve sufficient skills for self-determination and a dignified life.

Digital technologies that aim to help in providing interventions to learners with ASD provide a viable option to help families in low-income and marginalized areas gain access to resources and tools that support home-based teaching. Mobile technologies can assist in life skills development through digitizing interventions and making them readily accessible. Common approaches such as video modeling, prompting, task analysis, picture exchange communication systems, and positive reinforcement can be developed within a mobile application (Villamin & Luppisini, 2024).

This study contributes by identifying practical design requirements for a scalable digital life skills platform that may be useful in contexts where formal diagnosis and specialist services are unaffordable or inaccessible. The findings offer exploratory and case-based insights that may inform future digital health solution interventions for underserved populations with autism.

Thesis Organization

This dissertation is organized into six chapters, each contributing to the overarching goal of designing a digital health solution for life skills development for learners with moderate-to-severe autism spectrum disorder (ASD).

Chapter 1: Introduction

The introductory chapter provided the background and context for the study, highlighting the significance of life skills development for learners with moderate-to-severe ASD, particularly

in low-resource settings. The chapter presented the research problem, the study's purpose, and the research question that guided it. The chapter also highlighted the scope, delimitations, and limitations of the research, with a focus on the potential impacts on marginalized and low-resource areas.

Chapter 2: Literature Review

This chapter reviewed theories and evidence guiding the design of a digital health solution for individuals with moderate to severe ASD. It covered cognitive and ASD-specific processing theories, learner-centered educational models, and life skills development. The chapter also focused on systemic barriers faced by marginalized families and low-resource areas, including service fragmentation, limited training, and caregiver burden. Digital health solution was explored as a scalable, personalized solution, integrating models like TEACCH and parent-implemented interventions. Finally, the chapter emphasized participatory, user-centered design to ensure the solution is inclusive, accessible, and responsive to real-world needs.

Chapter 3: Methodology

The methodology chapter discussed the methodological approach used to investigate the research questions within a qualitative case-study framework. It integrated design thinking, requirements engineering, and an iterative methodology within a participatory design approach to determine the requirements of a digital health solution for autism. The chapter also detailed the sampling strategy, data sources, and collection methods, including qualitative surveys and interviews. It defined the context and boundaries of the case, the researcher's role, and the procedures for data analysis. Ethical considerations and strategies to ensure trustworthiness, such as credibility, transferability, and reflexivity, were also discussed to support the validity and integrity of the study.

Chapter 4: Findings

This chapter presented findings from three interconnected workstreams: literature review research, qualitative surveys and interviews, and iterative design and development. It explored the capabilities, interests, needs, and challenges of learners with moderate-to-severe ASD through empathy maps, user personas, and individual profiles. Insights from parents and teachers were also analyzed, highlighting their goals, pain points, and perspectives on digital tools. The chapter synthesized design themes and user requirements into key features for a digital health solution for life skills development. It concluded with the development of app prototypes, detailing the Alpha, Beta, and Charlie versions of the designed digital platform.

Chapter 5: Analysis

In the analysis chapter, the findings were critically examined in light of the theoretical framework and research questions. It explored the implications of the results for the design and implementation of the digital health solution. The chapter connected empirical insights to theoretical components, providing a deeper understanding of how the solution can address the identified gaps and challenges.

Chapter 6: Conclusion

The concluding chapter summarized the key findings and their significance for digital technology and autism intervention. It discusses the study's broader implications, provides recommendations for future research and practice, and reflects on its contributions to addressing inequities in access to life skills development for learners with moderate-to-severe ASD. The chapter concluded with a call to action for health, education, technology, and policy stakeholders to support inclusive and equitable solutions.

Chapter II: Literature Review

Low resource areas

A low-resource area (also referred to as a low-resource setting or resource-limited context) is a geographic, social, or institutional environment in which individuals and service systems face persistent structural constraints that limit access to adequate health, educational, and developmental supports. These settings are defined not only by economic poverty, but also by shortages in infrastructure, trained personnel, culturally appropriate services, and sustainable intervention systems (Carr & Lord, 2016; Gulsrud et al., 2021; Divan et al., 2021; Naithani et al., 2022; Schlebusch et al., 2020; McConkey, 2022; Magallanes et al., 2025; Okwara & Donald, 2024; Imanpour et al., 2025; Gulsrud et al., 2021).

Low-resource settings frequently include communities in which families have low income, limited educational attainment, and limited financial capacity to access specialized care. These conditions create substantial barriers to participation in early autism intervention, especially when services are costly or centralized in distant institutions (Carr & Lord, 2016). Families in such contexts are often described as under-resourced, meaning they lack the economic and informational supports needed to navigate complex service systems (Gulsrud et al., 2021).

A defining feature of low-resource areas is the scarcity of autism-specific and developmental disability services, particularly in low- and middle-income countries (LMICs). In these contexts, early identification and intervention services are often inadequate, underfunded, and inaccessible, producing major “detection” and “treatment” gaps (Divan et al., 2021; Naithani et al., 2022). Specialist models of care are often not scalable due to severe shortages of trained

professionals such as developmental pediatricians, child psychiatrists, and therapists (Schlebusch et al., 2020; McConkey, 2022).

Low-resource settings are frequently associated with under-resourced public health and education systems, in which primary care facilities and special-needs services remain limited even when nominally available (Okwara & Donald, 2024). Rural communities in particular face additional barriers, including geographic isolation, lack of SPED infrastructure, and inadequate institutional support for teachers working with children with disabilities (Magallanes et al., 2025).

Low-resource contexts also include marginalized populations living within high-income countries, where barriers arise from cultural stigma, language mismatch, immigration-related stress, and limited social support. Immigrant families often report difficulties accessing autism services due to systemic complexity and lack of culturally responsive care (Imanpour et al., 2025). Similarly, non-English-speaking families and those with smaller caregiver social networks experience delayed and reduced service engagement (Gulrud et al., 2021).

Low-resource areas may also be shaped by systemic inequities linked to colonial histories and jurisdictional gaps, particularly in Indigenous communities. Autism services for Indigenous peoples in Canada remain severely underdeveloped, with limited research, poor access, and ongoing structural discrimination contributing to inequitable care provision (Bruno et al., 2024).

Because conventional specialist-driven intervention systems are often unrealistic in low-resource settings, many authors emphasize the need for decentralized, family-centered, community-based approaches. These include task-sharing models in which non-specialists are trained to deliver key intervention components to address service scarcity and improve universal coverage (Naithani et al., 2022; Sivayokan et al., 2023).

Lack of universal health coverage and service fragmentation in the Philippines

Despite growing global awareness and research into ASD, disparities persist in the availability and accessibility of autism services, particularly for populations in LMIC. These disparities reflect systemic, structural, and cultural barriers that hinder timely diagnosis, limit access to evidence-based interventions, and reduce caregiver support.

Some LMIC countries, such as the Philippines, lack universal health coverage, forcing families to pay out-of-pocket for health services. The lack of awareness about conditions such as ASD in health care professionals prevents early detection and diagnosis, leading to delayed intervention and education, which is crucial in the early years of a child with ASD. Services are often fragmented in LMICs, making it hard for families to navigate public health systems and access services. The insufficient funding and resources for health care workers exacerbate the situation, as educators and health care workers are often left unequipped to deliver quality care due to limited training opportunities and ineffective health care policies that are not implemented effectively. Most families also don't have developmental disabilities covered by their health insurance (Divan et al., 2021; McConkey, 2022). Individuals with ASD from LMIC, such as the Philippines, seldom receive quality education, as there are very few public schools that offer free education to people with intellectual disabilities. Private schools are also very costly and often hard to afford (Autism Society PH, 2022).

According to the United Nations Industrial Development Organization (UNIDO), the Philippines is a lower-middle-income country with an emerging market economy, driven by a globally recognized workforce in South Asia and the Pacific (Country Context | UNIDO, 2020). The country is one of the world's most populous, with over 109 million citizens as of 2020 (Mapa, 2021). About 19.99 million of this population live below the poverty threshold, meaning

their income is insufficient to meet their basic food needs (Mapa, 2022). Statistics also showed that around 12% of the population aged 15 and up are experiencing severe disability (Bersales, 2019).

Disability policies in the Philippines, specifically for those who have intellectual and mental deficiencies, are still in their infancy. In 1982, the first law on physical disability was passed, known as *Batas Pambansa Bilang 344*, to improve the accessibility of public and private buildings and establishments (National Council on Disability Affairs, n.d.). In 1992, an act called the Magna Carta for Disabled Persons (RA 7277) was enacted to help disabled persons integrate into society through rehabilitation, self-development, and self-reliance (Republic Act No. 7277 | Senate of the Philippines Legislative Reference Bureau, 2022). In 2013, this act (RA 10524) was expanded to mandate that government agencies, offices, and corporations set aside at least 1% of their positions for people with disabilities (Congress of the Philippines, 2013). Finally, in 2022, RA 11650 was passed, mandating that all public and private schools include education for children with disabilities in their curricula (Congress of the Philippines, 2022; Magsambol, 2022).

Due to the rate at which policies in the country are enacted, the scope, breadth, and rigor in implementing these policies, the lack of resources to sustain them, and the prevalence of families living below the poverty line, it is extremely difficult for children and people with moderate to severe ASD to access the services, education, and support that they need. Filipino parents faced tremendous challenges, including guilt, regret, financial strain, and difficulties in managing their child's behavior, communication, and social interaction. Cultural factors, such as stigma and the importance of social networks, also play a significant role in shaping parents' perceptions and health-seeking behaviors.

Structural and economic barriers in LMICs

One of the most pervasive challenges across LMICs and underserved populations in high-income countries is the limited availability of diagnostic and intervention services for ASD. Several systemic factors, including under-resourced healthcare systems, a shortage of trained professionals, and inadequate funding for mental health services, shape this limitation.

In LMICs, healthcare systems often lack a dedicated infrastructure for neurodevelopmental conditions like autism. For instance, the prevalence of ASD in countries like Sri Lanka and India is comparable to global averages; however, the capacity to diagnose and treat these conditions remains severely limited due to a shortage of trained professionals and weak health system implementation. This results in significant detection and treatment gaps, particularly for young children (Naithani et al., 2022).

Even within high-income countries, resource inequities remain stark in rural and socioeconomically disadvantaged areas. The study of Carr and Lord (2016) revealed that families from low-income backgrounds in Southeast Michigan often lack transportation, face long waitlists, and cannot afford the high costs associated with ASD services. Systemic inadequacies, such as the lack of coordinated service delivery and language support for non-English-speaking families, compound these constraints.

Diagnostic inequities among marginalized populations

Delays in diagnosis are another challenge for racialized minorities, immigrants, and indigenous populations. Research showed that Black, Latino, and immigrant children tend to receive ASD diagnoses later than their white, English-speaking counterparts. Studies have shown that these delays can be traced to deep structural inequalities, including implicit provider biases,

language barriers, and a lack of culturally sensitive diagnostic tools (Patrick et al., 2025; Qu et al., 2025).

In low-resource settings like South Africa, caregivers often experience frustration navigating healthcare systems that are underfunded, difficult to access, and not designed to accommodate developmental disabilities. Stigma surrounding autism, as well as differing cultural interpretations of developmental delays, further contribute to diagnostic delays and underreporting (Okwara & Donald, 2024).

Disparities between rural and urban areas in access to autism screening and diagnostic services are also a problem. For instance, in China, urban centers have more developed diagnostic frameworks, while rural populations are often left to navigate a complex, fragmented healthcare system with little guidance, exacerbating diagnostic inequities (Qu et al., 2025).

Cultural and linguistic barriers

Culture deeply shapes how caregivers understand, respond to, and seek help with autism-related concerns. Immigrant families, particularly those with limited proficiency in the dominant language of their host country, face unique challenges in navigating autism services.

According to Carr and Lord (2016), cultural beliefs may influence how symptoms are interpreted or communicated to healthcare providers, thereby affecting both diagnosis and uptake of interventions. Moreover, many intervention programs are designed with assumptions rooted in Western developmental norms and parenting practices, making them ill-suited for cultural contexts that differ significantly. Schlebusch et al. (2020) emphasized that cultural misalignment can lead to poor engagement with services or a mismatch between caregiver expectations and provider recommendations.

Language barriers exacerbate these challenges, particularly when diagnostic and therapeutic services are not available in a family's native language. Non-English-speaking caregivers often report confusion about diagnoses, lack of understanding of treatment plans, and limited access to support resources (Gulstrup et al., 2021).

Social vulnerability and geographic disparities

Geography plays a pivotal role in access to autism services, especially in rural areas and among indigenous populations. The GapMap study of Albert et al. (2017) revealed that 83.86% of U.S. counties lacked any diagnostic resources for autism, with rural and sparsely populated areas disproportionately affected. For many families, this means traveling long distances to urban centers, incurring significant financial and emotional burdens.

Indigenous communities face even greater barriers. These populations often live in remote locations with minimal healthcare infrastructure and have historically been marginalized in terms of policy attention and funding. Moreover, services offered in mainstream health systems may not align with indigenous ways of knowing and community practices, leading to underutilization or mistrust (Bruno et al., 2023; Hus, 2023; Antony et al., 2022).

Public health strategies must address these geographic and cultural disparities by decentralizing services, integrating indigenous knowledge systems, and fostering partnerships with local community organizations.

Caregiver burden and quality of life in underserved contexts

The burden placed on caregivers, particularly mothers of children with ASD, is well-documented across both high-income and low to middle-income settings. Caregivers often face a convergence of psychological, financial, and systemic stressors that impact their QoL, especially when services are fragmented, unaffordable, or culturally misaligned (Shafi et al., 2024; Boulé &

Rivard, 2024; Bruno et al., 2023; Casale et al., 2023; Millau et al., 2016; King et al., 2017; Khanlou et al., 2017).

According to Edmunds et al. (2025), caregivers of toddlers with autism features report significantly lower QoL compared to caregivers of children without developmental concerns. The most influential predictors of caregiver well-being were income, perceived family-centered care, and parenting stress. Notably, parenting stress was the strongest predictor of QoL, underscoring the urgent need for supportive services to reduce psychological burden. While family-centered care positively influenced QoL, it did not mitigate the impact of parenting stress, suggesting that comprehensive interventions must also directly target caregiver mental health (Boulé & Rivard, 2024; Leosala, 2023).

In LMICs, stressors are often compounded. As documented by Okwara and Donald (2024), caregivers in low-resource settings, such as South Africa, report inadequate post-diagnosis support, poor communication from healthcare professionals, and a lack of coordinated services. Many caregivers are forced to navigate under-resourced public health systems while also managing stigma and discrimination within their communities. Financial strain further exacerbates caregiver distress. In both LMICs and underserved areas of high-income countries, the cost of accessing diagnosis, therapy, and educational services can be prohibitively high. For example, Carr and Lord (2016) found that families living below the poverty line in Southeast Michigan frequently opted out of services due to indirect costs such as transportation, childcare, and missed work hours. These financial pressures can lead to reduced treatment adherence and early program dropout outcomes that disproportionately affect children in socioeconomically marginalized families.

Challenges and needs of parents and families

Families living in LMICs and low-resource settings in North America, including marginalized and indigenous parents, face numerous challenges in supporting their children with autism. Key barriers include language and communication difficulties, as well as limited access to information, training, and educational opportunities. Financial hardship, resource limitations, and systemic inequalities often constrain parental engagement and teacher collaboration. These challenges are compounded by emotional, psychological, and mental stress, along with experiences of discrimination, stigma, and other social and institutional barriers (Leosala, 2023; Casale et al., 2023; Catubigan, 2023; Millau et al., 2016; King et al., 2017; Shafi et al., 2024; Bruno et al., 2023; Ladaga, 2022; Resurreccion, 2013).

Language barriers, limited access to information, training and education

Families face significant educational and informational challenges when navigating autism services, largely due to language barriers, limited system familiarity, and a lack of culturally tailored support and services. In LAMIC such as the Philippines, parents struggle due to a lack of information regarding effective strategies for managing their child's behavior and needs. Difficulties in communication with educators and therapists were also identified, which hindered the effective delivery of intervention and other services (Leosala, 2023).

Even when language is not a personal barrier, families recognize its impact on others within their communities (Casale et al., 2023). A widespread lack of knowledge about available services, support systems, and educational rights exacerbates these challenges. Catubigan (2023) explored the experiences of Mansaka mothers in Mindanao, Philippines, who have children diagnosed with ASD. Most mothers faced difficulty understanding and identifying the signs of ASD and struggled with coping with the impact on their family, work relationships, and personal

life. Mansaka mothers expressed a lack of understanding and knowledge about their children's atypical behaviors, which often led to confusion and uncertainty in addressing their children's needs and made it difficult for them to cope. These brought stress and misery to mothers, affecting their overall self-concept and overall well-being.

Understanding autism is often shaped by cultural context and the availability of accessible educational resources. In some communities, there is limited terminology to describe autism accurately, which affects early recognition and communication about the condition (Shafi et al., 2024). This lack of understanding may be compounded by minimal public awareness campaigns or professional outreach, making it difficult for families to fully grasp their child's diagnosis or the purpose of recommended interventions.

Families unfamiliar with the host country's healthcare and education systems also face difficulties navigating complex processes for diagnosis, treatment, and support. Many are uncertain how to access a family doctor or appropriate special education programs and are unaware of the existence of translation services, which further impedes effective care (Millau et al., 2016; King et al., 2017). For indigenous and racialized communities, the situation is compounded by stigma, cultural misunderstanding, and systemic inequities, prompting the need for inclusive education programs that address these specific experiences (Bruno et al., 2023). Parents from culturally diverse backgrounds, such as South Asian families, often lack appropriate terminology in their native languages to describe autism, making early recognition and intervention particularly difficult. Educational resources are often not translated or culturally sensitive, and many parents feel overwhelmed by materials they cannot fully understand or implement effectively (Shafi et al., 2024; Ladaga, 2022).

Concerns also arise about the adequacy of school curricula and their support for the learning needs of children with autism, particularly when individualized education programs (IEPs) are underdeveloped or inconsistently applied (Abear et al., 2017). Efforts to create culturally inclusive materials and programming are being made, yet challenges persist in ensuring these resources reach all families who need them (Bruno et al., 2023). In addition, parents frequently report a lack of confidence in applying evidence-based practices needed to support the implementation of their children's IEPs, due to insufficient training or overwhelming instructional materials. Without step-by-step support or mentorship, families may struggle to implement strategies at home or may abandon them due to frustration or emotional burnout (Ladaga, 2022). Clear instructions, practical coaching, and ongoing motivation have been identified as critical to supporting parents as they assume educator or advocate roles for their children. In educational settings, collaboration with teachers is often hindered by unclear expectations or communication gaps, leading to inconsistent and difficult-to-sustain parental involvement (Abear et al., 2017). Even when families are willing to engage actively, they may lack the institutional support and reassurance needed to feel effective in their efforts.

To address these challenges, several researchers proposed improved access to information and tailored support for families such as the provision of comprehensive, culturally appropriate information about autism; development of multilingual materials; home visits by service providers; and the involvement of social or settlement workers to guide families through systems (Millau et al., 2016; King et al., 2017; Casale et al., 2023). Other effective approaches included hosting educational workshops and community training programs, which not only informed families of their rights and available services but also helped them develop the skills needed to support their children.

Community mentorship programs, peer coaching, and professional guidance can also increase parents' confidence and competence in implementing evidence-based practices (EBPs), which are often inconsistently applied due to limited training or clarity (Ladaga, 2022; Leosala, 2023). Self-directed learning opportunities, such as local resource centers and online platforms, were also identified to help empower parents to manage better their child's developmental needs (Leosala, 2023; Abear et al., 2017). Moreover, parental involvement in curriculum advocacy and school engagement was identified as vital to ensuring that educational systems evolve to meet the specific needs of children with autism (Abear et al., 2017).

Poor parent - teacher collaboration

Parents of children with autism often struggle with maintaining consistency in applying EBPs, resulting in reduced effectiveness of interventions. This inconsistency is frequently linked to varying levels of parental understanding, ability, and access to professional guidance (Ladaga, 2022). Even when EBPs are introduced, their success hinges on parents' capacity to integrate them into daily routines, a task made harder by unclear instructions and a lack of confidence in managing their child's behavior. This points to a broader need for interventions that are not only evidence-based but also parent-friendly and adaptable to diverse family circumstances.

Effective collaboration between parents and teachers remains one of the most critical, yet underdeveloped, aspects of autism interventions. Many parents experience difficulties establishing productive partnerships with educators, often due to unclear communication channels or institutional barriers that limit engagement (Leosala, 2023).

Regularly scheduled meetings, clear goal alignment through IEPs, and transparency in updates about the child's progress are essential to promoting parent involvement in school-based interventions (Leosala, 2023). Moreover, teachers who actively listen to and integrate parental

feedback tend to foster more trusting relationships, which can enhance outcomes for the child (Resurreccion, 2013). Parents appreciate guidance that is empathetic and grounded in practical strategies, particularly when navigating the emotional toll of autism diagnosis and intervention. Teachers who demonstrate professionalism, compassion, and ethical standards are more likely to earn families' trust. Multidisciplinary teams, timely progress updates, and educational support have all been noted as valuable elements in implementing successful interventions (Resurreccion, 2013).

Systemic and structural barriers

Service accessibility is one of the main struggles faced by caregivers, as most experience lengthy waiting periods to get interventions for their child, and would require travel of two to three hours to attend therapy sessions. Many families also have limited transportation options, and in extreme weather conditions, commuting can be a safety risk. These conditions further exacerbate family stress and cause financial strain (Fong et al., 2023).

Long wait times for diagnostic assessments and therapy services continue to be a significant source of stress, especially for immigrant and indigenous families (Millau et al., 2016; Shafi et al., 2024). These delays often result in missed opportunities for early intervention, which is crucial for developmental progress. Immigrant families also report difficulty navigating fragmented services, cultural misunderstandings, and a lack of linguistically appropriate resources (Casale et al., 2023; Khanlou et al., 2017). Refugee families face an additional layer of systemic neglect, with limited data on their specific needs, further marginalizing them from policy and program development (Casale et al., 2023).

Indigenous families face unique barriers, including mistrust of healthcare systems rooted in historical injustices, lack of culturally safe diagnostic services, and under-resourced

community supports (Bruno et al., 2023; Antony et al., 2022; Hus, 2023). Many indigenous families express a desire for services that incorporate traditional knowledge and respect cultural identity. However, current autism supports are overwhelmingly based on Western medical models, which may not align with indigenous worldviews (Antony et al., 2022).

The division of responsibilities between federal and provincial governments further complicates access to services for indigenous populations, creating confusion and inconsistent support (Antony et al., 2022). Parents also expressed frustration over having to independently search for information, manage complex paperwork, and advocate for services in a fragmented system (King et al., 2017; Khanlou et al., 2017). Financial hardship and transportation challenges are compounding factors, particularly for those in remote areas (Khanlou et al., 2017).

Improving service delivery requires comprehensive reforms that recognize cultural, linguistic, and socio-economic differences across families. Shafi et al. (2024) recommended developing less resource-intensive support programs for families on waitlists, increasing culturally responsive training for healthcare providers, and implementing interpretation services in medical and educational settings. Additionally, collaboration with indigenous communities is necessary to co-develop autism engagement frameworks that prioritize cultural safety, equity, and holistic care models (Bruno et al., 2023).

Family-centered care models should also integrate education, health, and social services, enabling a holistic approach that eases the burden on caregivers and improves outcomes for children with autism (King et al., 2017). A feedback loop mechanism in which parents can report on the effectiveness of interventions and suggest improvements can contribute to a system of continuous improvement (Ladaga, 2022).

Policies grounded in anti-racism and anti-ableism, designed in partnership with indigenous and immigrant communities, are crucial for addressing historical and ongoing inequities (Antony et al., 2022). Without such contextual awareness, future policies risk replicating existing barriers and excluding those most in need of support.

Financial and resource challenges

Families of children with ASD face a variety of financial and resource-related challenges that often intersect with structural inequities, employment instability, and service accessibility. The financial burden associated with therapy and intervention is among the most consistently reported stressors across both high and low-income countries. Many parents struggle to afford therapies such as occupational therapy, speech therapy, and behavioral interventions, which can cost hundreds of dollars per session. In some cases, families are forced to withdraw their children from essential programs due to these high costs, despite their importance to the child's development and learning progress (Abear et al., 2017; Capote et al., 2016; Cuaresma et al., 2014; Leosala, 2023).

In addition to therapy, specialized educational programs represent another major financial pressure. These programs are often priced at levels comparable to private school tuition, and for many families, participation in such programs means sacrificing basic needs or incurring debt. Parents in both developed and developing contexts report that while these specialized programs are critical for their child's learning and social development, the associated costs are often unsustainable (Capote et al., 2016; Cuaresma et al., 2014; Bruno et al., 2023).

The impact on parental employment further compounds the economic toll of raising a child with ASD. Many caregivers are required to reduce their work hours, take lower-paying or part-time jobs, or leave the workforce entirely to provide daily care. This results in significant

income loss, which exacerbates the already overwhelming costs of care (Millau et al., 2016; Abear et al., 2017; Shafi et al., 2024). Some parents report needing dual incomes to meet household needs but face challenges balancing work obligations with caregiving responsibilities, leading to further financial strain (Leosala, 2023; Casale et al., 2023). Mothers are also restricted from working or engaging in activities outside the home due to the need for close and strict supervision of children with atypical behaviors. This placed additional strain on the mothers and impacts their personal and professional lives (Catubigan, 2023)

Casale et al. (2023) expounded on the challenges faced by immigrant and refugee caregivers of children with ASD, foremost of which is access to adequate services, including transportation. Families living in remote or underserved areas face additional challenges due to transportation and geographic barriers. Accessing therapy or specialized schools often requires long commutes, particularly for indigenous families who must travel significant distances for diagnostic or intervention services. These costs can be particularly burdensome when compounded by the lack of nearby alternatives (Hus, 2023; Antony et al., 2022). In the Philippines, rural families face similar struggles because essential services are often centralized in urban areas, leading to recurring transportation costs and missed workdays (Capote et al., 2016; Abear et al., 2017).

The long wait times, service fragmentation, difficulty obtaining information on service locations and availability, and excessive paperwork contribute to immigrants' barriers to access. Economic hardships from low-paying jobs and costs associated with immigration also hinder service accessibility, and the lack of social support due to a lack of family and community support systems adds to the feeling of isolation, making it more challenging for caregivers to

cope. Some have experienced mental health struggles due to the combination of adapting to a new country and the feelings brought by social isolation, such as anxiety and depression.

These financial pressures are magnified by systemic inequities in access to public funding and services. Indigenous families frequently contend with jurisdictional conflicts between federal and provincial governments, resulting in inconsistent service provision and unreliable funding mechanisms (Hus, 2023; Antony et al., 2022). Similarly, many immigrant families find themselves excluded from government programs due to complex eligibility requirements, lack of documentation, or poor communication from public institutions (Shafi et al., 2024; Khanlou et al., 2017). Underfunding of programs in indigenous communities and bureaucratic inefficiencies only deepen existing disparities (Bruno et al., 2023; Antony et al., 2022).

For immigrant families in particular, financial constraints are often tied to broader patterns of socioeconomic marginalization. Many arrive with limited resources and face access barriers to stable or well-paid employment. These challenges make it difficult to afford therapies or navigate a healthcare system that may not be designed with cultural or linguistic inclusivity in mind. Misunderstandings about medical terminology and unfamiliarity with concepts such as respite care further hinder effective advocacy for needed services (Khanlou et al., 2017; King et al., 2017; Casale et al., 2023). Even when services are technically available, these families may not know how to access them or may encounter stigma and systemic bias that make access more difficult.

The lack of accessible financial and informational support adds to this burden. Many parents report that available government and community resources are either insufficient, difficult to apply for, or poorly advertised. This leaves families feeling isolated and unsupported, particularly when they are already navigating a complex care landscape (Cuaresma et al., 2014;

Millau et al., 2016; Shafi et al., 2024). In addition to the financial and logistical barriers, the emotional toll of persistent uncertainty and instability can lead to parental burnout. Caregivers often feel overwhelmed by the competing demands of work, caregiving, and navigating systems, leaving little time to implement consistent support strategies for their children (Ladaga, 2022; Abear et al., 2017).

Ultimately, these intertwined financial and resource-related barriers reveal the urgent need for more equitable, comprehensive, and culturally responsive systems of support. Without addressing the overlapping challenges of affordability, accessibility, and systemic inequity, families of children with autism will continue to face disproportionate hardship in providing the care their children need and deserve.

Emotional, psychological stress and personal sacrifices

Parenting a child with ASD is widely recognized as emotionally and psychologically demanding, and these challenges are significantly magnified in LMIC and immigrant families and those facing economic or social marginalization. Numerous studies across diverse geographical contexts consistently report heightened stress levels, emotional exhaustion, and mental health concerns among caregivers. Stress often arises not only from the behavioral demands of the child but also from navigating complex healthcare and education systems, societal stigma, and limited support networks.

Roxas et al. (2022) analyzed the lived experiences of Filipino parents of children with ASD with an emphasis on the unique challenges and stress they face and classified them into three: parenting caught off-guard; parenting strains and struggles of childcare; and parenting the unique spectrum. Parenting off-guard is when parents feel unprepared to deal with the early onset of ASD in their children. Most mothers observed their child's observable behaviors as

typical. However, when they noticed certain behaviors that directly affected the child's social behavior, they sought professional help and advice. Parenting and childcare strains and struggles revolved around financial and emotional burdens, as well as the need for continuous support and care. Children with ASD require treatments such as medication, occupational therapy, and speech therapy. These treatments aim to address the limited social behaviors and nonverbal interactions characteristic of ASD. Medication, occupational therapy, and speech therapy are often necessary to support the child's development and improve their quality of life. However, the treatments can be costly for parents, and the frequency of occupational and speech therapy sessions can be demanding for both the child and the parents. The parenting journey of Filipino parents is largely characterized by the challenges they face in providing the necessary care for their child and in finding parenting strategies that cater to their child's unique needs. Despite the lifelong nature of their child's condition, parents continue to provide care, support, and help their child acquire the necessary life skills for their child with ASD. This involved adapting to the unpredictability of their child's condition and seeking additional support for their child even after they are no longer around. The parenting journey for these parents is unending, as they continue to navigate the unique challenges that come with raising a child with ASD. The parents of children with ASD treat their child as a special gift and emphasize the importance of continuous support from relatives. They view the experience of raising a child with ASD as a valuable life lesson that not everyone gets the chance to experience.

In Canadian contexts, caregivers report significant emotional strain as they attempt to balance daily caregiving responsibilities with the logistical and emotional challenges of accessing services—many experience symptoms of anxiety, depression, guilt, and emotional burnout. Parents often express feelings of helplessness, fear for the future, and inadequacy when

they feel unable to meet their child's needs or secure appropriate interventions. Cultural isolation and perceived marginalization further exacerbate stress, especially for immigrant families who face unique sociocultural barriers. These emotional challenges are often compounded by stigma, which discourages open discussion of their experiences and hinders access to supportive resources. Parents commonly conceal their struggles from extended family or peers, further deepening their sense of isolation and emotional vulnerability. Across these studies, parental stress is intricately linked to broader structural issues such as language barriers, financial hardship, and insufficient culturally appropriate services (Boulé & Rivard, 2024; Bruno et al., 2023; Casale et al., 2023; Khanlou et al., 2017; King et al., 2017; Millau et al., 2016; Shafi et al., 2024).

Beyond initial reactions to a diagnosis, caregivers undergo a complex emotional trajectory as they come to terms with their child's developmental condition. Many parents report an initial period of denial, shock, or grief that is akin to mourning, followed by feelings of sadness, fear, or anger. Acceptance is not a linear process but rather evolves alongside the child's development, family circumstances, and interactions with the service system. When parents accept the diagnosis, their psychological well-being improves, which, in turn, can enhance the effectiveness of their caregiving. Programs that focus on building parental resilience, such as mindfulness training and coaching in managing challenging behaviors, have been shown to offer emotional relief and improve family dynamics. Peer support groups tailored specifically for immigrant or underserved families provide valuable spaces for shared learning, community-building, and emotional validation. These groups also serve as important platforms for advocacy and stigma reduction (Abear et al., 2017; Capote et al., 2016; Cuaresma et al., 2014; Florentino et al., 2022; Leosala, 2023; Shafi et al., 2024).

Another recurring theme is the emotional toll of caregiving on family relationships, particularly among married couples. Some parents report strain in their marriages, rooted in differing approaches to care or a lack of mutual understanding (Capote et al., 2016; Bruno et al., 2023). Fathers are often underrepresented in parent support programs and may face unique emotional barriers. Research highlights that some fathers lack emotional intelligence or awareness of their child's needs, which hampers effective caregiving. Additionally, they often cite logistical challenges such as work commitments or dissatisfaction with existing programs, which they perceive as impersonal or irrelevant. Peer-led, father-focused interventions have been recommended as more relatable and potentially more impactful. These should include education on emotional intelligence, strategies for self-care, and tools to better communicate within the family unit (Cuaresma et al., 2014; Abear et al., 2017)

Caring for a child with autism often demands immense personal sacrifices from parents, particularly mothers. Many parents, especially in the Philippines and similar contexts, are compelled to give up their professional careers to provide full-time care, prioritizing their child's developmental needs over personal advancement. The responsibility for managing daily routines, therapy sessions, and behavioral challenges often leads to reduced working hours or job resignations, resulting in financial and emotional stress (Capote et al., 2016; Florentino et al., 2022).

Additionally, the intensive demands of caregiving severely limit parents' personal time and opportunities for rest and self-care, often leading to long-term physical and mental health concerns such as fatigue, anxiety, and depression. Some parents are hesitant to utilize external caregiving services due to trust issues or cultural expectations, which further increases their caregiving burden and isolation (Shafi et al., 2024; Casale et al., 2023; Leosala, 2023; Abear et

al., 2017; Capote et al., 2016; Cuaresma et al., 2014; Resurreccion, 2013). Family dynamics also become strained as parents struggle to balance the needs of their autistic child with those of other family members, contributing to emotional and relational conflicts within the household (Capote et al., 2016).

Religion and spirituality also emerge as important coping mechanisms for some parents, particularly in contexts where systemic supports are limited. Faith-based interpretations of their child's condition offer comfort, a sense of purpose, and resilience amid ongoing stress. These spiritual beliefs can help caregivers reframe their experiences and may even inspire them to become involved in advocacy or educational efforts within their communities. Engagement in such activities is associated with improved self-esteem and reduced feelings of helplessness, indicating the therapeutic potential of meaning-making practices in coping with the challenges of autism caregiving (Florentino et al., 2022).

Recent developments in service delivery, such as the adoption of telemedicine, have introduced alternative avenues for accessing care and support. Especially during the COVID-19 pandemic, telemedicine provided a safe, accessible, and effective means for families to consult with professionals. In the Philippine context, caregivers of children with neurodevelopmental disorders, including ASD, reported high satisfaction with telemedicine services, citing benefits such as reduced travel time, increased convenience, and perceived safety. Despite these advantages, some parents still prefer in-person visits, suggesting the need for hybrid service models that accommodate individual family preferences and comfort levels. Satisfaction with telemedicine also highlights the importance of addressing caregivers' technological comfort, perceived privacy, and communication quality with providers, as these factors significantly influence treatment adherence and service engagement (Aurea et al., 2024).

Cultural beliefs, discrimination, and stigma

Cultural beliefs profoundly influence how families perceive and respond to autism, shaping their decisions about seeking support and services. Immigrant and minority families often encounter significant cultural dissonance when navigating Western models of autism care. For example, immigrant families may interpret autism through different cultural frameworks, believing in alternate causes or treatments that conflict with medical approaches in host countries (Millau et al., 2016; Casale et al., 2023). These beliefs can affect their willingness to engage with available services, often leading to underutilization of care (Millau et al., 2016; Casale et al., 2023; Bruno et al., 2023).

Quilendrino et al. (2015) examined the perceptions and health-seeking behaviors of parents of children with ASD in the Philippines. The study found that cultural beliefs played a significant role in shaping parents' perceptions, with some parents holding beliefs that do not conform to biomedical explanations. The study also highlighted the importance of social networks and community support in influencing health-seeking behaviors. Pascua and Dizon (2022) explored the recurring emotions and coping mechanisms of parents with children having ASD. They found that parents often experience intense emotions such as shock, disbelief, grief, guilt, and frustration following their child's diagnosis. Coping mechanisms included joining parent support groups and investing in relationships with family and peers.

The stigma associated with autism remains a powerful barrier across various cultural contexts. In South Asian communities, for instance, societal pressure and negative perceptions lead many parents to avoid disclosing their child's diagnosis due to fear of judgment and ostracism. Parents frequently experience felt stigma, which is internalizing shame and embarrassment, and enacted stigma, where they face overt discrimination and isolation. These

stigmas are often so intense that families may choose to self-censor or disengage from their social networks to avoid further scrutiny or pity (Shafi et al., 2024).

Stigma not only affects parents' individual experience but also significantly shapes family dynamics and community interactions. Mothers, in particular, report feeling socially isolated due to the negative judgments they face from both extended family and the broader community (Florentino et al., 2022). In many cases, this stigma is internalized, leading to strained familial relationships and heightened guilt or inadequacy among caregivers (Shafi et al., 2024; Florentino et al., 2022). Cultural differences faced by newcomers and refugees are also cited by Casale et al. (2023), where different cultural perceptions of ASD, such as those associated with stigma for individuals with developmental disabilities, affect their willingness to look for help or seek financial services, leading to a delay of access. The need for tailored information and support that is appropriate to specific needs, reflecting newcomer and Indigenous cultural contexts and experiences, can help provide strength-based and holistic approaches (Horrill et al., 2018; Fong et al., 2023). In contexts such as the Philippines, societal expectations and the lack of autism awareness further exacerbate this burden. Parents, especially mothers, often report being blamed or judged for their child's behavior, leading to feelings of shame and helplessness (Florentino et al., 2022; Capote et al., 2016). According to Gray (1993), the public's misperceptions about autism contribute to its heightened stigmatization, and this continues to be reflected in recent Filipino studies where over 85% of mothers reported feeling societal stigma when raising a child with ASD (Florentino et al., 2022; Gray, 1993).

A lack of culturally competent services compounds the issue of stigma. Healthcare providers often lack training in cultural sensitivity, which can result in service mismatches and further discourage families from seeking help (King et al., 2017; Khanlou et al., 2017; Shafi et

al., 2024). For indigenous and immigrant families, the systemic disregard for their cultural perspectives contributes to a lack of trust in services rooted in colonial or Western models (Hus, 2023; Antony et al., 2022). Many of these families express a preference for strength-based, culturally grounded approaches that honor traditional values and practices (Antony et al., 2022; Hus, 2023). The strong demand from indigenous caregivers for services that are culturally relevant and supportive of their heritage calls for cultural safety training for health care providers that includes understanding of indigenous culture and language, along with the historical context and trauma experienced by indigenous people to create culturally appropriate and socially safe environments (Horrill et al., 2018).

To bridge these cultural gaps, researchers have advocated for culturally competent and safe services. Programs tailored to specific cultural norms and values, particularly for indigenous and refugee communities, are seen as essential for meaningful engagement and improved outcomes (Bruno et al., 2023; Hus, 2023; Antony et al., 2022). Training for service providers is a key recommendation across several studies, emphasizing the need for cultural humility, awareness of systemic discrimination, and respect for alternative worldviews (King et al., 2017; Casale et al., 2023; Khanlou et al., 2017).

Several studies stress that without culturally responsive services, families may continue to feel alienated, misunderstood, or infantilized by systems that do not reflect their values (Antony et al., 2022; Hus, 2023). This is especially true in indigenous communities where traditional models of autism, which often are deficit-based, clash with holistic views that emphasize individual strengths and community inclusion (Bruno et al., 2023; Hus, 2023). Similarly, immigrant families face barriers such as language difficulties, unfamiliarity with

service structures, and a lack of representation among service providers (Boulé & Rivard, 2024; King et al., 2017).

Enhancing cultural competence in autism services requires a multifaceted approach: training professionals, incorporating translators, involving culturally diverse staff, and, most importantly, co-creating services with community leaders to ensure they are contextually relevant and respectful (Bruno et al., 2023; Antony et al., 2022; Shafi et al., 2024). Strength-based, indigenous-led, and family-informed frameworks are recommended to address historical trauma and rebuild trust in care systems (Antony et al., 2022; Hus, 2023).

Social challenges

Parents of children with ASD often face a complex array of social challenges that extend beyond the child's diagnosis. One of the most pervasive issues is social isolation (Shafi et al., 2024; Bruno et al., 2023; Ladaga, 2022; Abear et al., 2017; Khanlou et al., 2017; Capote et al., 2016; Millau et al., 2016). Parents, particularly mothers, frequently report withdrawing from their communities due to the stigma and judgment associated with their child's socially inappropriate behaviors. This isolation is both emotional and practical, resulting in loneliness and reduced access to support systems (Shafi et al., 2024). In countries like the Philippines, mothers may avoid public outings or family gatherings to prevent potential embarrassment, further compounding their sense of solitude (Leosala, 2023). Similarly, immigrant families relocating to new countries often leave behind familiar support networks, which makes them more vulnerable to isolation in host societies that may lack culturally competent services (Casale et al., 2023). This isolation can severely limit their ability to seek or sustain support, leading to greater stress and reduced well-being (Abear et al., 2017; Casale et al., 2023; Florentino et al., 2022; King et al., 2017; Leosala, 2023; Millau et al., 2016; Shafi et al., 2024).

In addition to these experiences, managing public perception and behavioral challenges in social settings remains a significant concern. Parents are often left to navigate the delicate task of explaining or justifying their child's behaviors in public spaces, which can be emotionally draining and stigmatizing. Some parents respond by avoiding social interactions altogether, sacrificing their own well-being to protect their children from public scrutiny (Leosala, 2023; Florentino et al., 2022). Moreover, the child's difficulties in socializing and forming friendships can indirectly affect the parent's social engagement, as they take on the added role of mediator in social integration efforts (Leosala, 2023). These issues are particularly acute among families in both developing and developed contexts, where access to inclusive and empathetic community-based programs remains inconsistent. Consequently, these challenges not only affect parental mental health but also hinder the development of meaningful social experiences for children (Abear et al., 2017; Leosala, 2023; Millau et al., 2016; Shafi et al., 2024).

The availability and quality of family and community support systems significantly influence how parents cope with the social and emotional demands of raising a child with ASD. Many immigrant families, particularly those new to North America, face limited access to extended family or community networks that typically provide emotional and logistical support. This is especially true for refugee families and those without pre-existing cultural communities in their new environments (Bruno et al., 2023; Casale et al., 2023; King et al., 2017; Khanlou et al., 2017; Millau et al., 2016). Without these networks, parents often rely heavily on formal services, which may not be adequately equipped to respond to culturally specific needs or practices. The gap between service availability and cultural compatibility can result in mistrust or disengagement from programs that might otherwise provide crucial support (King et al., 2017; Millau et al., 2016; Shafi et al., 2024).

Community-based support groups have emerged as promising interventions for reducing parental stress and social isolation. These groups offer a safe space for parents to share experiences, receive practical advice, and build emotional resilience. In both Canadian and Philippine contexts, studies have shown that peer support initiatives and NGO collaborations can help parents feel less alone and more empowered. Such initiatives also facilitate informal mentoring, in which experienced parents guide newer parents through the complex processes of accessing therapy, managing behavior, and navigating school systems. In areas where support groups are lacking, schools and local organizations are encouraged to foster informal parent engagement, such as meet-ups and resource-sharing sessions (King et al., 2017; Leosala, 2023; Millau et al., 2016).

Importantly, the effectiveness of support groups is heightened when cultural sensitivity is embedded in their design. Programs that acknowledge and incorporate local customs, beliefs, and communication styles are more likely to be embraced by families. For example, indigenous parents have emphasized the need for culturally respectful interventions that do not impose Western norms but instead integrate cultural values (Shafi et al., 2024). Immigrant parents have made similar calls for culturally competent services who feel alienated by mainstream healthcare systems (Millau et al., 2016). These findings highlight the need for inclusive, family-centered approaches that not only assist but also affirm the cultural identities and dignity of those they serve (Leosala, 2023; Millau et al., 2016; Shafi et al., 2024).

Challenges and needs of individuals with ASD

Individuals with moderate to severe ASD face a wide range of interconnected challenges that significantly affect their daily lives. Physical health issues, motor coordination difficulties, and heightened sensory sensitivities often interfere with routine activities. Behavioral challenges

such as rigidity, meltdowns, and aggression can further hinder their ability to engage socially and form peer relationships. Emotional and psychological difficulties, including anxiety and problems with self-regulation, are also common. These challenges hinder the learning of life skills, the achievement of independence, and the development of effective communication. Academic difficulties and limited access to appropriate support services compound these issues, often leading to long-term financial hardship and reduced opportunities in adulthood (Bauman, 2010; Müller et al., 2024; Waizbard-Bartov et al., 2024; Memari et al., 2015; Eow et al., 2020; Lagada, 2022; Balbin et al., 2022; Delafield-Butt et al., 2019; Silveira-Zaldivar et al., 2021; Matson et al., 2008; Gorlin et al., 2016; Zaldivar et al., 202; Gao, 2023).

Physical health, motor, and nutrition challenges

Individuals with ASD frequently face a broad array of physical health and motor coordination challenges, which are often intertwined with their cognitive and social difficulties. Common comorbidities include gastrointestinal dysfunction, sleep irregularities, sensory integration disorders, and immune-related conditions such as allergies and asthma (Balbin et al., 2022; Bauman, 2010). Additionally, children with ASD are at increased risk of developing metabolic disorders, including obesity, diabetes, and cardiovascular conditions, further complicating their developmental trajectories (Bauman, 2010).

Motor skill deficits are especially prevalent, with up to 79% of children with ASD experiencing some level of impairment in gross or fine motor coordination (Müller et al., 2024). In fact, studies have found that motor delays, such as late crawling or walking, are early indicators of ASD, as motor deficits typically emerge during infancy and persist into adulthood. This later manifests as clumsiness, poor balance, asymmetrical movements, and difficulties with

everyday motor tasks such as writing or using utensils (Waizbard-Bartov et al., 2024; Müller et al., 2024).

The consequences of these motor and physical health issues are compounded by low participation in physical activities. Memari et al. (2015) found that only 12% of children with ASD met physical activity guidelines, with 85.5% rarely or never participating in exercise. This inactivity is more pronounced in girls, older children, and those from lower-income or single-parent households. In addition, the study found that lack of social engagement also contributes to inactivity, as children with limited social interactions are less likely to engage in physical activity. Financial constraints, social isolation, parental safety concerns, and limited access to inclusive spaces further complicate the challenge.

Addressing barriers to physical health requires not only structural interventions, such as adapted programs and supportive environments, but also motivational strategies. Positive reinforcement, parental involvement, and activities aligned with children's interests, such as obstacle courses or animal-assisted therapies, can enhance participation. In addition, personalized approaches tailored to each child's strengths and preferences have proven more effective than generalized programs (Müller et al., 2024).

Closely linked to motor and physical health is the nutrition of children with ASD. The study of Eow et al. (2020) found that children with ASD commonly exhibit food selectivity, as most prefer starchy and carbohydrate-rich foods over fruits and vegetables, leading to nutritional imbalances and a higher risk of obesity. Mealtime rigidity and abnormal sensory responses to food are typically associated with increased autism severity, which further complicates dietary management. In addition to food selectivity, parental behaviors such as overly restrictive feeding practices, often driven by concerns about their child's weight, could exacerbate behavioral issues

and health problems. Furthermore, socioeconomic factors such as poverty and unemployment delay diagnoses and limit access to early nutritional interventions.

Beyond physical activity and nutrition, neurological disorders, including seizures, affect between 7% and 35% of children with ASD. Gastrointestinal issues such as chronic constipation and reflux, along with food allergies, are common and found to influence behavior and learning. Other prevalent conditions include hypotonia or low muscle tone, sleep disorders, hearing impairments, and dental issues, each contributing to discomfort and behavioral dysregulation (Bauman, 2010).

Effectively treating these comorbid conditions can improve therapy outcomes, reduce disruptive behaviors, and enhance quality of life. For example, managing sleep disorders can improve daytime behavior and academic performance, while addressing gastrointestinal distress may reduce self-injurious behavior (Bauman, 2010). In addition, promoting physical activity through daily routines and structured programs can improve social, cognitive, and motor outcomes in children with ASD (Lagada, 2022). Furthermore, aligning interventions to each learner's development level and socio-motor interests could encourage cooperative play and sports for older children (Müller et al., 2024). Parental involvement is also vital to reinforce physical activities at home and promote social engagement among their child's peers through group activities. In addition, integrating holistic, multidisciplinary, and culturally responsive approaches, with the help of health professionals, educators, and families, is also essential to address the complex interplay of challenges in ASD (Müller et al., 2024; Eow et al., 2020).

Sensory sensitivities

Learners with ASD often experience significant challenges related to sensory processing, which can profoundly affect their daily functioning and quality of life. Either hypersensitivity or

hyposensitivity to environmental stimuli is frequently observed in sensory sensitivities in autism. For instance, hypersensitive individuals may experience intense discomfort from certain textures, loud noises, or bright lights, leading to distress in everyday environments such as classrooms or public spaces. Conversely, those with hyposensitivity may demonstrate high pain tolerance or exhibit behaviors that seek out intense sensory input, such as frequent touching or exposure to strong stimuli. These sensory challenges are not merely inconvenient; they often serve as precursors to other behavioral and emotional difficulties that complicate social participation and learning (Balbin et al., 2022; Delafield-Butt et al., 2019; Silveira-Zaldivar et al., 2021; Waizbard-Bartov et al., 2024).

To cope with overwhelming sensory input, many individuals with autism engage in repetitive behaviors such as rocking, hand-flapping, spinning objects, or vocalizations. These stereotypic actions can function as self-soothing strategies or as attempts to regain control over unpredictable surroundings (Matson et al., 2008; Delafield-Butt et al., 2019; Gorlin et al., 2016). However, while these behaviors may be adaptive for the individual, they are often perceived by others as disruptive or unusual, particularly in structured environments such as schools. In educational contexts, such behaviors may interfere with classroom routines and learning, not only for the autistic student but also for their peers, potentially leading to social isolation and discrimination (Gao, 2023).

Behavioral challenges

Behavioral challenges associated with ASD extend beyond repetitive actions and often include more overtly disruptive conduct such as aggression, tantrums, self-injury, and property destruction. These behaviors are typically responses to communication barriers, emotional

dysregulation, or difficult transitions that the individual cannot manage. Aggression and self-injury, for example, are frequently interpreted as expressions of internal distress, frustration, or sensory overwhelm (Matson et al., 2008; Gorlin et al., 2016). Such behaviors may escalate over time if unaddressed, diminishing quality of life and limiting opportunities for education, employment, and social inclusion.

Emotional regulation difficulties are a critical factor underlying many of these behaviors. Learners with autism often struggle to interpret and express their emotions, resulting in either withdrawal or behavioral outbursts in stressful situations. The co-occurrence of anxiety and other mental health challenges further compounds these difficulties, highlighting the need for interventions that address emotional as well as sensory and behavioral domains (Silveira-Zaldivar et al., 2021; Delafield-Butt et al., 2019). Without appropriate support, emotional dysregulation can manifest as meltdowns or aggressive incidents, particularly during transitions between activities or changes in routine, which are especially challenging for many children with autism (Waizbard-Bartov et al., 2024).

In response to these complex and interrelated challenges, experts have advocated for more nuanced and comprehensive approaches to assessment and intervention. Rather than focusing solely on core ASD symptoms, researchers recommend multidimensional assessments that consider sensory profiles, emotional health, and the presence of co-occurring conditions such as anxiety or depression (Waizbard-Bartov et al., 2024). Interventions should be individualized and flexible, recognizing the diversity within the spectrum and the unique combination of needs each child presents. Traditional interventions may not always be effective across the board, and the application of tailored strategies, such as incorporating music and art

therapy, modifying physical environments, or using hands-on learning tools, has shown promise in improving engagement and reducing distress (Gao, 2023; Delafield-Butt et al., 2019).

Creating supportive environments, both at home and in educational settings, is essential to enhancing the well-being and developmental outcomes of learners with autism. Adjustments that promote a better person-environment fit, such as sensory accommodations or visual schedules, can reduce anxiety and foster greater independence and participation (Waizbard-Bartov et al., 2024). These efforts call for a broader need for systemic and inclusive practices that recognize the lived realities of learners with autism, not only as a clinical population but as diverse individuals navigating a world that often fails to accommodate their needs.

Social integration and relationships

Learners with ASD frequently face significant challenges in social integration, stemming from core difficulties in communication and understanding social cues. Many individuals struggle to interpret nonverbal signals such as facial expressions, body language, and tone of voice, often leading to misunderstandings and missed social opportunities. Figurative language, sarcasm, and nuanced conversational norms such as turn-taking and topic maintenance may be difficult to grasp, making interactions feel awkward or strained (Balbin et al., 2022; Delafield-Butt et al., 2019; Silveira-Zaldivar et al., 2021). These pragmatic language deficits can impair the ability to engage in reciprocal communication and inhibit the formation and maintenance of friendships, thereby contributing to social isolation and emotional distress (Silveira-Zaldivar et al., 2021; Memari et al., 2015; Waizbard-Bartov et al., 2024).

Furthermore, social isolation is exacerbated by widespread social exclusion, both in educational settings and in broader community contexts. Children and adults with autism often report feeling left out of group activities or peer circles, and this exclusion is compounded by

limited friendship opportunities and difficulties participating in team-based or collaborative environments (Gao, 2023; Memari et al., 2015). Communication barriers due to fear of judgment or low self-esteem discourage many learners with ASD from initiating interactions or engaging in classroom and extracurricular activities (Memari et al., 2015; Gorlin et al., 2016).

Stigmatization and unfavorable public perceptions of autism also pose major barriers to social participation. Misunderstandings about ASD foster an environment of low expectations, where peers and educators underestimate the social potential of individuals with ASD or exclude them from meaningful social engagement. These biases typically manifest in subtle ways, such as being overlooked during group work, or in more overt forms of discrimination, which further limit inclusion and reinforce feelings of otherness (Balbin et al., 2022; Gorlin et al., 2016; Waizbard-Bartov et al., 2024).

Social vulnerabilities among learners with ASD often extend beyond isolation to include heightened risk of bullying and exploitation. Due to difficulties in recognizing manipulative behaviors or deceit, many individuals with ASD are more susceptible to being taken advantage of, placing them in unsafe or emotionally harmful situations. These experiences can result in increased anxiety, mental health challenges, and maladaptive coping mechanisms such as substance misuse (Hasson et al., 2022; Gorlin et al., 2016; Balbin et al., 2022). In educational settings, bullying has been shown to negatively impact emotional well-being, reduce school attendance, and exacerbate existing communication or behavioral challenges (Memari et al., 2015; Gao, 2023).

In early childhood, social difficulties may manifest as atypical behaviors, such as noncompliance, unusual play patterns, or repetitive actions that seem excessive or contextually inappropriate. These include behaviors like lining up toys, mouthing or swallowing objects, or

repetitive movements such as spinning or jumping. In some cases, behaviors such as removing clothing may arise from sensory sensitivities, reflecting the complex interplay between sensory discomfort and social expectations (Balbin et al., 2022). While such behaviors are often misunderstood as defiance or lack of discipline, they may in fact represent attempts to manage anxiety, seek sensory regulation, or express unmet needs in the absence of effective communication.

The COVID-19 pandemic further amplified concerns around social development, particularly for children with autism. The shift to online learning and reduced opportunities for in-person interaction disrupted social routines and diminished opportunities to practice interpersonal skills, leading to fears of regression in both academic and social domains (Gao, 2023). These disruptions highlighted the importance of sustained, structured social engagement and inclusive educational practices to support the long-term development of learners with ASD. To address these barriers, researchers have emphasized the importance of early, sustained, and multi-level interventions to improve social communication and foster inclusive environments. Techniques such as peer-mediated interventions, social skills training, pivotal response training, and social narratives have been effective in enhancing interpersonal engagement and promoting reciprocal interaction (Silveira-Zaldivar et al., 2021). Naturalistic strategies, video modeling, structured play groups, and social-emotional learning programs further support the development of emotional intelligence and real-life social application (Silveira-Zaldivar et al., 2021). Furthermore, complementary practices such as intensive interaction and dance movement therapy can utilize attunement and embodied communication to foster connection, particularly for nonverbal individuals. At the same time, strategies like structured turn-taking and predictive engagement can deepen affective bonds and reduce anxiety in social contexts (Delafield-Butt et

al., 2019). Importantly, the creation of safe, predictable, and affirming environments, both in educational and home settings, can empower individuals with autism to express themselves more authentically and engage more confidently in social activities (Delafield-Butt et al., 2019; Gao, 2023).

Finally, collaborative approaches that involve parents, educators, and service providers are essential for sustaining meaningful progress. Parental engagement plays a crucial role in bridging communication between school and home, while professional training and centralized outreach services are necessary to build inclusive educational systems and reduce systemic exclusion (Hasson et al., 2022; Gao, 2023). Collectively, these findings highlight the need for culturally responsive, contextually grounded, and person-centered interventions to improve the social integration, emotional well-being, and life outcomes of individuals with autism.

Emotional and psychological challenges

Learners with ASD frequently experience a range of psychological comorbidities that significantly impact their well-being and ability to navigate everyday life. Commonly reported conditions include anxiety, depression, attention deficit hyperactivity disorder, schizophrenia, obsessive-compulsive disorder, and bipolar disorder, all of which complicate emotional regulation, cognitive functioning, and social interaction. These comorbidities often remain undiagnosed or are misdiagnosed, particularly in adults, due to overlapping symptoms and a lack of specialized healthcare access, leading to further personal and professional challenges. Emotional and mental health issues such as anxiety and depression are especially prevalent, with research highlighting their detrimental effect on quality of life. Yet, they often go unaddressed due to insufficient mental health services and inadequate transitions from pediatric to adult healthcare systems. In parallel, individuals with ASD also contend with physical health concerns,

including motor coordination difficulties and sensory sensitivities, which further hinder participation in routine and occupational activities (Balbin et al., 2022).

This psychological vulnerability is especially pronounced in academic environments, where students with ASD experience high levels of stress and anxiety stemming from both academic demands and complex social dynamics. Depression and low self-esteem are also common, often rooted in persistent difficulties with peer relationships and perceived failures in social or educational contexts. These emotional struggles frequently manifest as behavioral issues, affecting classroom engagement and overall school climate. Compounding these challenges is the absence of robust support systems; students with ASD may lack adequate emotional reinforcement from family, educators, and peers, which further intensifies feelings of isolation and emotional distress. Moreover, many people experience adjustment disorders during key life transitions, such as moving between educational levels or entering the workforce, which can exacerbate existing psychological difficulties and disrupt mental well-being. Collectively, the evidence highlights the urgent need for integrated mental health services, targeted interventions, and supportive infrastructures to address the complex psychological profiles of individuals with autism throughout their lifespan (Memari et al., 2015).

Life skills and independence

The development of daily living skills (DLS) is a fundamental component of adaptive functioning for individuals with ASD, significantly influencing long-term outcomes, including independence, community participation, and quality of life. The rate at which individuals with ASD acquire DLS varies. While longitudinal studies suggest that DLS may improve from early childhood into young adulthood, a plateau is commonly observed in late adolescence, and in some cases, a regression occurs by the early 30s (Baker et al., 2021; Bal et al., 2015). Factors

contributing to this variability include cognitive abilities, language development, executive functioning, and comorbid conditions such as intellectual disability (ID) or attention-deficit/hyperactivity disorder (ADHD), which further complicate adaptive behavior challenges (Baker et al., 2021; Kilincaslan et al., 2019). Notably, even individuals with high IQ scores may demonstrate significant DLS deficits, particularly when externalizing behaviors such as aggression or impulsivity are present (Baker et al., 2021).

Many learners with autism experience deficits in DLS, including personal hygiene, meal preparation, money management, and household safety, which persist even when cognitive abilities are within or above the average range (Baker et al., 2021; Bal et al., 2015). These challenges are often caused by a combination of biological factors and social-cognitive pressures, with adolescence being a key period when learning adaptive behaviors becomes more difficult due to increased emotional and executive functioning demands (Baker et al., 2021).

Executive functioning deficits, including difficulties in planning, organizing, and impulse control, are commonly associated with poor DLS outcomes, affecting the individual's capacity to complete daily tasks independently and consistently (Waizbard-Bartov et al., 2024). These challenges often interact with a strong preference for routine among individuals with autism, where disruptions can trigger anxiety and further reduce task performance (Waizbard-Bartov et al., 2024). Moreover, social-communication impairments, particularly those evident in early childhood, can hinder the development of DLS by limiting opportunities for modeling, feedback, and social learning (Bal et al., 2015).

Communication difficulties are closely linked to problems with daily functioning, so programs that include speech and language therapy often help in areas beyond just language

development (Kilincaslan et al., 2019). Furthermore, co-occurring psychiatric or behavioral conditions, such as anxiety, ADHD, or externalizing behaviors, can exacerbate DLS deficits, necessitating a dual focus on behavioral regulation and functional skill development to maximize outcomes (Baker et al., 2021).

Parental and family influences also play an important role in DLS outcomes. Family engagement in early, targeted interventions, particularly those emphasizing prompting, modeling, and visual supports, has been shown to significantly enhance DLS acquisition (Kilincaslan et al., 2019; Bal et al., 2015). Despite this, many parents report limited training or support in teaching self-help skills, especially in non-Western contexts such as Turkey, where educational services may lack the resources and professional expertise required for comprehensive adaptive skills training (Kilincaslan et al., 2019). Lowered expectations for independence among parents of children with ASD, compared to those with other disabilities, have been linked to reduced self-efficacy and motivation in individuals with autism (Balbin et al., 2022). Parental involvement is a critical determinant of success in DLS acquisition, as they serve as primary models and facilitators of adaptive behaviors, and their ability to scaffold learning while managing stress and externalizing behaviors can significantly shape a child's developmental trajectory. When parents receive targeted training on supporting their child's DLS at home, intervention effectiveness improves markedly, particularly when these skills are practiced in naturalistic, everyday contexts (Balbin et al., 2022; Kilincaslan et al., 2019). However, without adequate support, caregivers may inadvertently limit their child's autonomy by completing tasks themselves, especially in the face of persistent behavioral challenges or overwhelming caregiving demands (Waizbard-Bartov et al., 2024).

Cultural and geographic differences can make it more difficult to support the development of DLS. For example, while Western research often emphasizes social and communication-focused interventions, studies from the Philippines and Turkey point to significant gaps in support for daily living, particularly during the transition to adulthood (Balbin et al., 2022; Kilincaslan et al., 2019). Families in lower-income settings or under-resourced regions face additional barriers to care, including limited access to trained professionals, culturally appropriate assessment tools, and inclusive community programs. As such, the development of validated, context-sensitive materials is vital (Silveira-Zaldivar et al., 2021).

DLS deficits in ASD are complex and persist throughout development, demanding a holistic approach that integrates biological, cognitive, behavioral, familial, and sociocultural factors. Effective support, therefore, requires early, sustained, and individualized interventions that address both skill-building and environmental supports, while also accounting for the broader familial, educational, and cultural systems that shape outcomes over the lifespan. Effective interventions must also be tailored to the individual needs of each child, recognizing that standardized approaches often fail to address the nuanced challenges faced by individuals with autism. Personalized support plans that assess an individual's unique strengths and difficulties, such as those involving communication, personal hygiene, or self-care, are more likely to yield significant improvements (Kilincaslan et al., 2019; Silveira-Zaldivar et al., 2021).

Structured teaching of adaptive behaviors, such as dressing, meal preparation, and personal hygiene, has also been shown to foster greater independence, especially when introduced early and reinforced consistently across environments (Silveira-Zaldivar et al., 2021). Programs such as "surviving and thriving in the real world" and naturalistic teaching strategies

using everyday materials have demonstrated encouraging short-term improvements, particularly when combined with occupational therapy and parent training (Baker et al., 2021). Moreover, incorporating community inclusion into intervention planning, through participation in activities such as shopping, cooking, or navigating public spaces, can reinforce DLS while also improving social engagement and confidence (Balbin et al., 2022).

Finally, policy advocacy remains vital to ensure sustained support for early intervention services and caregiver resources. Greater investment in training, assessment tools, and community inclusion initiatives will not only enhance individual outcomes but also contribute to a more inclusive society for people with ASD and intellectual disabilities.

Communication challenges

Communication challenges are a major concern in the education and social development of individuals with ASD, as many exhibit language impairments that hinder their ability to communicate effectively with teachers and peers (Gao, 2023; Gorlin et al., 2016). These impairments can manifest as limited vocabulary, difficulty forming coherent narratives, or an inability to engage in reciprocal conversations, which are essential for building relationships and expressing needs (Delafield-Butt et al., 2019; Gorlin et al., 2016). For some, communication can be inconsistent, with skills that fluctuate over time, adding complexity for educators and caregivers (Gorlin et al., 2016). Verbal communication is not the only challenge, as many individuals also struggle to interpret or express nonverbal cues, such as gestures, facial expressions, and body language. These difficulties disrupt the reciprocal nature of communication and can lead to social isolation or misunderstandings in both peer and adult interactions (Waizbard-Bartov et al., 2024; Delafield-Butt et al., 2019).

Innovative approaches have been proposed to bridge these gaps, including motor imitation techniques that facilitate shared action and engagement by encouraging synchronization between the therapist and the child. These approaches promote non-verbal interaction as a foundation for more complex communication skills. Additionally, the use of multimodal communication strategies, such as combining gestures, vocalizations, and body movements, can enhance expressiveness and support a more comprehensive understanding between autistic individuals and their communication partners (Delafield-Butt et al., 2019). In addition, tailoring educational strategies to address these communication needs is necessary, especially as IEPs are developed to reflect each student's unique strengths and challenges. IEPs should incorporate flexible goals and adaptive communication strategies that evolve as the child grows and changes, ensuring sustained support (Gao, 2023). Facilitating shared narratives in therapeutic and educational settings can also provide individuals with ASD with a structure in which they can express themselves more effectively, helping build stronger social and emotional connections over time (Delafield-Butt et al., 2019).

Academic challenges

Students with ASD face a range of academic challenges that are rooted in both their individual learning profiles and the broader educational systems they navigate. Traditional educational models often do not accommodate the neurodiverse ways in which students with autism process and engage with information. Many experience significant stress related to academic performance, which can lead to anxiety, burnout, and motivational difficulties, particularly when compounded by repeated academic failures or transitions between educational stages (Memari et al., 2015). Students also struggle with time management, especially when balancing academic responsibilities with extracurricular demands, further exacerbating stress

levels (Memari et al., 2015). These challenges are intensified for those with co-occurring learning disabilities, who require tailored educational approaches that are frequently unavailable due to a lack of support services, inadequate learning resources, and insufficient numbers of trained staff (Memari et al., 2015; Silveira-Zaldivar et al., 2021).

The structure and environment of mainstream classrooms often fail to meet the needs of students with autism. Many educational settings are overcrowded, follow unclear routines, or are led by teachers lacking appropriate training in autism-inclusive practices, all of which hinder engagement and learning (Gorlin et al., 2016). These systemic shortcomings can be especially problematic for students with social-communication deficits, a core characteristic of autism, which impair peer interactions and participation in group learning activities (Silveira-Zaldivar et al., 2021). Additionally, test anxiety is prevalent among students with ASD, negatively affecting academic outcomes and further limiting opportunities for success (Memari et al., 2015).

Historically, autism research has concentrated on limitations and behavioral issues, but recent studies emphasize the importance of identifying and nurturing the unique strengths and abilities of autistic individuals. Neurocognitive research suggests that the brains of people with autism process information in distinctive ways that may confer strengths in memory, attention to detail, and pattern recognition. Indeed, up to one-third of individuals with autism demonstrate exceptional abilities, though these often remain unrecognized or unsupported in traditional educational contexts. Early identification of such strengths, sometimes visible in preschool settings, can lead to substantial long-term benefits when nurtured appropriately through tailored strategies (Halder et al., 2024).

Personalized teaching approaches that align with a student's learning style and intrinsic motivations are therefore essential for addressing both strengths and deficits of learners with ASD. For example, students who excel in specific areas may still struggle with standardized assessments that fail to capture their true capabilities. Interventions should therefore aim to bridge this gap by incorporating flexible assessments and interest-based learning. Adult coaches and mentors, attuned to the emotional and cognitive needs of students with autism, are particularly effective in guiding them toward independence while supporting skill development in both areas of strength and difficulty. These coaches play a crucial role in fostering autonomy, especially when they support students in understanding and working through their challenges using their strengths as a foundation (Halder et al., 2024).

Creating supportive, enriching environments is another key factor in academic success. Opportunities such as nature exploration, workshops, and hands-on learning camps have been shown to stimulate natural interests and improve social acceptance among peers. Importantly, this approach requires an understanding of the child's interests and emotional state, as interests do not always align neatly with areas of strength. A flexible, guided enrichment strategy, often facilitated by adult coaches, can therefore help students discover and build on what they love while continuing to develop necessary life skills (Halder et al., 2024).

Parental involvement is an indispensable component of effective support for students with autism. Parents bring deep, experiential knowledge of their children's behaviors, motivations, and needs, making them vital partners in the co-design of educational and intervention strategies. Their insights contribute to more effective individualized education plans and can enhance collaboration between educators and families. Moreover, many parents extend

their roles into community advocacy, participating in workshops and peer networks to address common challenges and promote systemic change (Halder et al., 2024).

Financial challenges and transition to adult life

Financial and resource-related challenges significantly impact the quality of life, educational attainment, and employment outcomes for individuals with ASD and their families. In many cases, the financial burden begins early, with high tuition fees and the cost of educational materials presenting considerable barriers to accessing quality education. These challenges are compounded by limited access to extracurricular activities, after-school programs, and academic support services due to financial constraints, especially for families from lower-income backgrounds (Memari et al., 2015). Furthermore, the cumulative cost of healthcare, including therapies, assessments, and specialized interventions, can overwhelm families, reducing their ability to invest in educational or developmental resources.

Limited access to affordable transportation and necessary technology, such as computers or stable internet, further hinders students' ability to engage fully in school, widening the equity gap between low-income and higher-income households. Financial stress not only affects logistical access to learning but also influences family dynamics and emotional well-being, creating an environment that can impede academic and social progress (Memari et al., 2015).

These financial hardships often persist into adulthood, particularly as individuals with ASD encounter systemic obstacles in securing and maintaining employment. Despite growing awareness of neurodiversity, employment rates for adults with autism remain low, with studies showing that nearly half of 25-year-olds with ASD have never held a job. Although awareness of autism has increased, with prevalence rising globally from 1 in 150 children to 1 in 44 as of

2021, employment outcomes remain bleak, with 66% to 86% of adults with autism either unemployed or severely underemployed (Balbin et al., 2022). This is despite growing willingness among major corporations such as Microsoft and SAP to hire neurodivergent talent. The discrepancy points to a persistent gap in early preparation, support, and employer awareness (Halder et al., 2024).

Even when employment is secured, the lack of understanding and accommodations in workplace environments frequently leads to dissatisfaction and high turnover. The transition from education to employment is often unsupported, with limited access to vocational training or employment readiness programs tailored to the cognitive, sensory, and communication needs of adults with autism. These gaps in the support infrastructure contribute to underemployment, economic instability, and social exclusion, underscoring the need for integrated policies that address both educational and employment pathways (Balbin et al., 2022; Memari et al., 2015). Without targeted investment in inclusive educational resources, vocational services, and workplace training, the cycle of economic marginalization for individuals with ASD is likely to continue.

Challenges and needs of educators

Despite differences in economic contexts, teachers in LAMIC and low-resource areas in North America face common difficulties in teaching learners with ASD. The core challenges range from classroom management and communication barriers to insufficient training and limited support. In addition, behavioral, communicative, social, instructional, systemic, and emotional demands can affect teachers' effectiveness and consequently student outcomes. While

many strategies and resources are available, several barriers continue to hinder their successful implementation.

Behavioral challenges of learners

Behavioral issues of students with ASD, such as tantrums and meltdowns, restricted and repetitive behaviors, aggression, non-compliance, self-harm, lack of focus, and difficulty in following instructions, are widely reported across various educational settings. These behaviors can stem from sensory sensitivities, communication difficulties, or changes in routine, and often disrupt classroom activities (Balading et al., 2023; Jaffal, 2022; Kim et al., 2024; Lewis et al., 2024; Miguel, 2020; Mpangane et al., 2024).

Behavioral issues of students with ASD make the learning environment complicated for teachers to implement effective interventions or implement new teaching strategies, ensure effective classroom dynamics, and uncertain about discipline methods appropriate for children with ASD (Flores, 2022; Lewis et al., 2024; Mangonon, 2022; Wilson and Landa, 2019; Mpangane et al., 2024; Chong, 2016). Strategies such as implementing individualized behavior management plans, positive reinforcement, visual cues, and structured environments were frequently recommended, but consistent application remains a challenge (Lewis et al., 2024; Jaffal, 2022).

Communication and social interaction

Communication and social challenges are also common among children who are nonverbal or have limited expressive and receptive language skills, which affect their ability to follow instructions, interact with peers, and progress in their academics (Mpangane et al., 2024; Kim et al., 2024). As a result, teachers face difficulties in communicating effectively with them,

which complicates lesson delivery and classroom management (Cook & Ogden, 2021; Mpangane, Maepa, and Muhadisa, 2024).

Educators also struggle to facilitate peer relationships due to the students' limited participation in school and community activities, which affects their social development (Ajoc, 2019). Due to children with ASD's limited social understanding and unconventional ways of interacting, they often face social isolation and bullying (Cook & Ogden, 2021). Structured group activities, visual schedules, and the use of augmentative and alternative communication are recommended, though successful implementation depends heavily on teacher training and classroom support (McDougal et al., 2020).

Diverse learning needs

The wide range of characteristics, needs, and behaviors these students exhibit makes educating students with ASD in mainstream classrooms a deeply complex challenge. This diversity overwhelms educators, requiring them to develop tailored strategies that effectively meet each pupil's unique requirements, including their varied academic, social, and physical needs (Chong, 2016; Cook & Ogden, 2021; Towle, 2015). This issue is compounded by the expectation to ensure that all students are engaged and learning, despite the lack of tailored resources and strategies that are needed to run inclusive classrooms (Russell et al., 2022).

The diverse learning needs of students require teachers to adapt their teaching methods to accommodate a wide range of challenging behaviors exhibited by different students, which complicate lesson planning and classroom management (Miguel, 2020). Lewis et al. (2024) further stressed that many teachers, particularly those without specialized training, struggle to manage classrooms that include students with ASD. The demand for individualized teaching approaches is evident, especially for students with anxiety, sensory sensitivities, and attention-

related challenges (McDougal et al., 2020). In effect, teachers need to implement flexible, responsive classroom strategies that are not only time-intensive but also emotionally and intellectually taxing (Balading et al., 2023).

Diverse student needs also demand nuanced understanding and adaptable interventions, such as visual schedules, structured routines, and sensory adjustments (Miguel, 2020; Cook & Ogden, 2021). However, tailoring sensory environments is particularly difficult due to the vast differences in individual preferences, as what helps one student might not work for another (McDougal et al., 2020). In effect, there is a need for special education teachers' participation in curriculum development, given their firsthand insights into which strategies could work under the constraints they commonly face (Balading et al., 2023). In addition, equipping educators with tools to monitor emotional and social needs, such as stress thermometers to track anxiety, would facilitate peer interaction and support social inclusion (Cook & Ogden, 2021). Kilag et al. (2024) and Miguel (2020) highlighted the necessity of individualized learning plans that account for varying learning styles and disabilities, but also the need for significant preparation and customization to be effective. In the same note, Flores (2022) also acknowledged the potential of interventions such as video modeling but noted that the broad spectrum of student needs makes it difficult to create universally effective solutions.

Beyond pedagogy, structural support is essential. According to Towle (2015), students with disabilities face numerous physical, social, and attitudinal barriers. Meaningful inclusion depends on environments that value accessibility and diversity. This includes ensuring that educational facilities are physically accessible and that materials are available in suitable formats (Towle, 2015). In addition, dedicated autism-focused classrooms within mainstream schools could offer a safe space for divergent learning, while supporting social integration (Chong, 2016)

Individualized support strategies, such as assigning personal cabinet spaces, establishing physical boundaries, and modifying schedules to include breaks and limit class size, are also essential for learners with ASD (Miguel, 2020). These accommodations help manage their need for predictability, reduce anxiety, and foster a sense of safety. However, as Ajoc (2019) and Towle (2015) pointed out, the shortage of qualified teachers and the lack of timely diagnostic assessments often leave students without adequate support, leading to long-term disadvantages in education, employment, and access to services.

To create a truly inclusive system, reforms must include increased funding, better access to diagnostic and educational services, and flexible teaching models that empower educators to adapt methods and materials (Towle, 2015; Balading et al., 2023). It is also critical to ensure that teachers are trained to manage students in an individualized manner, which is fundamental to an effective and compassionate teaching strategy (Cook & Ogden, 2021).

Insufficient training and professional development

Across educational contexts, teachers feel unprepared to support students with ASD effectively. This lack of preparedness stems from issues such as insufficient pre-service education, limited and often ineffective professional development, and inadequate institutional support. Despite its critical role in enhancing teaching effectiveness and inclusive practices, ongoing continuous professional development remains out of reach for many educators due to persistent barriers such as limited funding (Mpangane et al., 2024).

Many general education (GE) teachers begin their careers without the foundational knowledge needed to support students with ASD. GE teachers report that their pre-service training offered minimal exposure to the unique needs of learners with autism. Most of the time, their learning focused only on a few hours of inclusive education, which is insufficient to equip

them with the capabilities they need (Jaffal, 2002; Senoo et al., 2024). In fact, the study of Kim et al. (2024) found that early childhood education (ECE) teachers rated their preparedness at a low 31.25% on average, and only a few of them felt fully equipped before entering the classroom

Similarly, many GE educators are appointed to teach autism-specific classes with insufficient training, or worse, without training or background in special education or understanding of ASD, which leads them to be overwhelmed, anxious, unprepared to handle the requirements of inclusive classrooms, and feel incompetent (Mpangane et al., 2024; McDougal et al., 2020; Kilag et al., 2024). The study by Lewis et al. (2024) further shed light on the gravity of the situation in which new teachers, who had taught for four years or less and had attended only nine hours or less of ASD-related training, were asked to handle a full class of ASD students. Furthermore, in cases where professional development opportunities are available, teachers view them as ineffective and impractical, as they mostly focus on lectures and handouts and do not provide hands-on, practical strategies applicable in the classroom (Jaffal, 2022). For instance, Flores (2022) highlighted the challenges teachers face when implementing video modeling techniques, including inadequate training and uncertainty about classroom application.

This training gap has tangible consequences. Studies have found that many GE teachers express low confidence in their ability to support students with ASD and in their overall effectiveness as teachers (Cook & Ogden, 2021; Russell et al., 2022). Educators without specialized training and a background in ASD also feel ill-equipped to implement effective evidence-based practices; appropriate teaching strategies; develop tailored lesson plans, and manage challenging behaviors (Jaffal, 2002; Senoo et al., 2024; Mangonon, 2022).

To build and continuously enhance educators' skills and efficacy, there is a need for hands-on, ongoing training throughout their careers, rather than sporadic or purely theoretical

workshops (Towle, 2015). For example, having specialized and hands-on workshops that focus on evidence-based strategies, behavioral management, culturally-responsive pedagogy, self-efficacy, along with ongoing professional development tailored to both general and special education teachers, is crucial (Jaffal, 2022; Senoo et al., 2024; Kim et al., 2024; Cook and Ogden, 2021; Miguel, 2020; Ajoc, 2019; Lewis et al., 2024; Scriney, & Smyth, 2021). Regular training and workshops should also be organized to enhance teachers' skills in using technology for remote learning (Balading et al., 2023; Flores, 2022).

In addition, approaches such as embedding intervention practices within existing instructional routines, aligning them with curriculum and students' individual learning plans, and encouraging the gradual integration of tools like video modeling, supported by training, help bridge theory and practice (Kilag et al., 2024; Flores, 2022). In the same note, Wilson and Landa (2019) highlighted the need to simplify intervention strategies and align them with curriculum goals and familiar instructional practices to reduce teacher resistance and feelings of being overwhelmed; and overall enhance implementation fidelity.

Mentorship programs, as suggested by Mpangane et al. (2024), can support novice teachers by pairing them with experienced mentors in ASD education. These mentorships, along with knowledge-sharing platforms, can foster a supportive teaching community. Similarly, collaborative partnerships between teachers, parents, and specialists can help ensure consistent, holistic support for students, and partnerships with local governments and NGOs can help bridge resource needs (McDougal et al., 2020; Miguel, 2020).

Limited collaboration and support networks

Supporting children with disabilities requires coordinated action across government sectors, including health, education, and family services. Fragmentation among these services could lead to accountability gaps and missed opportunities for support (Towle, 2015). However, collaboration is often insufficient or inconsistent, leading to significant challenges in delivering appropriate support to students with ASD.

Interdisciplinary collaborations are essential for aligning strategies, sharing resources, and exchanging insights to support learners with autism better. Administrators are encouraged to develop professional learning communities where staff can share and refine strategies for working with students with ASD, and establish mentorship programs, where experienced teachers support newcomers to build their confidence and competence (Jaffal, 2022; Chong, 2016; Senoo et al., 2024; Kim et al., 2024). Flores (2022) adds that collaborative environments support not only inclusion but also pedagogical innovation. For instance, teachers who share experiences with tools such as video modeling can cultivate a community of practice that fosters ongoing development and adaptation. Miguel (2020) also highlighted the importance of documenting and sharing successful practices across educational institutions. Such knowledge-sharing can broaden the application of effective strategies and support the evolution of best practices in diverse educational contexts. The employment of paraprofessionals, or educational assistants, can further alleviate some of the burdens on teachers, allowing them to focus on instruction while support staff assists students with ASD (Chong, 2016; Jaffal, 2022; Lewis et al., 2024; Russell et al., 2022).

Despite this need, many teachers report insufficient time and opportunities for meaningful professional interaction. General education teachers frequently lack opportunities for

collaboration with special education professionals, which can leave them feeling burned out, distressed, isolated, frustrated, dissatisfied with their jobs, and underprepared to implement effective interventions (Balading et al., 2023; Chong, 2016; Jaffal, 2022; Russell et al., 2022).

This need for interdisciplinary collaboration, involving not just educators but also healthcare professionals such as speech and language therapists, occupational therapists, and psychologists, is vital to creating a holistic support system. However, systemic issues such as a shortage of specialists and the high costs of hiring them often hinder access to this expertise (Senoo et al., 2024; Russell et al., 2022). Mpangane et al. (2024) reinforced these findings, advocating for collaboration among teachers, therapists, and other professionals and further highlighted the importance of community involvement in supporting learners with ASD. A broader support network, including families, local organizations, and community members, can provide resources and reinforce educational efforts.

Cook and Ogden (2021) argued that integrated approaches are essential. Schools should not only facilitate access to specialists but also embed therapeutic interventions into everyday educational practices. This integration benefits all students, not just those with ASD. Kilag et al. (2024) also emphasized the potential of community partnerships. Collaborations with local non-government offices and advocacy groups can supplement teacher training, provide additional resources, and enhance overall support systems within schools.

Resource constraints

Across educational systems worldwide, the issue of limited resources remains a pervasive and deeply entrenched barrier to the effective inclusion of students with ASD. Many schools fall short in providing critical resources such as materials, technology, and support staff to adapt curriculum and instruction to meet the diverse needs of students and overall create an inclusive

environment for students with ASD (Jaffal, 2022; Senoo et al., 2024; Mpangane et al., 2024; Russell et al., 2022; Lewis et al., 2024; Kim et al., 2024). In effect, teachers lack the necessary tools and support system to modify curricula and adapt instruction, which restricts the effectiveness of the curriculum, leading to suboptimal learning outcomes (Kilag et al., 2024; Mangonon, 2022; Balading et al., 2023) and making it difficult for students to engage fully in their education (Ajoc, 2019).

For example, the chronic shortages of specialized teaching aids, textbooks, assistive technologies, and learning aids force teachers to extensively modify curricula, often at the cost of educational quality. In addition, inadequate classroom modifications and the near-total absence of sensory rooms both contributed to students' behavioral challenges and hindered their progress (Senoo et al., 2024; McDougal et al., 2020; Kilag et al., 2024). Modern tools such as PECS and evidence-based practices such as TEACCH and ABA are also seldom implemented due to a lack of resources (Mpangane et al., 2024).

Numerous studies, including those by Russell et al. (2022) and Lewis et al. (2024), reaffirmed that insufficient instructional materials and a lack of support staff are significant barriers. McDougal et al. (2020) and Kilag et al. (2024) reported that educators often face large caseloads without adequate support personnel, such as speech or occupational therapists. Mangonon (2022) and Kim et al. (2024) further illustrated how resource limitations affect the assessment and progress tracking of students with ASD. Teachers struggle without access to specialized evaluation tools, and early-career teachers, in particular, feel unprepared due to the absence of physical teaching aids and classroom modifications. Studies by Miguel (2020) and Ajoc (2019) described the situation in the Philippines, where special education centers often operate with minimal staff and insufficient materials. This is in addition to the challenges of

overcrowded or under-equipped classrooms and limited funding that teachers face, further reducing the effectiveness of special education programs.

Studies call for strong administrative support to empower educators to provide individualized curricula and to communicate more clearly about available resources and access procedures. Oftentimes, teachers do not know what support is available or how to obtain it, leading to further frustration and inefficiency in teaching (Wilson & Landa, 2019; Balading et al, 2023; Chong, 2016). However, the variability in education funding across jurisdictions, especially in relation to special-needs education, makes achieving consistency difficult, leading to fragmented services and unequal access to vital resources for students (Towle, 2015).

Huge class size and workloads

Alongside resource shortages, large class sizes, and heavy workloads, these factors significantly hinder educators' ability to implement inclusive practices. The number of students with ASD is rising significantly, leading to increased enrollment in special education programs (Miguel, 2020). In effect, educators struggle to manage large groups while still offering the individualized attention that is fundamental to students with ASD's learning (Wilson & Landa, 2019). Larger class sizes can dilute instruction's effectiveness, as it is hard to provide individualized attention and support for each student with special needs while maintaining overall classroom effectiveness (McDougal et al., 2020; Kilag et al., 2024).

To help address these needs, Cook and Ogden (2021) suggested using structured schedules and visual supports to manage classroom activities and transitions effectively and, at the same time, to develop clear, consistent transition strategies to help students navigate changes in activities, thereby reducing anxiety and improving engagement. They also recommended designated quiet areas and adaptive resources to accommodate students with sensory needs, to

help improve their focus and participation. Teachers are also encouraged to incorporate more group-based learning, which provides peer support and reduces the burden on individual teachers to meet every student's needs. Through structured group activities, peer relationships can be fostered, encouraging collaboration and, over time, helping reduce the emphasis on individual performance and promoting a supportive classroom culture. Beyond these approaches, there is also a need for continuous feedback mechanisms in which educators can share their experiences and challenges to help continuously refine the intervention based on practical classroom experiences (Wilson & Landa, 2019).

Huge workloads also prevent educators from planning and preparing lessons that accommodate all students and from incorporating new interventions into their teaching. The demands of administrative tasks, combined with teaching responsibilities, leave little room for individualized planning and effective implementation of teaching strategies (Wilson & Landa, 2019; Russell et al., 2022; Mangonon, 2022; Cook & Ogden, 2021). For example, implementing a video modeling intervention requires considerable time. As teachers often face overwhelming workloads, including lesson planning, report writing, and communication with parents, the effort required to create and use video modeling can feel burdensome, leading to strong reluctance to adopt this method (Flores, 2022).

In addition, teachers also frequently manage extensive paperwork, lesson planning, and grading outside of school hours, which further adds to their already heavy workload (Balading et al., 2023). This reduces educators' ability to nurture positive student-teacher relationships, as there is limited time available to build them, overall affecting the quality of their interactions.

Geographical barriers also pose additional obstacles, particularly in remote or rural areas. Mangonon (2022) stressed that teachers face significant difficulties in reaching learners with autism in far-flung regions, limiting access to both educational resources and professional support services.

Schools should seek to alleviate conflicting responsibilities that hinder teachers' ability to implement teaching strategies and implement a school-wide culture that prioritizes continuous learning and adaptation (Cook & Ogden, 2021). One way to address this is to improve access to educational resources through resource-sharing, using technology such as websites, which could enable educators to plan and share resources more efficiently across teams. These websites can also enable the sharing of best practices among educational staff to help mitigate some barriers related to isolation in instructional approaches (Wilson & Landa, 2019). Flores (2022) also advocated that educational institutions provide adequate video-recording resources for teachers. This includes access to cameras and editing software that can facilitate the creation of effective video modeling content, so teachers can focus on adopting new teaching strategies like video modeling without feeling overwhelmed.

Cultural and attitudinal barriers

Negative attitudes and perceptions surrounding autism continue to present significant barriers to inclusive education. While many general education teachers express support for inclusive education in principle, some harbor implicit biases about the academic and social abilities of students with ASD, which can negatively influence their teaching methods and interactions, often resulting in reduced engagement and support for students (Jaffal, 2022; Senoo et al., 2024; Russell et al., 2022; Kilag et al., 2024; Kim et al., 2024; Ajoc, 2019).

One example is the negative perception of the capabilities of students with ASD. Some teachers were found to express more positive views towards physical disabilities compared to cognitive or emotional ones, which led to lowered expectations and limited opportunities, ultimately impacting educational outcomes. This issue is further compounded by the “Pygmalion effect,” wherein students tend to perform in line with the expectations their teachers hold of them (Russell et al., 2022). If teachers automatically perceive students with ASD as less capable compared to their peers with other forms of disabilities, students turn to live up to what is expected of them, which could negatively impact their future, such as limiting beliefs of their capabilities to pursue higher education or limiting opportunities to blue-collar jobs.

To address this, it is essential to raise awareness about the wide variability within the autism spectrum and to promote a deeper understanding among educators of neurodiversity and its associated strengths (Cook & Ogden, 2021).

The issue of stigma does not end within school walls; societal attitudes and misconceptions surrounding disabilities can also exacerbate challenges in the classroom. Stigma often deters families from seeking educational resources or engaging with schools, limiting the support autistic children receive (Senoo et al., 2024; Kilag et al., 2024). Kim et al. (2024) further elaborate on this by noting that cultural stigmas around autism prevent families from seeking necessary educational resources, thereby complicating the inclusion of autistic children in mainstream classrooms. Ajoc (2019) revealed that this stigma extends to special education programs themselves, which are often viewed negatively by some communities. This perception results in reduced parental involvement and weak support from local stakeholders, further

isolating these programs and their students. Addressing these deeply rooted negative perceptions requires a concerted effort through public awareness campaigns and school-based initiatives.

To address these issues, schools must play their role in creating a culture of acceptance, starting with actively dispelling stereotypes about autism. Creating a school culture that values diversity and inclusion is essential. Schools should implement policies that support inclusive practices and foster respect and understanding among students (Kilag et al., 2024). In addition, schools can also conduct awareness campaigns and advocacy efforts about ASD within the community and among parents of typically developing children to reduce stigma, increase acceptance, and promote cooperation (Senoo et al., 2024; Kilag et al., 2024; Kim et al., 2024).

Educators must also strive to increase their awareness of and variability in cognitive disabilities and to participate in training programs that foster positive attitudes towards neurodiversity and the strengths of individuals with autism (Russell et al., 2022; Cook & Ogden, 2021). Being well-versed in the legislative requirements of inclusive education, which mandate the inclusion of students with disabilities in general education settings through training, would help teachers understand their legal obligations (Jaffal, 2022).

Poor parental engagement

Poor parental cooperation remains a significant challenge in the successful inclusion and education of children with ASD. Across various studies, researchers consistently identified gaps in parent-teacher collaboration that hinder the effective implementation of educational strategies (Mpangane et al., 2024; Lewis et al., 2024; Kilag et al., 2024).

Senoo et al. (2024) highlighted several key barriers to parental cooperation. One prominent issue is the unrealistic expectations set by parents, who compare their child's progress to that of a typically developing student. This puts undue pressure on teachers to commit to

unrealistic expectations. In addition, denial and superstitious beliefs about disabilities can prevent parents from acknowledging their child's unique challenges, leading to a lack of support for essential educational interventions. Financial constraints also emerge as a significant concern, as the expectation that families bear the cost of additional resources can impede teachers' ability to deliver adequate support.

This disconnect is further emphasized by Mpangane et al. (2024), who found that teachers often experience a lack of meaningful interaction with parents, despite its necessity to foster a supportive learning environment for children with ASD. Kilag et al. (2024) found that this lack of engagement stems from parents' lack of acceptance regarding their child's disability.

Strengthening parental engagement through improved communication and educational programs is therefore vital. Regular communication with parents about their child's progress and challenges helps tailor educational strategies to meet individual needs and, at the same time, build trust and enhance collaboration in supporting students' educational journeys (Kilag et al., 2024; McDougal et al., 2020). Workshops and training sessions aimed at helping parents understand the complexities of ASD are crucial to build a home environment that complements and reinforces classroom efforts (Senoo et al., 2024; Mpangane et al., 2024). In addition, collaborative approaches among educators, special education staff, and families would help create a supportive environment and could enhance understanding and resource sharing, benefiting the overall educational experience for both educators and students (Russell et al., 2022; Ajoc, 2019).

The development of family-centered approaches, particularly in the development and implementation of individual educational plans, can help families advocate for their children's needs and ensure that schools are held accountable for delivering appropriate support. Engaging

parents in school-wide inclusion policies and establishing support networks for families of children with disabilities can further enhance cooperation and build a strong community of shared understanding and advocacy (Towle, 2015).

Teacher well-being and mental health

The mental health of teachers is a critical factor in the success of creating an effective and inclusive environment for students with ASD. Yet, research showed that the emotional, psychological, and physical demands placed on teachers, particularly those who worked with students with ASD, can lead to stress, increased anxiety, emotional exhaustion, and burnout that impact their job performance and work satisfaction (Mpangane et al., 2024; Russell et al., 2022; Lewis et al., 2024; McDougal et al., 2020; Miguel, 2020; Balading et al., 2023).

General education teachers who are transitioning to autism-specific learning often feel unprepared and overwhelmed. Studies reported that educators experience anxiety and emotional exhaustion, particularly as they struggle to adapt to the unique dynamics of special education classrooms, which differ drastically from their previous mainstream experiences (Mpangane et al., 2024). Managing diverse needs and behavioral challenges, handling persistent stressors such as physical outbursts and the need for constant vigilance, and the continuous demand for the emotional labor of being present, patient, and supportive every day can leave teachers emotionally drained, negatively impacting their performance and satisfaction. These physical demands, combined with emotional stress, can significantly heighten their risk of burnout and reduced job satisfaction (Lewis et al., 2024; McDougal et al., 2020; Miguel, 2020). Russell et al. (2022) also echoed these concerns and noted that educators grapple with fears about job security and pressure to perform, which further exacerbates their stress. Balading et al. (2023) delved into the multifaceted nature of teacher burnout, where educators reported negative mental health

effects stemming from emotional burden, excessive demands, and a lack of systemic support.

The expectations to produce positive outcomes often, without adequate resources or recognition, and the disruption of work-life balance, encroaching on personal time, resulted in chronic exhaustion and contributed to feelings of isolation.

These challenges are compounded by a lack of adequate training and support systems, leading to a sense of isolation and increased vulnerability to mental health issues (Mpangane et al., 2024). Due to the lack of preparedness, coupled with high expectations and complex classroom demands, imposter syndrome, which is a deep-seated fear of being exposed as incompetent in their roles, was reported in some educators (Mpangane et al., 2024). For instance, the dual challenge of promoting inclusion while ensuring academic achievement for all students demands a balancing act that often results in feelings of inadequacy, especially in resource-limited settings. In effect, teachers tend to view their situations through a deficit lens, which undermines their confidence and willingness to implement inclusive practices (Cook & Ogden, 2021).

To combat these challenges, educators must be encouraged to shift their mindset toward capability rather than deficiency through a comprehensive mental health support system tailored to educators handling students with ASD. In addition, access to counseling services, peer support groups, and targeted stress management programs, along with recognizing teachers' efforts through awards and professional development incentives, can enhance morale and motivation. Establishing robust feedback systems in which teachers can voice concerns and influence policies was also found to be vital to creating a more responsive and supportive educational environment (Balading et al., 2023; Russell et al., 2022; Cook & Ogden, 2021). In line with this, Chong (2016) emphasized the importance of work-life balance and the need for school

administrators to acknowledge the heavy demands on teachers' workloads and implement strategies to prevent burnout and professional isolation. Efforts to protect teachers' well-being must also be prioritized by promoting a healthier balance between professional responsibilities and personal life.

Systemic and policy-level barriers

Educational systems across various regions continue to face deep-rooted constraints that hinder the effective implementation of inclusive practices and interventions, particularly for students with ASD. At a systemic level, broad educational policies and practices are often not conducive to supporting new interventions, creating significant barriers to innovation and progress (Senoo et al., 2024; Mpangane et al., 2024; Cook & Ogden, 2021; Russell et al., 2022; Lewis et al., 2024; Flores, 2022; Wilson & Landa, 2019).

A recurring issue is the rigidity of school policies and curricula, which limit teachers' ability to adapt their methods to the unique needs of students with ASD. In many cases, school-selected curricula are misaligned with evidence-based strategies, making it challenging for educators to implement interventions effectively (Wilson & Landa, 2019; Senoo et al., 2024). Furthermore, prevailing educational philosophies in some schools reinforce a one-size-fits-all mentality, which fails to accommodate the diverse learning profiles of students with autism. Such approaches often involve making generalized assumptions about students' needs, rather than recognizing their individuality and providing tailored support. Teachers are encouraged to know students as individuals and adapt teaching methods and materials to suit diverse learning styles. However, without institutional backing to do so, their ability to personalize learning remains constrained (Cook & Ogden, 2021).

The implementation of teaching strategies like video modeling also faces structural hurdles. Teachers often lack access to technology, instructional materials, and relevant training, which limits their ability to use video modeling effectively. Aligning these strategies with existing curricular goals is another challenge, leading to confusion about their value and applicability. Without proper integration and evaluation systems, teachers may struggle to assess the effectiveness of such methods, further diminishing their impact in the classroom. Comprehensive training plans for video modeling are needed, along with hiring experienced educators to lead these efforts and improve implementation outcomes (Flores, 2022).

Another consistent barrier is the lack of support from school administrators. Teachers across multiple studies report that administrators often lack the knowledge or commitment needed to provide meaningful assistance, leaving educators shoulder the burden of inclusive education largely on their own. While some management teams attempt to assist, many fall short due to an insufficient understanding of the specific requirements for supporting students with ASD. This lack of alignment between administrative leadership and classroom realities leads to frustration and burnout among educators, who feel unsupported and overwhelmed (Wilson & Landa, 2019; Senoo et al., 2024; Mpangane et al., 2024; Russell et al., 2022; Lewis et al., 2024).

Financial limitations compound these challenges. Teachers frequently report not receiving adequate guidance or resources to manage inclusive classrooms effectively (Lewis et al., 2024). Many spend their own money on classroom supplies and specialized teaching materials, leading to financial strain and dissatisfaction. Compensation is another concern, with many special education teachers reporting that their salaries do not reflect the complexity and workload of their roles (Balading et al., 2023).

Staffing issues, particularly frequent changes in teaching personnel, disrupt continuity and weaken the support systems necessary for consistent learning experiences. Although awareness campaigns for SPED programs exist, they often lack strategic outreach and advocacy, resulting in minimal impact. The use of evaluation frameworks like the Context, Input, Process, Product (CIPP) model has revealed significant weaknesses in resource allocation and teaching methodologies. Regular assessments and evaluations of SPED programs are largely absent, preventing timely adjustments and impeding program effectiveness (Ajoc, 2019)

At the policy level, outdated and inconsistent regulations further exacerbate these systemic issues. For example, many special education policies are more than a decade old and do not reflect current inclusive education standards, leading to inadequate support for students with disabilities. There is also a lack of consistency in how inclusion is defined and implemented across jurisdictions. Some provinces mandate that children with disabilities be placed in regular classrooms, while others allow for segregation, resulting in unequal access to quality education. These inconsistencies create confusion and reinforce disparities in educational outcomes (Towle, 2015).

To address these systemic barriers, comprehensive reforms are necessary. These include revising teacher education curricula to ensure pre-service educators receive in-depth training on ASD, its characteristics, and effective teaching strategies (Senoo et al., 2024). Policy implementation must also be strengthened by providing adequate funding and institutional resources to support inclusive practices. Mechanisms for regular evaluation and feedback should be established within schools to track progress and identify areas for improvement (Russell et al., 2022; Towle, 2015). Moreover, a cultural shift is required within schools to foster environments

that value diversity and inclusion, where physical accessibility and individualized accommodations are seen as standard practice rather than exceptions (Kilag et al., 2024).

Finally, the government must take steps to ensure that SPED teachers are adequately compensated and that all teachers are provided with the necessary resources, thereby reducing the financial burden currently borne by individual educators (Balading et al., 2023). Employment conditions must also be stabilized, as many new teachers face precarious work arrangements with limited job security (Chong, 2016). Collectively, these actions can help create an educational system that not only acknowledges but also actively supports the rights and needs of all students, especially those with ASD, ensuring a more inclusive, equitable, and effective learning environment.

Alternative solutions in low-resource settings

Given the widespread service gaps and burdens experienced by children, their parents and families, and their teachers, more collaborative models of intervention that emphasize flexibility, cultural responsiveness, and affordability could be explored as an alternative or a supportive means.

Parent-implemented interventions

One such model is parent-implemented interventions (PII). In this approach, caregivers are trained to deliver therapeutic strategies within everyday routines, promoting developmental progress outside of formal therapy sessions. Naithani et al. (2022) found that PIIs were effective across multiple LMICs, particularly when delivered by non-specialists using structured curricula. These interventions are more scalable, lower-cost, and more culturally adaptable than traditional clinician-led models.

Carr and Lord (2016) employed a similar approach in their pilot intervention with low-income families. By conducting in-home sessions and allowing for flexible scheduling, the program increased participation among families who would otherwise face barriers to clinic-based care. Participants reported not only improved child outcomes but also a greater understanding of ASD and enhanced confidence in managing behaviors at home.

In South Africa, Schlebusch et al. (2020) advocated for a strength-based model that emphasized community involvement, participatory design, and integration of caregiver voices in intervention planning. This approach aligned with a broader shift in global health that moves away from deficit-focused paradigms and instead prioritizes the assets, knowledge, and resilience of families and communities.

Task-sharing and non-specialist delivery models

One of the most promising approaches to bridging the autism care gap in LMICs is task-sharing or the delegation of intervention tasks to non-specialist providers such as community health workers, educators, parents, and caregivers. As Naithani et al. (2022) noted, task-sharing can significantly expand service reach in settings with limited specialist availability. Community-based workers are often more trusted by families and better able to deliver interventions in ways that align with local practices and norms.

For instance, Divan et al. (2021) found that with proper training and supervision, non-specialists could deliver psychosocial interventions that led to meaningful improvements for children and caregivers. The benefits of task-sharing include increased accessibility, cost-effectiveness, and scalability. Importantly, it also helped localize the autism response by embedding services within communities rather than centralizing them in urban hospitals.

Task-sharing aligns well with the World Health Organization's Caregiver Skills Training (WHO CST) program, which is designed for use in both low-resource and high-resource settings. The program focuses on empowering caregivers with practical, evidence-based strategies they can implement at home. Studies have shown positive outcomes in caregiver confidence and child developmental gains (Schlebusch et al., 2020).

However, the success of task-sharing depends heavily on supervision and training. Without consistent monitoring and opportunities for professional development, non-specialists may struggle to manage complex cases or ensure fidelity of intervention. Naithani et al. (2022) emphasized the need for robust supervisory frameworks that enable non-specialist workers to consult with experts and receive feedback, especially when dealing with cases involving co-occurring conditions or severe behavioral challenges.

Barriers to implementation in LMICs and marginalized communities

Despite their promise, intervention models such as task-sharing and parent-mediated programs face significant implementation challenges in resource-limited settings. A major barrier is that intervention programs are often not adapted to the lived realities of marginalized families. Schlebusch et al. (2020) argued that interventions developed in high-income contexts must undergo systematic cultural adaptation before being introduced in LMICs. This includes adjusting content to match local language, values, and caregiver roles, and co-developing materials with families to ensure relevance and acceptability.

In immigrant communities and indigenous populations, cultural worldviews surrounding disability, parenting, and healing may differ substantially from biomedical frameworks. Gulsrud et al. (2021) highlighted that misalignment between provider recommendations and caregiver beliefs can erode trust, reduce engagement, and limit the effectiveness of interventions.

Furthermore, stigma remained a powerful deterrent to service uptake. In many societies, autism is misunderstood or associated with shame, leading families to conceal symptoms or avoid seeking help. Okwara and Donald (2024) found that caregivers in South Africa often delayed accessing services due to fear of judgment from community members or negative interactions with providers. This stigma also affects funding and policy prioritization, as developmental disabilities receive less attention compared to communicable diseases or maternal health.

Moreover, the lack of validated, culturally appropriate screening and diagnostic tools poses another barrier to implementation. Divan et al. (2021) found that many available tools are normed for Western populations and do not account for cultural differences in child-rearing practices or communication styles. This limits diagnostic accuracy and can result in misclassification or missed cases.

Community engagement and participatory design

To overcome these barriers, researchers and practitioners are increasingly advocating community-engaged approaches to intervention development. This included participatory design, community-based participatory research, and the integration of caregivers as co-researchers or co-facilitators. These strategies not only enhance cultural relevance but also empower communities to shape services according to their needs.

In South Africa, Schlebusch et al. (2020) described a participatory project in which caregivers helped design a pyramid of interventions that prioritized simple, affordable strategies over complex therapies. This participatory process ensured that interventions were both locally feasible and more likely to be sustained.

Similarly, Carr and Lord (2016) demonstrated the value of adapting interventions based on caregiver feedback. By modifying scheduling policies, offering financial incentives, and conducting home visits, the pilot program achieved substantial improvements in attendance and engagement compared to traditional models.

Based on the reviewed research, this researcher believes that there is a need to shift from top-down service delivery to collaborative approaches that center on caregivers' knowledge, cultural values, and community networks, which could help address some of the challenges in implementing various intervention models.

Systemic policy barriers and opportunities for reform

Improving access to autism services in low-resource settings requires more than innovative interventions; it demands systemic reform. Policy frameworks in both LMICs and high-income nations often overlook neurodevelopmental disorders, contributing to fragmented service delivery, inconsistent funding, and inequitable access to care.

Divan et al. (2021) argued that autism care must be integrated into national health systems as a core component of child health services. This integration includes standardized early screening protocols, expanded health insurance coverage for developmental services, and investment in human resources. Without such systemic support, task-sharing and community-level interventions may remain underutilized or unsustainable.

In South Africa, for instance, Okwara and Donald (2024) found that although public health services are theoretically available to all children, the actual availability of specialized developmental services is limited, especially in rural and under-resourced areas. The three-tiered health system frequently results in bottlenecks at tertiary hospitals, which are overburdened and geographically inaccessible for many families.

The lack of coordination among government departments, such as health, education, and social services, also hinders service delivery. Schlebusch et al. (2020) highlighted that families often navigate disjointed systems, leading to duplication, service gaps, or delays in care. A more integrated model of service provision, supported by national policy and cross-sector collaboration, is critical to overcoming these systemic inefficiencies.

Recommendations from multiple studies advocated for decentralization of services to bring care closer to communities (Okwara & Donald, 2024); government subsidies for autism-related therapies and assessments to reduce out-of-pocket costs (Naithani et al., 2022); formal inclusion of ASD in primary care training curricula to improve early detection (Divan et al., 2021); and national surveillance systems to track prevalence, service access, and health outcomes for children with ASD (Patrick et al., 2025).

Based on the reviewed research, it is believed that reforms must be tailored to local needs and priorities and share a common objective: establishing autism care as a right, not a privilege, for all children, regardless of geography or income.

Health equity and digital technology

Health equity is a state in which everyone has a fair chance to attain their highest level of health. Systemic factors that contribute to health disparities, such as socioeconomic status, race, ethnicity, and access to health services, contribute to unequal access to healthcare. Better economic resources provide citizens with good access to healthcare, nutrition, living conditions, and higher educational attainment, which typically enables stronger health literacy and information access. In areas with poor infrastructure and weak social support networks and community ties, access to healthy food, adequate services, and support systems often leads to

negative health impacts. Lack of insurance, high health costs, and limited availability of services pose barriers to timely, high-quality care (Richardson et al., 2022).

Digital health solution's potential to bridge the gap

Digital health solution has significantly reshaped contemporary healthcare by introducing a suite of technologies to enhance service delivery and patient outcomes (Topol, 2019; WHO, 2019). These tools are not merely supplementary but are redefining how care is coordinated, accessed, and experienced, especially for populations with complex needs such as individuals with ASD. Given the challenges frequently encountered by individuals with ASD and their caregivers, including delays in diagnosis and fragmented service delivery, digital health solution interventions (DHIs) present new opportunities to deliver timely, personalized, and scalable care (Ji et al., 2025; Jang et al., 2021).

Digital health solution encompasses a range of technologies integrated into healthcare systems to improve care delivery and health outcomes (Ji et al., 2025). It includes mobile health (mHealth) applications, telemedicine platforms, health information technology (HIT), wearable devices, and approaches such as personalized and precision medicine (Kuwabara et al., 2019). The objective is not only to digitize existing practices but to fundamentally enhance the responsiveness, accessibility, and personalization of care (Papademetris et al., 2022).

The structure of digital health solution is informed by principles such as interoperability, data-driven decision-making, patient empowerment, and system-wide efficiency (WHO, 2019). In resource-constrained settings or for populations where specialist support is limited, such as rural areas or individuals with ASD, digital health solution offers a means of extending care and reducing inequities in access (Jang et al., 2021).

Characteristics of digital health solution

Digital health solution is the field and practice that leverages digital technologies to improve healthcare delivery, patient engagement, and management. A defining feature of digital health solution technologies is their accessibility. These tools overcome traditional barriers to care by enabling health service delivery across geographic and time constraints (Ji et al., 2025; Kuwabara & Krauss, 2019). Digital platforms allow users to access support at their convenience, which is particularly beneficial as an alternative solution to help in providing interventions for ASD in inaccessible communities, low-income families, and marginalized populations.

Digital health solution has several types. Virtual health refers to the use of online platforms for consultations and health services, while mobile health applications (also known as m-health) help users manage their health on their phones. Wearable devices such as fitness trackers and smartwatches help monitor health metrics, while the Internet of Medical Things connects various devices to collect and share health data. Artificial intelligence and machine learning provide predictive analytics and support decision-making in healthcare, and newer approaches for storing and sharing health records using blockchain technology. Telemedicine leverages video conferencing technologies to provide remote medical services (Lawrence, 2022).

Digital therapeutics is another area in digital health solution where evidence-based digital tools that are approved by regulatory institutions such as the US Food and Drug Administration integrate technology to treat and reverse diseases. For example, digital therapeutics are used to treat diabetes and support weight loss, as well as to manage other chronic diseases. Patient education is typically included in digital therapeutics; for example, a 12-week remote digital program aimed at treating lower back pain included education, behavioral coaching, and tracking, along with exercise and cognitive-behavioral therapies (Kuwabara et al., 2019).

Equally important is the capacity of digital systems to personalize care and enable patients to take a more active role in managing their health. Applications often leverage data from user profiles, health histories, and wearable devices to tailor interventions and recommendations (Kuwabara et al., 2019). The integration of multimedia, such as videos, interactive simulations, and text, allows content to be adapted to individual learning preferences, enhancing user engagement and comprehension (Ji et al., 2025). Features such as personalized dashboards, reminders, and educational content empower users to take an active role in managing their health (Kuwabara et al., 2019). In the context of autism care, where collaboration among families, teachers, and clinicians is essential, such engagement can significantly improve outcomes.

Furthermore, digital health solution interventions have demonstrated positive effects on caregivers' mental health. Ji et al. (2025) reported that these tools can alleviate stress and enhance coping strategies among parents of children with ASD. Such benefits underscore the broader psychosocial impact of digital health solution beyond its clinical utility.

Another hallmark of digital health solution is its reliance on real-time monitoring. Tools such as wearable sensors provide continuous data on physiological states, allowing healthcare providers or caregivers to respond promptly to emerging issues (Wang et al., 2020). These insights enable proactive health management rather than reactive treatment. Massive datasets collected through real-time monitoring can be synthesized to inform individual care plans, monitor population trends, and improve predictive modeling (Topol, 2019). Interoperability further enhances this function by enabling digital tools to communicate with electronic health records and other platforms, ensuring cohesive care delivery (Papademetris et al., 2022).

Cost-efficiency is a major advantage of digital health solution, as it reduces reliance on physical infrastructure and human labor, thereby lowering operational costs without compromising service quality (Topol, 2019). This makes digital health solution a practical solution for remote or under-resourced communities, where traditional healthcare services may be limited or unavailable. Many digital platforms are also highly scalable, making them well-suited for large public health campaigns and population-wide interventions (Wang et al., 2020). This positions digital health solution as a viable solution to reduce disparities in access to care. Through telemedicine, individuals in underserved areas can consult with specialists and receive ongoing support (WHO, 2019). These capabilities are especially important in autism care, where geographic and systemic barriers often delay diagnosis and treatment (Jang et al., 2021). Together, these strengths position digital health solution as a powerful tool for delivering equitable, scalable, and cost-effective care.

Industry standards for digital health solution

To ensure that digital health solution technologies meet stringent requirements for safety, effectiveness, and quality, several international standards and best practices have been established. These frameworks guide developers and implementers in creating medical software and devices that are not only clinically reliable but also ethically and legally compliant. They serve as essential tools in mitigating risks and enhancing user trust, particularly when digital health solutions are used in sensitive contexts such as autism care.

One of the foundational standards in quality assurance is ISO 9001, which outlines the principles of a quality management system (QMS). This standard applies across industries and emphasizes the need for organizations to consistently deliver products and services that meet both customer expectations and regulatory obligations. For digital health solution developers,

ISO 9001 facilitates a systematic approach to continuous improvement, risk-based thinking, and customer satisfaction (International Organization for Standardization [ISO], 2015).

Expanding this foundation, ISO 13485 is specifically designed for the medical device sector. It incorporates additional requirements related to regulatory compliance and product safety in the healthcare domain. By adhering to ISO 13485, developers of digital health solution tools, including those used in autism diagnostics or therapy, can ensure that their products are developed under rigorous quality controls, reducing the likelihood of harm and improving overall performance (ISO, 2016).

Risk management is further addressed in ISO 14971, which focuses on identifying, evaluating, and controlling risks associated with medical devices. This standard is crucial in digital health solution, where software errors or misuse can have serious clinical consequences. For instance, applications used to assess or monitor individuals with ASD must account for the potential impacts of false positives or system failures. ISO 14971 supports a lifecycle approach to risk, emphasizing proactive hazard identification and mitigation strategies (ISO, 2019).

In parallel, the IEC 62304 standard provides detailed guidance on the development and maintenance of medical device software. It specifies processes for planning, designing, coding, testing, releasing, and updating software for clinical use. Digital health solution tools, especially those integrating AI algorithms or data analytics, benefit from this framework by ensuring transparency, traceability, and reliability throughout the development lifecycle (International Electrotechnical Commission [IEC], 2006).

The usability of digital health solution systems is equally important. IEC 62366 addresses this by outlining how to apply usability engineering to medical devices. It emphasizes the importance of designing technologies that are intuitive, safe, and appropriate for their intended

users. For applications aimed at children with autism or their caregivers, usability can influence engagement, learning outcomes, and safety. By applying the principles in IEC 62366, developers can design with empathy and inclusivity, ensuring that the end-users' needs are prioritized (IEC, 2007).

In addition to these ISO and IEC standards, the International Medical Device Regulators Forum (IMDRF) has provided guidance specific to Software as a Medical Device (SaMD). This includes detailed recommendations on applying quality management systems to standalone medical software, which is often central to digital health solution. The IMDRF emphasizes the importance of risk-based classification, clinical evaluation, and post-market surveillance, particularly for digital tools used in therapeutic or diagnostic pathways without associated hardware (IMDRF, 2013).

Equally critical to the responsible deployment of digital health solution technologies is compliance with data privacy and cybersecurity regulations. Legal frameworks such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in the European Union provide specific guidelines for protecting sensitive personal health data. These regulations require developers to implement robust encryption, consent protocols, breach-notification mechanisms, and user-rights protection. In autism interventions, where data may include behavioral video recordings, communication patterns, or developmental assessments, adherence to these privacy laws is vital to maintaining ethical standards and public trust (European Parliament and Council, 2016; U.S. Department of Health and Human Services, 2013).

Based on the reviewed research, these standards and regulations, taken together, form a comprehensive scaffold that enables digital health solution technologies to be safe, effective, and

aligned with user needs. By embedding these frameworks into the design and deployment of digital health solution tools, developers can contribute to more equitable and high-quality care systems, particularly for marginalized populations such as children with ASD.

Best practices in design and development

Implementing digital health solution tools effectively requires more than technical competence. Adhering to best practices in design and development ensures these tools are usable, inclusive, and contextually relevant (Papademetris et al., 2022).

User-centered design is essential in autism-related applications. Engaging end users throughout development helps ensure that products are accessible and aligned with real-world needs (Ji et al., 2025; Jang et al., 2021). This process includes iterative prototyping, usability testing, and community feedback. Accessibility features, such as customizable interfaces, audio support, and visual prompts, allow digital tools to accommodate a range of abilities (Wang et al., 2020). These adaptations are particularly crucial in ASD, where sensory sensitivities and communication styles vary widely.

Integration into existing care frameworks enhances the effectiveness of digital health solutions. Tools should be interoperable with existing databases, support collaborative workflows, and be complemented by user training (Topol, 2019). Sustainability and scalability must also be considered. This includes evaluating cost models, infrastructure requirements, and adaptability of tools to changing user needs (WHO, 2019). Continuous monitoring, including user analytics and performance metrics, allows for ongoing refinement.

Data privacy, PII, PHI, and regulatory frameworks

The use of digital technologies in healthcare raises critical questions about the protection of personal information. Two central concepts in this domain are Personally Identifiable

Information (PII) and Protected Health Information (PHI). PII refers to any data that could identify an individual, such as name, address, or social insurance number. PHI, a subset of PII in the healthcare context, includes health records, diagnostic reports, or any data generated during medical care that is linked to a specific person (U.S. Department of Health and Human Services [HHS], 2013).

To ensure this information is safeguarded, digital health solution tools must comply with privacy legislation such as HIPAA in the United States. HIPAA mandates standards for securing PHI, emphasizing data encryption, controlled access, and breach-notification processes. These provisions are particularly relevant in autism care, where sensitive developmental and behavioral data are collected, stored, and potentially shared among multidisciplinary teams (HHS, 2013).

In Europe, GDPR enforces even broader data protection. It grants individuals the right to access, correct, and delete their personal data, while imposing strict requirements on how organizations collect, store, and process personal data. GDPR applies not only to entities operating within the EU but also to those handling the data of EU citizens, making it globally influential (European Parliament and Council, 2016). Importantly, GDPR's emphasis on 'privacy by design' requires that data protection be considered from the earliest stages of software development.

Both HIPAA and GDPR recognize the high stakes involved in handling health-related data. Violations of these regulations can lead to severe financial penalties and reputational harm. For developers and implementers of digital health solutions, understanding the distinctions between PII and PHI and complying with relevant privacy laws is not merely a legal requirement; it is a foundational aspect of ethical practice and public trust.

Digital health solution for ASD life skills development

Due to mobile device affordability; proliferation of applications targeting people with ASD or intellectual disabilities (Ayres et al., 2013); portability and mobility (Cabiell-Hernandez et al., 2017); and natural inclination of people with ASD to technologies, most especially children who are digital natives (Mintz, 2014, Mintz, 2013, Mintz et al., 2012), studies on the use of mobile technologies as a form of digital health solutions for individuals with ASD and intellectual disabilities to provide evidence-based interventions for life skills development are increasing.

Mobile, tablet, and smartwatch devices, as well as web applications, are ubiquitous, affordable, and portable (Cabiell-Hernandez et al., 2017), and people with ASD have a natural affinity for them (Mintz, 2014; Mintz, 2013; Mintz et al., 2012). Because of this, digital technologies have huge potential to democratize access to interventions, especially in rural areas, underprivileged communities, and developing and low-income countries. These technologies could also facilitate the learning of life skills, maintenance of learned skills, reduce costs to acquire these interventions, and help in reducing the stress of families taking care of a family member with ASD.

Digital health solutions for ASD, such as mobile and tablet applications, can support the uniqueness and varying needs of learners by leveraging various core capabilities and features. Studies on the use of mobile technologies for people with ASD and intellectual disabilities to help in life skills development are increasing, due to mobile device affordability; proliferation of applications targeting people with ASD or intellectual disabilities (Ayres et al., 2013); portability and mobility (Cabiell-Hernandez et al., 2017); and natural inclination of people with ASD to

technologies, most especially children who are digital natives (Mintz, 2014, Mintz, 2013, Mintz et al., 2012).

Prototyped applications for life skills development of people with ASD demonstrated a range of capabilities such as teaching children activities of daily living (Cruz-Torres et al., 2019; Lu, 2011; Perez-Fuster, 2019; Shepley et al., 2018; Yasir, 2018;); communication (Abdallah et al., 2019, Alhazbi et al., 2018, Cabiellles-Hernandez et al., 2017); math (Bassette et al., 2019; Yakubova et al., 2019); social skills (Mintz, 2014; Mintz, 2013; Mintz et al., 2012); arts (Akmanoğlu and Pektaş-Karabekir, 2019); job preparation (Ulgado et al., 2013); sports (Yucesoy-Ozkan et al., 2018); sustaining attention (Vlez-Cotoa et al., 2017; Wang & Zhang, 2020); and joint attention (Mangafa et al., 2015). Some applications provide motivation (Bakhai et al., 2020); enable activity and task management (Cesario et al., 2022; Skillen et al., 2016); behavior management (Khan et al., 2018; Reis et al., 2021); and self-instruction (Smith et al., 2015). There is also a study that leveraged commercially available applications for neurotypical people and repurposed them for use by people with autism (Maich et al., 2019) and a study that enabled customizable, personalizable applications using pre-built mobile application templates and existing database integrations (Shabalina et al., 2019).

Content supported

Application prototypes supported various content types, including videos, illustrations, animations, pictures, augmented reality, audio, audio-visual content, and text-based content. The table below summarizes the various content types and the studies in which they were used.

Table 1*Content Types Supported*

Category	Content	Studies
Videos	Video clips to teach leisure activity	Yucesoy-Ozkan et al., 2018
	Social stories using videos	Yasir, 2018
	Instructional videos	Yakubova, et. al, 2019; Mintiz, 2013; Akmanoğlu and Pektaş-Karabekir, 2019; Howard et. al, 2021
	Self-instructional videos	Smith et al., 2015; Wilkens et al., 2021
	Videos teaching interviews	Ulgado et al., 2013
Illustration, Animation, Picture and Augmented Reality	Three and two-dimensional animations	Vlez-Cotoa et al., 2017
	Character illustrations	Khan et al., 2017; Bakhai et al., 2020),
	Pictograms and pictures	Cabiellés et al., 2017; Mangafa et. al, 2015; Cesario et al., 2022; Prez-Fuster, Sevilla and Herrera, 2019; Mintz, 2013; Maich et al., 2019; Cesario et al., 2022
	Three-dimensional (3D) objects	Bassette et. al., 2019
	Virtual environments	Shabalina et al., 2019
	Augmented reality	Wang and Zhang, 2020
Audio and Audio-Visual	Verbal commands	Abdallah et al., 2019
	Pictures with sounds	Wilson, et al., 2018; Yakubova, et. al, 2019; Alhazbi et al, 2018; Maich et al., 2019; Howard et. al, 2021
Text-based content	Instructions on how to execute interventions (for teachers and parents)	Reis et al., 2021
	Tasks to be executed	Skillen et al., 2016; Shepley et al., 2018; Torres et. al., 2019
	Descriptions and checklists	Wilkens et al., 2021
	Tests (for employment preferences)	Shabalina et al., 2019
	Calendars	Prez-Fuster, Sevilla and Herrera, 2019; Maich et al., 2019
	Text based information	Mintz, 2013; Maich et al., 2019; Howard et. al, 2021
	SMS	Lu, 2011; Mintz, 2013

Capabilities and Features

Capabilities refer to the main problem or benefit that the application aims to address or provide. At the same time, features are major functionalities within the application that enable it to deliver its core capability. Prototyped applications have core capabilities to teach children activities of daily living (Cruz-Torres et al., 2019; Lu, 2011; Perez-Fuster, 2019; Shepley et al., 2018; Yasir, 2018;), communication (Abdallah et al., 2019, Alhazbi et al., 2018, Cabiell-Hernandez et al., 2017), math (Bassette et al., 2019; Yakubova et al., 2019), social skills (Mintz, 2014; Mintz, 2013; Mintz et al., 2012), arts (Akmanoğlu and Pektaş-Karabekir, 2019), job preparation (Ulgado et al., 2013), sports (Yucesoy-Ozkan et al., 2018), sustaining attention (Vlez-Cotoa et al., 2017; Wang and Zhang, 2020), and joint attention (Mangafa et al., 2015). Some apps provide motivation (Bakhai et al., 2020); enable activity and task management (Cesario et al., 2022; Skillen et al., 2016); behavior management (Khan et al., 2018; Reis et al., 2021); and self-instruction (Smith et al., 2015). There is also a study that leverages commercially available applications for neurotypical people and repurposes them for use by people with Autism (Maich et al., 2019); and a study that enables customizable, personalizable applications using pre-built mobile application templates and existing database integrations (Shabalina et al., 2019).

Table 2

Features of prototyped applications and their related use cases

Feature	Use Cases	Studies
Content customization and delivery		
Web-based content configuration	Teachers or caregivers create individualized content (e.g., vocabulary, videos, sensory supports), build child profiles with	Abdallah et al. (2019); Mintz (2014, 2013); Mintz et al. (2012); Pérez-Fuster (2019); Reis et al. (2021); Skillen et al. (2016); Shabalina et al.

	health/behavior info, set geofencing, and emergency contacts, and configure daily monitoring questions. Content is synced with mobile apps for real-time access.	(2019); Vlez-Cotoa et al. (2017); Wilson et al. (2018) piloted web platforms delivering individualized interventions to mobile devices, enabling coordinated home-school support.
Mobile-based content configuration	Parents and educators configure study plans, upload and edit instructional videos, and create playlists directly on mobile devices for structured guidance. Data can be stored locally.	Alhazbi et al. (2018); Akmanoğlu & Pektaş-Karabekir (2019); Smith et al. (2015) tested mobile video prompts and playlists for daily tasks, improving structured learning.
User interface customization	Modify interface colors, layouts, text, and images via API or settings to reduce overstimulation and increase engagement.	Pérez-Fuster (2019); Shabalina et al. (2019) demonstrated customizable UI elements improved accessibility and user comfort.
Dynamic content display	Content configured on web or mobile is automatically displayed on the learner's device for real-time access to lessons, strategies, and feedback tools.	Abdallah et al. (2019); Mintz (2014, 2013); Mintz et al. (2012); Pérez-Fuster (2019); Reis et al. (2021); Skillen et al. (2016); Shabalina et al. (2019); Vlez-Cotoa et al. (2017); Wilson et al. (2018) showed automatic content delivery improved coordination between caregivers and children.
Task setup and sequencing	Teachers/parents design activities and break them into stepwise tasks, attaching photos to guide learners.	Cesario et al. (2022); Skillen et al. (2016) implemented photo-guided sequences to support independent completion of daily activities.
Virtual character design	Children can customize in-app avatars to increase engagement.	Khan et al. (2018) found personalized avatars improved motivation and participation.
General app adaptation	Commercial apps for neurotypicals can be configured to partially meet autistic learners' needs.	Maich et al. (2019) adapted mainstream apps for scheduling and reminders.
Support for diverse media types	Display text, pictograms, images, audio, video, and virtual/3D objects to support multi-sensory learning.	Alhazbi et al. (2018); Vlez-Cotoa et al. (2017); Cabiell-Hernández et al. (2017); Cruz-Torres et al. (2019); Smith et al. (2015); Ulgado et al. (2013); Bassette et al. (2019); Yakubova et al. (2019) supported multi-sensory content to improve engagement and comprehension.
Personalization		

Child profile setup	Create a profile with name, photo, and preferences for personalized content delivery.	Wilson et al. (2018) used child profiles to tailor learning materials and track engagement.
Custom media use	Teachers or parents upload their own photos, recordings, or culturally relevant social stories to make learning relatable.	Cabiellles-Hernández et al. (2017); Wilson et al. (2018); Yasir (2018) allowed learners to access personal and culturally relevant content, improving comprehension.
Personalized reinforcement	Deliver rewards aligned with child interests after task completion.	Alhazbi et al. (2018); Skillen et al. (2016) tested reinforcement systems, such as favorite toys or playtime, to improve task completion rates.
Task management and learning support		
Task analysis	Break activities into smaller steps for structured learning.	Bakhai, et al. (2020); Cesario et al. (2022); Cruz-Torres et al. (2019); Mintz (2014, 2013); Mintz et al. (2012); Shepley et al. (2018); Ulgado et al. (2013); Yakubova et al. (2019); Yucesoy-Ozkan, Gulboy, & Kaya (2018) showed task decomposition improved learning independence.
Immediate feedback	Provides instant confirmation when children answer correctly or incorrectly.	Bassette et al. (2019) demonstrated immediate feedback supports learning and reduces errors.
Picture-based communication	Teachers can organize and present words and sentences using pictograms.	Cabiellles-Hernández et al. (2017) used pictograms to teach structured communication.
Progress tracking	Sends notifications to teachers when tasks are completed and tracks activity completion.	Lu (2011); Skillen et al. (2016) tracked learner progress, enabling remote monitoring.
Scheduling and calendars	Interactive calendars, reminders, activity boards, and task boards show stepwise pictures to manage daily routines.	Maich et al. (2019); Mintz (2014, 2013); Mintz et al. (2012); Pérez-Fuster (2019); Reis et al. (2021); Shepley et al. (2018); Skillen et al. (2016) improved independent routine completion.
Interactive learning functions	Drag-and-drop, sorting, or matching exercises reinforce concepts.	Bassette et al. (2019); Vlez-Cotoa et al. (2017); Cabiellles-Hernández et al. (2017); Wang & Zhang (2020) used these functions to teach categorization and matching skills.
Reminders	Provide structured prompts to sustain engagement and support task execution.	Skillen et al. (2016) tested reminders for consistent activity participation.
Self-management and independence		

Behavior tracking	Track emotional and behavioral responses via interactions with virtual characters and app.	Khan et al. (2018) monitored emotional and behavioral responses to guide interventions.
Independent living support	Supports independent and safe navigation for daily activities.	Skillen et al. (2016) implemented GPS-enabled apps for safe, independent travel.
Guidance and prompting		
Error correction	Visual cues (like a hand pointing to the correct answer) guide learners toward the right choice.	Alhazbi et al. (2018) demonstrated visual error correction improved task accuracy.
Just-in-time guidance	Automated verbal or visual prompts help learners when they are unsure of next steps.	Bassette et al. (2019) provided just-in-time cues during math and daily living tasks.
Motivation and reinforcement		
Gamified learning	Virtual characters evolve as learners complete tasks.	Bakhai, et al. (2020) used avatar growth to reinforce engagement and motivation.
Rewards and achievements	Children earn badges, playtime, or device access after completing tasks.	Cesario et al. (2022); Mangafa et al. (2015); Mintz (2014, 2013); Mintz et al. (2012) demonstrated gamified rewards increased engagement.
Contingency rewards	Token-based rewards exchanged for real-life incentives, like trips or activities.	Skillen et al. (2016) used contingency contracts to reinforce task completion.
Virtual character interaction	Tasks paired with avatars respond to verbal commands to reinforce motivation.	Bakhai, et al. (2020) showed avatar-driven interaction improved learner engagement.
Hardware and integration		
External speakers	Amplify instructions or caregiver responses for better auditory guidance.	Abdallah et al. (2019) used speakers to broadcast instructions for improved compliance.
Sensor-enabled tasks	Detect task completion (e.g., throwing trash) and notify caregivers.	Lu (2011) attached sensors to objects to track task performance.
Light-based prompts	Visual signals indicate where tasks should be performed.	Pérez-Fuster (2019) activated lights to guide learners to task locations.
Safety and security		
Geofencing	Track child location and alert caregivers if they leave designated safe zones.	Skillen et al. (2016) implemented geofencing to enhance safety and mobility independence.
User authentication	Secure login and access via API ensure only authorized users interact with child data.	Shabalina et al. (2019) implemented authentication to protect sensitive information.
Support and reporting		

Behavioral reporting	Graphical tracking of positive/negative behaviors to support therapy decisions.	Khan et al. (2018) visualized behavioral trends for clinical evaluation and intervention planning.
Chatbot support	Automated, on-demand support to answer learner queries 24/7.	Cesario et al. (2022); Reis et al. (2021) tested chatbots for continuous learner guidance.

Life skills addressed and digital interventions used

According to Clark et al., as cited by Chiang et al. (2017), life skills can be categorized into five areas: “self-care and domestic living, recreation and leisure, social interaction, employment, and community participation” (p.1113). To teach these life skills, 35 types of technology-based life skills interventions were identified.

Most mobile applications developed for ASD research and development focus on self-care and domestic living, followed by social interaction, employment, community participation, and recreation and leisure. Most of these apps focus on supporting medium- to high-functioning children, teenagers, and young adults, or those with communication and/or executive functioning skills. Only a few apps focus on low-functioning users, all of whom are children. As most assistive technologies were targeted at children, teenagers, and young adults, they were geared towards learning or acquiring specific skills and behaviors. There were no applications that aimed to maintain life skills acquired or support middle-aged to late adults with ASD, such as those aged 35 and older. Some of the apps supported different user types, including children, teenagers, and young adults with ASD; the person with ASD and their parents or caregivers; the person with ASD and their teachers; and the person with ASD, together with their parents and teachers.

The table below shows the life skills addressed by the prototyped applications and into which category each falls.

Table 3*Life skills addressed by the ASD-focused applications*

Subcategory	Targeted Life Skills	Users
Self-care and domestic living		
Autonomous self-care	Activities of daily living (ADL) - budgeting, time management, physical health, coping, safety (Maich et al., 2019)	Young adults with intellectual disability (ID), including ASD; and their caregivers
	ADL - managing money, time management, managing public transport and aiding self-monitoring of the administration of medication (Mintz, 2014; Mintz, 2013; and Mintz et al., 2012).	Children with ASD (high functioning) including their teachers
Autonomous task execution	Performing of daily tasks with autonomy (Cesario et al., 2022)	Young adults with ASD (high functioning) & their teachers
	ADL - Making the bed, making pasta and shoe tying (Cruz-Torres et al., 2019)	Adolescent child with ASD and their Parents
	ADL - Washing dishes, doing laundry (Perez-Fuster, 2019)	Children with ASD
	ADL - setting the table, making a snack using a microwave, making a cup of punch (Shepley et al., 2018)	Children with ASD
	ADL - support daily living such as organizing daily activities, daily self-reflection, travel assistance, providing reminders, and improving overall safety (Skillen et al., 2016).	Teenagers with ID, ASD and down syndrome
	ADL - Peeling bananas, spreading butter, using handkerchief, performing household chores, cleaning up after play (Yasir, 2018)	Children with ASD
Behavior management	Behavior – regulate stimuli response (Khan et al., 2017)	Children with ASD
Cleaning	ADL – proper waste disposal (Lu, 2011)	Children with ASD
Information processing	Holding of attention span, object recognition, sorting of objects, with adult interaction (Vlez-Cotoa et al., 2017)	Children with ASD (low functioning)
Sensory management	Managing hypo reactivity, hyper reactivity, and sensory seeking behaviors (Reis et al., 2021)	Parents of children with ASD
Self-management	Attention management (Wang & Zhang, 2020)	Young adults with ASD
Social interaction		

Communication	Social interaction through voicing out requests and listening to responses (Abdallah et al., 2019)	Family members and caregivers of people with ASD
	Early literacy through drawing (Akmanoğlu & Pektaş-Karabekir, 2019)	Children with ASD
	Receptive language (Alhazbi et al., 2018)	Children with ASD and their parents
	Receptive and expressive language, vocabulary, socialization, motor skills (Cabiellles-Hernandez et al., 2017)	Children with ASD
	Widening of vocabulary (Wilson et al., 2018)	Children with ASD (low functioning)
Peer collaboration	Joint attention skills (Mangafa et al., 2015)	Teachers of children with ASD
Self-management	Remembering to consider other people's perspectives; how to calm down in situations that may lead to outbursts (Mintz, 2014; Mintz, 2013; and Mintz et al., 2012).	Children with ASD (high functioning) including their teachers
Socialization	Social interaction: greeting, sharing, turn-taking, welcoming guests, playing with peers (Yasir, 2018)	Children with ASD
Employment and community participation		
Autonomous task execution	Self-instruction to change the memory of a computer tower (Smith et al., 2015)	Teenagers with ASD
Job preparation	Preparing for a job interview (Ulgado et al., 2013)	Young adults with ASD
	Labor preferences and shopping (Shabalina et al., 2019)	Parents, caregivers, teachers or health professionals and adults with intellectual disabilities including ASD
Literacy	Mathematics – teaching subtraction (Bassette et al., 2019)	Children with ASD (high functioning)
	Mathematics - through inventorying e.g., counting number of items and recording in inventory sheet (Yakubova et al., 2019)	Teenagers with ASD
Self-management	Self-Motivation - studying (Bakhai, et al., 2020)	Young adults with ASD pursuing higher education (high functioning)
Recreation and leisure		
Learning sports	Recreation - Bowling and Golf (Yucesoy-Ozkan, et al., 2018)	Children with ID including ASD

Digital interventions used to teach life skills

To teach life skills through mobile applications, mainstream intervention approaches were transformed into digital interventions, including prompting, modeling, stimulus-based strategies, building autonomy, communication, motivation, task reduction, providing assistance, improving behaviors, and miscellaneous arts-related activities.

Table 4

Digital interventions used to teach life skills

Digital approach	Strengths of the intervention and/or the prototype	Limitations / Weaknesses of the intervention and/or the prototype
Video-based interventions		
Video prompting	Teaching emergent literacy (early verbal & non-verbal communication patterns) through short videos made the intervention readily accessible to the child and their caregivers or teachers (Akmanoğlu and Pektaş-Karabekir, 2019). It also required less assistance to use and was easily accessible in social settings. Aside from this, it is economical, doesn't require a huge learning curve, and allowed freedom of movement (Yucesoy-Ozkan et al., 2018)	Creating and recording video instructions took a lot of time and effort. This intervention needed high quality education materials and at the same time, direct assistance from teachers and/or caregivers.
Video modelling with visual activity schedules and self-instruction	Through recorded videos and visual schedules, children were given the opportunity to increase their independence by self-instructing to learn a new skill (Shepley et al., 2018)	This app relied heavily on teacher prompting to provide initial instruction to children on how to access the right app and which content to open.
Video modelling with video-based instruction and self- instruction	Children were taught how to instruct themselves to successfully execute a task through recorded videos. Video instructions enabled highlighting relevant steps which were faster to execute and more	The effectiveness of this intervention depended heavily on the initial training that participants get before using the mobile device. There was also a need for users to be taught to identify when they need help, and

	affordable compared to in-vivo modelling (Smith et al., 2015).	when to get help using VBI. This intervention was only tested on high-functioning learners with ASD.
Video modelling using peer and self modelling with task analysis	Videos recorded by learners themselves and their peers provided an efficient and cost-effective way to learn and retain life skills. This enabled self-evaluation through visual progression of their skills. VM also used TA, to break down the overall interview process to smaller steps, making it easier for learners to follow (Ulgado et al., 2013)	The content quality of the app is highly dependent on teachers or health providers, who can perform TA, record, and upload videos for learners to use. Content needs to be updated periodically, especially if the user has already mastered a specific skill.
Social stories and video modelling	Stories that tell usual scenarios that the learner encounters every day, recorded through a video, can help in effective teaching of daily life, self-help, and adaptive skills. Social stories that were culturally appropriate helped improve child behavior. Delivering them through a mobile app makes it economical, easily available, and intuitive to use (Yasir, 2018).	Since social stories are culture specific, content developed using such may not be applicable to other learners.
Video prompting with self-instruction and least to most prompting	Short videos that help learners to execute a task, combined with minimal adult guidance, helped decrease reliance on adult prompting and increase independence (Yakubova et al., 2019).	Successful execution of the task still depended on the initial guidance provided through error correction using gestural and LMP. Learners needed at least three sessions for them to execute the task on their own using VP.
Parent implemented interventions using video prompting	Interventions that are done by parents helped produce immediate, but also lasting effects in teaching daily living skills and are also effective in acquisition and maintenance of various independent living skills (Cruz-Torres et al., 2019).	The success of a PII using VP depends on the quality of training and guidance parents receive before executing the intervention.
Task analysis-based interventions		
Task analysis with self-operated prompting	The process of splitting multi-step activities into sub-activities helped lower task complexity. The prompts that users activate by	This app was dependent on the capability of the teacher to assign an agenda, event, and activity for each student based on their learning

	themselves, enabled them to follow and complete sequence of steps at their own pace (Cesario et al., 2022)	objectives. It was also heavily dependent on SOP; hence progression would be dependent on the learner's capabilities, actions, and comfort level of moving to the next step.
Task management with positive reinforcement and voice activated digital assistant	Organizing daily tasks helped in encouraging adults with ASD to manage challenges such as getting distracted and the lack of motivation to study. The use of a voice assistant with a visual screen helped adult students reduce the complexity of verbal interactions (Bakhai, et al., 2020)	The prototype was specifically targeted at high-functioning adult students with Autism. It has not been tested on children and non-verbal users.
Task Analysis with Kairos and persuasive technology	Breaking tasks into small steps enabled users to use the app as reference while executing an activity. It also provided a higher chance of learning new things or adopting new behaviors through providing persuasive messages, most especially at the time when they are most receptive to giving them (Mintz, 2014; Mintz, 2013; Mintz et al., 2012).	This app would only benefit high functioning learners with ASD, who can read, understand instructions, and execute them with little to no guidance. Authors also emphasized that this is more effective for "digital natives" or people who have grown up accustomed to the use of digital technologies.
Task analysis with visual prompting	Breaking tasks into smaller steps reduced task complexity as it allowed learners to execute them one step at a time. Tying this with a prompt, such as a lighting system enabled task association to a specific location helping children build autonomy over time (Perez-Fuster, 2019)	The configuration needed to tie the lighting system to each task breakdown would require technical skills and a significant amount of effort and could be prone to error. The set-up would also be dependent on a technical expert or an educator who has received training in configuring the system
Self-management with positive reinforcement and task analysis	Task organizations helped in improving communication while self-management helped reduce the challenging behaviors of teenagers. Gamification helped in establishing positive behaviors, and the web portal enabled parents to customize activities, tasks, and rewards. Task analysis was used to breakdown activities into smaller tasks to help reduce	This app was limited to high functioning users who have the capability to read and understand instructions.

	complexity to execute (Skillen et al., 2016)	
Mobile application development management system	With templates and configurable settings, the system enabled users to perform Task Analysis to break down activities into smaller tasks, and enabled the application to adapt to user needs through customization of text and images (Shabalina et al., 2019)	Non-computer savvy users may need training to configure a mobile app. The selection of activities and how to break it down into smaller tasks may also need guidance from a teacher or health care professional. As this is a template-based system, there are limitations on what the app can do.
Sensor network	Automatic and continuous tracking and reinforcement of positive behavior using sensor-triggered alarm signals and prompts encouraged child autonomy through independent task execution. Technology used was cost-efficient compared to commercial or enterprise use (Lu, 2011)	Positive reinforcement in the form of praise given when a task was successfully executed, was still provided in person.
Text, picture, digital objects and voice-based interventions		
Sensory regulation	Providing parents with sensory management techniques, helped them address the sensory demands of their children through reliable and personalized information that was specific to the context of their child (Reis et al., 2021)	The app was dependent on each child's Occupational Therapist who would assess their sensory needs and their recommended strategies on how to address them.
Digital picture exchange system	Using a picture system helped improve both receptive (understanding what people are saying to them) and expressive language (express themselves through words and gestures) of children with ASD and helped in fostering the acquisition of a vocabulary. The system was also affordable, mobile, and portable (Alhazbi et al., 2018; Cabiell-Hernandez et al., 2017).	To be effective, the system was highly dependent on the capability of the teacher to provide customized learning content that matched the child's capability and learning plans. Immediate feedback was also needed to let the child know if they had correctly executed a task or provide correction guidance when needed.
3.3 App-based (digital) manipulatives	Through digital blocks combined with guidance from teachers, children were given a chance to have a more convenient and efficient way to learn math. Using 3D objects that can be rotated,	This app was limited to teaching subtraction to high-functioning children. It did not teach other basic mathematical concepts, such as addition, multiplication, and division.

	flipped, and turned, helps simulate the manipulation of concrete blocks by hand (Bassette et al., 2019)	
Augmentative and alternative communication	Through an audio-visual dictionary that leveraged children's personal interests and motivations; and personal and context-relevant words, helped them improve their communication skills, engagement, interaction, and self-expression (Wilson et al., 2018)	The app did not provide the capability to track the child's learning progress. Being a personalized and individualized application, teachers would also need to regularly check the words that children created and provide feedback, correction, or areas for improvement.
Audio-visual media	Through videos, pictures, pictograms, drawings, and games, using a mobile device, low functioning children with ASD were taught to improve their attention, interaction, categorization, and object recognition skills (Vlez-Cotoa et al., 2017)	Producing the learning materials needed to customize interventions for each child could be time consuming and could require specialized skills in illustration, video editing, and overall design. Learning assessments were also not built-in in the device and would require external evaluation.
Vocal communication tool (VCT)	Through speech acts played in a phone connected to a speaker, family caregivers were provided a digital means to conveniently play commonly used and repetitive commands, instructions and responses (Abdallah et al., 2019)	There was no voice recognition capability that would allow the system to automatically detect and interpret words and sentences from adult children.
Augmented reality	Three dimensional objects helped in attention management through using them to execute drag and drop tasks. It provided a readily available and accessible alternative that can be used to help manage overwhelming emotions that could be triggered by certain experiences or events (Wang and Zhang, 2020)	AR requires a relatively higher computing resource and device memory. Because of this, smart phones with lower compute resources may not be compatible to run this app.
Digital floor time (DFT) using a virtual character	Interaction with a virtual character helped in more accurate and efficient tracking behavior. The digital version of the floor time intervention also helped to address the challenge encountered by children in rural areas such as	This app collected sensitive information that could potentially cause data privacy and security challenges, especially if patient information were made available to different health care practitioners.

	restricted access to quality healthcare resources; and the lack of continuum caused by constant change of healthcare providers (Khan et al., 2017).	
Commercially off the shelf-based interventions		
Education technology with positive reinforcement	The built-in software features of Apple iPad helped to enhance mainstream approaches to teaching Joint Attention (JA) skills by using it to teach the curriculum, encourage sharing, turn-taking and as a form of reward (Mangafa et al., 2015)	This would only be effective if teachers were knowledgeable about their use, or if they received proper training. The availability of iPads in classrooms was another consideration, as its shortage may only cause frustration to children, if they are denied use.
Commercially-available mobile assistive technologies	Adults living in semi-independent living homes can use carefully curated applications typically targeted for neurotypicals, as they were readily available and are most of the time free to use (Maich et al., 2019)	Effective implementation of these suites of applications was heavily dependent on health care professionals or teachers. Pre-assessments, careful selection of applications, together with trial and error of what works and what doesn't are crucial to success.

The TEACCH model enables structured learning.

A digital health solution for moderate to severe ASD will only bring lasting change and value if it is continuously used by learners together with their caregivers or parents. The treatment and education of autism-related communication-handicapped children (TEACCH) model is a family-centered approach to lifelong learning of people with ASD (Siu, Lin & Chung, 2019). Implemented as a program, TEACCH is committed to tailoring interventions to the distinctive characteristics and requirements of each individual with ASD. Over the years, it gained recognition for its professional contributions and has positively impacted numerous clients and their families. The TEACCH program aims to enhance the strengths, skills, interests, and specific needs of individuals with ASD to build independence.

Rooted in a neurodevelopmental approach, the TEACCH program employs various strategies to address both deficits and strengths among individuals with ASD. This includes the use of visual strategies and clear information, establishment of a structured teaching-learning environment and curriculum, leveraging individuals' special interests as motivational tools, and adopting a pragmatic approach to foster meaning and self-initiated communication (Siu, Lin & Chung, 2019; Zeng et al., 2021). Aligned with its commitment to understanding and promoting the culture of autism, TEACCH actively supports parents, educators, and others in seeing the world through the eyes of individuals with ASD, along with nurturing daily living and communication skills that can help build functional independence in adult life (Virués-Ortega, 2017).

The TEACCH program's implementation as a clinical service and professional training initiative was first conducted at the University of North Carolina at Chapel Hill. Established in 1972 by Eric Schopler, it is dedicated to delivering evidence-based interventions for individuals of all ages diagnosed with ASD. At the core of the TEACCH approach is the recognition that individuals with ASD exhibit specific patterns of strengths and challenges. These encompass a preference for visual information processing, difficulties in sequencing and extracting meaning from details, and variability in attention. A central tenet of the program is the incorporation of structure in various dimensions. This involves implementing physical structures, such as the use of visual cues and the arrangement of the environment, to minimize distractions. It also entails the organization and communication of event sequences through personally meaningful schedules. Moreover, individual tasks are meticulously structured using visual support, offering guidance on what needs to be done, the duration of the activity, and the subsequent steps (Mesibov & Shea, 2009).

Components of TEACCH

TEACCH advocates against a one-size-fits-all curriculum, recognizing the unique learning styles and skills of each individual. Nevertheless, all TEACCH programs incorporate components of structured teaching, including the organization of the physical environment, utilization of visual information, task organization, and implementation of work systems. Individualized programs within the structured teaching framework consider the child's developmental level and specific needs. Goals typically revolve around fostering communication and daily living skills that lead to functional independence in adulthood (Schopler et al., 1995; Mesibov & Howley, 2003; Mesibov et al., 2005).

Visual information.

Visual information is employed to make tasks clear and meaningful for learners, utilizing various forms such as written checklists, visual schedules, and tangible objects. For instance, visual schedules outline the order of tasks, aiding transitions, and promoting independence by reducing reliance on external cues. The use of visual schedules, or activity schedules, has shown effectiveness in increasing skill acquisition and on-task behavior while decreasing challenging behavior (Virués-Ortega et al., 2017).

Transition objects, representing specific activities or locations, help learners understand and navigate transitions. For instance, a diaper could serve as a transition object for going to the changing table. The consistent use of transition objects and corresponding language aids learners in understanding and reduces transition difficulties over time (Hume & Turner-Brown, 2018).

Organization of the physical environment.

The organization of the physical environment is modified by TEACCH practitioners to provide clarity and facilitate independence. In a classroom setting, furniture placement can signal

upcoming activities, and clear boundaries at home help learners discern areas for different activities. Creating structured environments can enhance children's work skills (Welterlin et al., 2012, as cited in Virués-Ortega et al., 2017).

Widely recommended and extensively studied, an organized intervention setting provides functional cues about activities and behavioral expectations, promoting sustained engagement in young children (Bailey & Wolrey, 1984; Norquist & Twardosz, 1990; Sandall et al., 2005, as cited from Hume & Turner-Brown, 2018). Creating a dedicated learning space reduces distractions and provides an opportunity for an effective learning experience even at home. For instance, the family implemented the TEACCH for Toddlers (FITT) strategy, organizing the physical space by creating distinct play areas for table-based activities (e.g., puzzles, ring stackers, paints) and floor-based play (e.g., balls, trucks, cars, bubbles). The table-based area serves as a location for introducing new play activities and teaching new skills during FITT sessions, fostering positive routines around learning (Hume, Plavnick, & Odom, 2012, as cited in Hume & Turner-Brown, 2018).

A designated area must also be prepared where computers, tablets, or other devices will be used. A table with a proper height provides the learner with a proper camera angle to see images and texts for online lessons. Chairs should also properly support the learner's back so that they form a perfect L-shape when seated and allow their feet to rest properly on the floor. Other learners may prefer to stand and walk back and forth across the room during learning. A different seating option, such as a bean bag, would provide a sensory seat cushion that would help improve focus. Fidget toys like fidget spinners, stress balls, rubric cubes, and marbles can also improve focus during lessons, and headphones can help reduce auditory distractions, especially if the room must be shared with other family members. The personal space should also consider the

learning needs and interests of the learner by leveraging TV characters to provide motivation and personalization to use the space on a regular basis. Building a routine to use the physical learning space is vital to its effectiveness. Practice daily use of the learning space by simulating a going to school routine, which could start with having a video call with family and friends in the learning space. From here on, gradually introduce lessons using a digital tool or in-person (Nowell et al., 2020).

Task organization.

Task organization, emphasizing predictability through activity schedules and routines, is believed to enhance understanding of the environment for individuals with ASD. Communication of this information through visual means is recommended, and while TEACCH emphasizes the importance of routines, it acknowledges the need for flexibility (Virués-Ortega et al., 2017)

For instance, to accommodate toddlers' developmental stage, their schedule should focus on short sequences, emphasizing a first/then schedule for some. This involves presenting two objects to signify the order of activities, such as transitioning from a favorite toy to the table for a snack and then back to the toy. Transition objects, selected based on specific challenges, are incorporated into FITT sessions, facilitating smoother transitions during parent-toddler interactions throughout the week (Hume & Turner-Brown, 2018)

Visual schedules, incorporating objects, photographs, icons, or written words, serve as effective between-activity supports, aiding transitions and holding a child's attention (Dooley et al., 2001; Rao & Gagie, 2006, as cited in Hume & Turner-Brown, 2018). Considering the concrete learning style of toddlers with ASD, the use of objects as schedule elements is particularly suitable. Schedules can also be effectively implemented using visual support such as

countdowns, timers, and task checklists. Schedules can be organized manually using calendars, sticky notes, or by downloading editable templates in Microsoft Word or Excel. There are also a lot of timer applications that can be downloaded for free on any smartphone (Nowell et al., 2020). Visual schedules are instrumental for young children with autism, offering a concrete representation of upcoming events or activities.

Work systems.

Work systems, presented as prerequisites for engagement, convey specific task demands, including what task to engage in, required effort, duration, criteria for completion, and post-task outcomes. For novel tasks, one-on-one instruction and support are recommended, while already mastered tasks are expected to be performed independently in a workstation with minimal distractions (Schopler et al., 1995 as cited in Virués-Ortega et al., 2017).

A digital intervention is an example of a work system, that when implemented using the TEACCH model is executed by following the principles of structured teaching which includes organizing the physical environment including providing visual cues; setting predictable sequence of activities; using visual schedules to show sequence of activities; leveraging work and activity systems to enable independent task completion; and the use of visual activities to clarify expectations (Carroll and Kodak, 2018 as cited in Virués-Ortega et al., 2017).

Technology-aided instruction and intervention (TAII) is a form of instruction or intervention wherein technology plays a central role in a learning goal. TAII is used to focus on targeted skills and behaviors that can be learned through technology. Some of the most used TAII are speech-generating devices which use augmentative and alternative communication systems (AAC) or pictures to communicate; interactive whiteboards which could be touch screen computers, or touchpad-controlled projectors; mobile or tablet devices connected to the internet,

cellular networks or bluetooth; and computers which are often used to academic, communication, adaptive and social skills (Hedges & AFFIRM, 2017).

Implementing TAI within a TEACCH model would enable learners to work at their own pace and level of understanding, as it allows them to repeat lessons as many times as they need until they have achieved mastery. This helps relieve the pressure on learners and reduce social demands of catching up with peers, and it can also serve as a communication system for parents and teachers to the learners and vice versa (Hedges & AFFIRM, 2017). The National Professional Development Center (NPDC) on autism spectrum disorder considered TAI as a recognized intervention, on as it met the evidence-based practice criteria of 11 single case design studies and 9 group design studies and can be effective with learners in preschool (3-5 years) to high school learners (15-22 years) (Sam et al., 2019).

Parent-implemented intervention

Parent-implemented intervention (PII) refers to strategies and practices to engage parents in the active role of implementing specific interventions for their child with ASD. As children spend most of their days with their parents or caregivers, engaging them in the learning process helps establish continuity, as instructions taught at school or in therapy are practiced in their natural environments and throughout their daily routines (Meadan et al., 2016). In addition, PII provides an opportunity for parents, health professionals, and teachers to collaborate to strengthen the mechanisms for children's learning. PII would enable parents to participate in developing learning goals for their child and to learn to implement various strategies from professional coaching (Stahmer & Pellecchia, 2015).

Skills that can be taught using PII

PII leverages the natural interactions among children that occur during daily routines and everyday interactions within their natural environment, such as their homes or communities (Scherts & Horn, 2018). There's a wide range of skills that can be taught to children using PII such as communication (Meadan et al., 2016; Robertson et al., 2017; Turner-Brown et al., 2016); socialization (Turner-Brown et al., 2016; Wetherby et al., 2014); joint attention or the capability of a child to share the focus of an event or object with another person (Siller & Morgan, 2018); various forms of playing such as functional to enhance cognitive and social skills, and symbolic play for imaginative thinking (Siller & Morgan, 2018); playing with toys and other children (Turner-Brown et al., 2016); problem solving (Robertson et al., 2017; Turner-Brown et al., 2016); behavior management and emotional regulation (Robertson et al., 2017; Turner-Brown et al., 2016); self-care skills such as toileting, eating and dressing to build independence (Turner-Brown et al., 2016); establishing structured routines (Robertson et al., 2017) and participating in family routines (Turner-Brown et al., 2016).

Coaching parents to implement PII

There's a wide variety of approaches used to teach parents about PII. These are using telepractice to teach parents to deliver interventions through the internet (Meadan et al., 2016); conducting home visits to provide individual coaching (Wetherby et al., 2014); providing individual parental coaching in clinics (Wetherby et al., 2014); teaching parents in areas frequently visited by the family, such as grocery stores and playgrounds (Wetherby et al., 2014); and conducting group sessions with parents to facilitate peer support and to encourage them to share their experiences (Turner-Brown et al., 2016).

In addition, some studies use curricula such as Social Communication, Emotional Regulation, and Transactional Support (SCERTS) to provide structured teaching in embedding sections in natural environments (Wetherby et al., 2014). Another program called Incredible Years (IY) aims to support parents of children with ASD and language delays. It focuses on enhancing parent-child relationships, promoting children's social and emotional development, and managing challenging behaviors (Webster-Stratton, Dababnah & Olson, 2018). Parents were also monitored during the coaching session to evaluate their ability to implement the interventions taught to them. For example, the study by Wetherby et al. (2016) reported that parents achieved an average fidelity of 81% during monitored implementation sessions. Video recordings of parent interactions were also used to highlight areas for improvement, which were discussed with parents in separate sessions (Meadan et al., 2016).

Methods that parents can implement using PII

In PII, parents are taught various methods for teaching their children in their natural environment. The methods are behavior strategies that would allow them to manage their children's behavior effectively (Robertson et al., 2017); modeling to demonstrate skills or behaviors so the children can observe and replicate (Meadan et al., 2016; Robertson et al., 2017); providing appropriate responses when dealing with challenging behaviors (Robertson et al., 2017); prompting their children with questions and choices to encourage responses, which is also known as the mand-model (Meadan et al., 2016); time delay or pausing for about 5-15 seconds to give the child a chance to communicate (Meadan et al., 2016); modifying their surroundings to encourage communication, which is also known as environment arrangement (EA); and how to use visual supports to establish expectations and routines (Robertson et al., 2017).

Designing digital health solution with individuals with ASD

Vulnerable and marginalized children, such as those with moderate to severe ASD, are seldom included in studies that aim to assist, support, or educate them (Bradbury-Jones et al., 2018). This is due to their limited communication and executive functioning skills (Wilson et al., 2019); methodological challenges, such as lack of guidance and best practice in engaging them (Bailey et al., 2014); the researchers' lack of experience in dealing with neurodiverse participants; few collaboration opportunities between schools and centers; and unwillingness of parents or caregivers to take part in the research (Çorlu, et al., 2017).

However, despite their disposition, learners with ASD can be considered experts on themselves (Wilson et al., 2017). They can therefore provide significant contributions to discovering pain points, needs, and gaps in solutions and technologies targeted for people like them. They can also provide insiders' insights (Wilson et al., 2019) to support a more user-focused design approach, co-creating solutions that leverage their strengths, interests, and motivations.

Qualitative design approaches provide a venue for researchers to involve minimally-verbal learners in the research process, specifically in the design, iterative prototype development, and testing of digital technologies. Through focusing on children's strengths and supporting their difficulties (Benton et al., 2014), leveraging their support group, such as parents, teachers and health care practitioners (Dreesen and Schepers, 2018) and focusing on more creative ways of contribution (Makhaeva, Frauenberger and Speiel, 2016), researchers can provide more genuine and meaningful participation for children with ASD.

While some researchers are seeing the importance of engaging people with profound intellectual disabilities in the research design process, this practice is still an emerging area. A

few researchers, such as Wilson et al. (2020), Frauenberger, Fitzpatrick, and Iversen (2015), Benton et al. (2014), and Robinson, Hannuna, and Metatla (2020), are trying to bring more rigor in the practice through introducing frameworks, methodologies, tools, and approaches leveraging participatory research approaches.

Each researcher also has their own approach to determining which part of the research process participants will be part of, as well as the role they play throughout the process. For example, Wilson et al. (2020) and Frauenberger, Makhaeva, and Spiel (2016) engaged children as research partners, while Robinson et al. (2020) mostly engaged them during the evaluation and iterative development phase.

Due to the exploratory and iterative nature of engaging people with profound intellectual disabilities in practice, there are no hard-and-fast rules for collaborating with them, and researchers new to the field would need to determine an approach that best fits their needs.

Designing neurodiversity, therefore, demands a shift from the medical model, which framed autism as a deficit, to a social model that recognizes diverse cognitive styles as part of human variation (Spiel et al., 2019). The development of digital interventions for individuals with ASD has advanced significantly in recent years, grounded in multidisciplinary methodologies that prioritize usability, the involvement of learners and their proxies, and functionalities tailored to learners' own contexts. Central to this evolution is the use of participatory design, co-design, iterative prototyping, and evidence-based instructional techniques to ensure that digital tools meaningfully address core challenges in communication, social interaction, and daily living skills among individuals with autism. The design of digital

health solution for minimally verbal learners must position the user, not merely as a subject of study, but as a co-creator in the design process (Benton et al., 2014; Druin, 1999).

There is a diversity of qualitative design approaches used to digital health solution with individuals with ASD, which include observations and interviews (Abdullah and Brereton, 2017; Mangafa et al., 2015; Mintz, 2014; Mintz, 2013; Mintz, March and Lerman, 2012); user centered design (Abdallah et al., 2019; Bakhai et al., 2020; Shabalina et al., 2019); iterative design (Ulgado et.al, 2013; Yasir, 2018); focus groups (Reis et.al, 2021); participatory design (Benton et al., 2012; Benton & Johnson, 2014; Dreesen & Schepers, 2018; Frauenberger et al., 2016, 2017; Kamaruzaman et al., 2016; Druin, 1999; Poovizhi et al., 2022; Howard et al., 2021; Wilson et al., 2017; Zhu, Hardy, & Myers, 2019; Spiel et al., 2017; Robinson et al., 2020; Wilson et al., 2019, 2020; Makhaeva, Frauenberger, & Spiel, 2016); content analysis (Wilkens et al., 2021); exploratory research (Wilson, et.al, 2018); literature review review (Alhazbi et al., 2018; Pavolv, 2014); and mixed methods (Bonsignore et al., 2013; Moreno, et al., 2020).

Methodologies to design and evaluate digital health solution for ASD

A wide range of methodologies have been used to design and evaluate mobile applications and digital interventions for children with ASD, each offering unique strengths and limitations.

Content analysis, as used by Wilkens et al. (2021), involved reviewing video content based on established accessibility principles of perceivability, operability, understandability, and robustness. This method effectively supported auditing the quality and common features of existing digital interventions. However, a core challenge identified was the paradox of accessibility: content tailored for one subgroup's needs might conflict with another's, thereby complicating generalizability across diverse user populations.

Literature review approaches (Alhazbi et al., 2018; Pavlov, 2014) relied on literature reviews to inform the development of tools for receptive language acquisition. These methods were efficient and grounded in best practices, but may have lacked the granularity needed to address individual learner differences.

Field-based exploratory research, such as that conducted by Wilson et al. (2018), involved naturalistic observations, recordings, and thematic video analysis (e.g., the “Debrief O’clock” approach) to evaluate how children and teachers engaged with an app in real classroom environments. This approach involves minimal verbalization in children by capturing authentic interactions. The implementation, though, required significant time, collaborative effort, and access to multidisciplinary networks (e.g., teachers, therapists), which could be barriers for researchers with limited resources and those without existing relationships within ASD communities.

Focus groups, such as the one done by Reis et al. (2021), provided a structured forum for parents and occupational therapists to contribute insights into children's daily routines, sensory regulation, and app design. This approach facilitated rapid feedback from experienced stakeholders. However, its reliance on verbal communication excluded direct participation from learners with moderate to severe ASD, whose needs may differ significantly from those of high-functioning individuals.

Iterative design methods, exemplified by Ulgado et al. (2013) and Yasir (2018), incorporated workshops, observations, and semi-structured interviews with educators to develop culturally and contextually relevant digital content, such as social stories. While this approach effectively aligned app features with the specific needs of learners through proxy input from

educators, it failed to incorporate the voices of individuals with ASD directly, thereby potentially missing firsthand experiential insights.

Similarly, user-centered design (Abdallah et al., 2019; Bakhai et al., 2020; Shabalina et al., 2019) followed iterative cycles based on learners' capabilities, incorporating user testing and adaptation informed by real-world feedback. While it supported early and continued learner engagement, its effectiveness was heavily contingent on the learner's verbal and cognitive abilities, making personalization both necessary and labor-intensive.

Mixed methods approach, as demonstrated by Bonsignore et al. (2013) and Moreno et al. (2020), integrated qualitative and quantitative strategies, such as grounded theory, genre analysis, content evaluation, and user analytics, within case study and participatory design frameworks. These studies benefited from methodological triangulation, broad user participation (including children with autism), and wider app dissemination (e.g., via app stores). However, such comprehensive approaches demanded substantial financial resources, advanced methodological expertise, and intensive data management.

Observation and interview-based studies (Abdullah & Brereton, 2017; Mangafa et al., 2015; Mintz, 2013, 2014; Mintz, March & Lerman, 2012) provided insights into real-world app use through direct teacher-child interaction and post-use validation with stakeholders. The combination of interviews and observations enhanced data reliability. However, interviews inherently excluded nonverbal participants, and observations primarily restricted learner involvement to evaluative phases.

Participatory design (PD) emerged as a central approach to inclusive digital health solution development. The interface design experience for the autistic spectrum (IDEAS) method (Benton et al., 2012; Benton & Johnson, 2014), grounded in TEACCH principles, comprises six

stages: team building, context setting, idea generation, design and development, design refinement, and evaluation and reflection. Though time-intensive, IDEAS allowed structured engagement with high-functioning autistic children. Similarly, the diversity for design (D4D) framework (Benton et al., 2014) enabled individualized and flexible session design, which was beneficial for time- and resource-constrained studies. D4D involved three stages: a literature review to identify users' strengths, preferences & difficulties; the structuring of design sessions, including individual design sessions through workshops, which produced a paper prototype; and conducting up to six iterative design sessions. However, successful execution relied on facilitators with a deep understanding of child-specific traits, which may be a limitation for less-connected researchers.

Case study-based PD approaches (Dreesen & Schepers, 2018; Frauenberger et al., 2016, 2017) emphasized tailored workshops and prototype development supported by adult co-designers, who played roles such as facilitator, motivator, or proxy. This approach generally involves phases such as understanding the users, workshops using drawing, writing, and crafts, and intense customization for each participant. PD using cooperative inquiry methods (Druin, 1999) also involved several stages, such as contextual inquiry, low-tech prototyping with adults and children, and technology immersion to help children make design choices. This approach incorporated intergenerational prototyping and contextual immersion. It proved effective for both neurotypical and special-needs children, though it similarly required adult facilitation and prior relationship-building with caregivers or educators.

Some PD approaches were implemented with proxies and/or high-functioning participants. For instance, PD using task-centered design, used by Kamaruzaman et al. (2016), adapted conventional design stages to the ASD context but involved children only in identifying

design requirements, excluding them from later stages. It involved nine steps: task user analysis; choosing representative tasks; defining interfaces; roughing out the design; analyzing user interaction; creating a prototype; testing the design; iteration; and building the design. Poovizhi et al. (2022) implemented PD in six stages: requirements gathering, database creation, frontend design, backend design, testing and development, and maintenance. This study involved a teacher in defining app requirements across six development stages, yielding efficiency but missing direct input from ASD learners, thereby limiting the potential to reflect user-specific needs. Similarly, Howard et al. (2021) implemented PD through co-design and adopted a five-step process in which participants analyzed, critiqued, and tested design concepts using vignettes. The approach involved the following stages: initializing individual design concept vignettes; distributing the vignettes to participants; interacting with the vignettes; evaluation, during which sessions were audio-recorded with consent; and transcription, review, and identification of themes in the process. However, this approach was limited to individuals with high-functioning autism due to the cognitive demands of the tasks. Participatory action research (PAR) (Wilson et al., 2017; Zhu, Hardy, & Myers, 2019) engaged children, parents, and teachers across phases of problem framing, solution design, and user experience reflection. Despite its community-based richness, the approach excluded children with significant communication and motor impairments. Finally, the participatory evaluation with autistic children (PEACE) framework (Spiel et al., 2017) introduced a structured participatory evaluation approach across the planning, implementation, and interpretation stages, emphasizing the agency of children with ASD. However, it was more suitable for high-functioning participants because it required evaluation of their reasoning.

Additional PD approaches introduced further innovations. Robinson et al. (2020) illustrated a promising single-case PD model for a non-verbal child, with weekly iterations guided by parent feedback and observational data. In this iterative co-design methodology and participatory evaluation, the prototype was adapted every week based on parents' feedback on how their children used the application; hence, the evaluation was conducted on an ongoing basis. Every week, meetings were held between the child and his parents to implement a user-led approach, with joint decisions drawn from the child's observations and unstructured interviews with his parents in their home. While this demonstrated a viable model for profound disability inclusion, its generalizability remains untested, as it was used in only one case, and it remains to be determined whether it would work for other learners with ASD who have different sets of strengths and weaknesses. Co-design beyond words (CDBW) promoted multimodal engagement (e.g., gestures, sounds, movements, also called moments of interaction) for minimally verbal children during playful design sessions, thereby facilitating self-expression and inclusion (Wilson et al., 2019; Wilson et al., 2020). It involved stages such as building a design foundation based on participant observation; child interaction, which focused on building prototypes using drawing, games, and play; and reflection, which involved reviewing recorded video interactions of design sessions. However, its application to a physical product (a smart ball) necessitates further study to determine its relevance for digital-based products. Makhaeva et al. (2016) introduced the "Handlungsspielraum" (HSR) lens, which views social, physical, and mental-methodological structures through a social, physical, and mental lens, to foster creative engagement in PD by enabling and motivating a child to interact, play, and explore during a PD session. However, HSR's adaptability in changing its design approach and activities based on how the child responds during a PD session would be challenging, especially in studies with a

specific objective, such as exploring design effectiveness. Frauenberger, Fitzpatrick, and Iversen (2015) proposed a “tool-to-think-with” for designers, which incorporated lenses such as epistemology, values, and stakeholders to guide reflective PD processes. While conceptually robust, its utility is based on a single case study and requires further testing across varied contexts.

Theoretical framework

This theoretical framework integrated cognitive processing theories, ASD-specific information processing theories, and learner-centered educational paradigms to lay the foundation for a digital health solution for ASD-centered learning. ASD-specific theories, particularly theory of mind (ToM), executive dysfunction theory (EDT), weak central coherence (WCC), and enhanced perceptual functioning (EPF), describe the unique cognitive profiles of learners with ASD, emphasizing their strengths in visual processing and detail orientation while accommodating challenges in flexibility, social understanding, and planning. Cognitive theories, including dual coding theory (DCT), cognitive load theory (CLT), cognitive theory of multimedia learning (CTML), and words as social words theory (WST), explain how information is processed and how accessible, visually rich, and multimedia-based instructional materials can aid in learning.

Grounded in the learner-centered paradigm of education (LCE) and Vygotsky’s sociocultural theory (SCT), this study draws on cognitive and autism-focused theories to explain how personalized, engaging, and flexible learning experiences can empower autistic learners and their families to take an active role in education. SCT further emphasizes that development does not occur in isolation but emerges through participation in meaningful social activities, supported

by communicative tools, scaffolding relationships, and culturally structured learning environments.

How humans process information

DCT, CLT, and CTML describe how humans typically process, store, and retrieve information. Each of these theories offers distinct yet complementary insights into the mental processes involved in learning, and together they provide a comprehensive framework to optimize instructional design for how individuals with ASD process information.

Cognitive load theory.

CLT described the limitations of working memory, particularly when individuals encounter new or complex information (Sweller, 1988). For individuals with ASD, especially those who experience executive function challenges, these limitations tend to be more pronounced. CLT emphasizes that instructional design should align with how the human mind naturally processes information. At its core, the theory proposes that educational materials should be structured to reduce unnecessary cognitive strain, enabling learners to process and retain information more effectively (Leaf, 2017).

A foundational concept of CLT is the distinction between biologically primary and biologically secondary knowledge. Biologically primary knowledge includes skills that humans evolved to acquire naturally, such as recognizing faces, speaking a first language, or solving everyday problems. These abilities are often developed effortlessly and without formal instruction. In contrast, biologically secondary knowledge involves domain-specific skills, such as reading, history, or advanced mathematics, which require deliberate instruction in structured environments (Paas & Sweller, 2012).

Paas and Sweller (2012) described five core principles to explain how individuals process and acquire knowledge. The borrowing-and-reorganizing principle explains how learners gain knowledge by observing, listening, or reading, then integrating that information with prior knowledge. While some skills, such as listening and mimicking, are innate, others, such as reading or using a search engine, must be explicitly taught and are considered biologically secondary. The randomness-as-genesis principle explains how learners generate new ideas and solutions through trial and error, resembling a process of natural selection. The narrow limits of the change principle refer to the limited capacity of working memory, which typically processes only two to four new elements at once. This restriction illustrates why complex information could overwhelm learners and reduce instructional effectiveness. The information store principle emphasizes the role of long-term memory as a central storage system, allowing previously learned material to be retrieved without relearning. Finally, the environmental organizing and linking principle describes how stored information interacts with environmental cues to guide behavior and decision-making.

In applying CLT to instructional design, researchers focused on managing the cognitive load imposed on working memory. DaCosta and Seok (2010a) explained that working memory processes both visual and auditory information, and overloading it could hinder learning. To mitigate this, there is a need for effective instructional design that reduces extraneous load, which refers to the unnecessary burden caused by distractions, disorganized layouts, or the need to integrate separate sources of information mentally. Intrinsic load, arising from the inherent difficulty of the content, should also be managed as it cannot be fully eliminated. Educators can use strategies such as sequencing lessons, breaking material into smaller parts, and scaffolding

complex ideas to help learners gradually build understanding. Providing learners with choices, such as selecting the order or timing of tasks, also supports the management of intrinsic load.

Ultimately, CLT encourages strategies that increase germane load, which is the mental effort directed towards meaningful learning. This involves supporting learners in building schemas and transferring knowledge to new situations. Facilitating transfer of learning allows students to apply skills in both familiar (near transfer) and unfamiliar (far transfer) contexts, helping them adapt what they learned to a range of tasks and environments (DaCosta & Seok, 2010a). These approaches align with the goals of CLT, which aims to create cognitively efficient and inclusive learning experiences, particularly valuable for neurodiverse learners such as those with ASD.

Dual coding theory.

DCT proposes that people learn more effectively when information is presented through both verbal and visual channels (Paivio, 2014). This theory is particularly relevant for learners with severe ASD, many of whom are minimally verbal and rely more heavily on visual support than on spoken language. For these learners, instructional methods that combine imagery with text or speech offer a more accessible and effective way to understand and retain information.

Developed by Paivio (2014), DCT posits that human cognition comprises two distinct yet interconnected systems: one based on language (verbal) and the other on imagery (nonverbal). Although these systems operate independently, they support one another in processing, storing, and retrieving information. In educational contexts, DCT emphasizes the importance of engaging both systems simultaneously. When verbal explanations are paired with visuals such as diagrams, illustrations, or physical demonstrations, students are more likely to form mental images that reinforce comprehension and memory. This interaction between verbal and

nonverbal representations contributes to deeper learning and improved recall (Clark & Paivio, 1991).

The theory also stresses the value of presenting information in a concrete, image-rich format. Students generally retain content more effectively when it is associated with vivid, meaningful experiences. As a result, teaching strategies that incorporate real-world examples, hands-on learning activities, and visual aids are particularly beneficial for neurodivergent learners.

Moreover, DCT acknowledges individual differences in cognitive processing. Some students process information more efficiently through verbal strategies, while others benefit more from visual or experiential approaches. By recognizing these variations, educators can adapt their instructional techniques to accommodate a broader range of learning preferences and needs (Clark & Paivio, 1991). This flexibility makes DCT especially useful for supporting inclusive education practices tailored to diverse learners, including those with ASD.

Cognitive theory of multimedia learning.

CTML, introduced by Mayer (2009), proposes that individuals learn more effectively when information is presented in both verbal and visual formats rather than in either format alone. This theory is grounded in three core assumptions: first, that humans possess dual channels for processing information, one for auditory/verbal material and another for visual/pictorial content; second, that each of these channels has limited capacity; and third, that meaningful learning occurs when learners actively select, organize, and integrate information from both channels.

CTML is particularly relevant for children with autism, many of whom rely more heavily on visual information but could also benefit from simplified auditory prompts when verbal

comprehension is possible. For learners with limited expressive or receptive language abilities, multimedia learning environments serve as an important bridge between instruction and real-world application. However, the effectiveness of these tools depends not merely on the presence of multimedia elements but on the quality of their instructional design. Poorly designed multimedia could overwhelm working memory, while well-structured materials could support comprehension and retention (DaCosta & Seok, 2010b).

The theory further emphasizes that learners processed only a limited amount of visual or verbal information at one time, even when exposed to rich multimedia formats such as illustrations, animations, or narration (Mayer, 2021). When these materials are designed to support active cognitive engagement, learners become more involved in the learning process. Rather than passively receiving information, they actively select relevant content, organize it into coherent mental models, and integrate it with prior knowledge stored in long-term memory.

CTML supports the idea that computer-based environments such as educational games, simulations, and microworlds could enhance learning by holding visual and auditory information briefly in working memory until it can be processed and transformed into meaningful representations. According to Mayer (2021), this process begins with selecting relevant images and words from a multimedia presentation, followed by organizing them into separate visual and verbal models. Learners then built connections between these models by mapping relationships and integrating them with existing knowledge from long-term memory. This integration increases the likelihood of knowledge retention and supports transfer to new contexts.

Words as social tools theory.

Language is not simply a neutral representational system used to label objects or transmit pre-formed thoughts. Instead, it functions as a foundational social and cognitive tool through

which meaning is constructed, negotiated, and stabilized in interaction. Holtgraves and Kashima (2008) conceptualize language as a semiotic tool, arguing that social cognition depends on interpretive meaning-making rather than raw behavior alone. Individuals respond not simply to actions, but to what actions mean within shared contexts, and language provides the symbolic medium through which interlocutors coordinate perspectives and establish common ground (Holtgraves & Kashima, 2008). Communication, therefore, shapes cognition: verbalizing experience can restructure internal representations, influence recipients' interpretations, and contribute to collective "shared realities" over time.

Building on this interactional view, Borghi et al. (2019) propose the Words as Social Tools (WAT) framework, which emphasizes that words operate not merely as referential labels but as tools for action, regulation, and social coordination. WAT is especially concerned with the acquisition and processing of abstract concepts, such as emotions, intentions, or moral categories, which lack stable perceptual referents and are therefore more variable and socially dependent than concrete concepts (Borghi et al., 2019). Fini et al. (2023) further argue that abstract thinking itself is intrinsically social. Despite its apparent private nature, abstract conceptualization entails the re-enactment of internalized interpersonal dialogue through which concepts were acquired in the first place. Across development, infants initially rely on bodily and interactive engagement to build self–other boundaries and predict others' behavior, and later progressively acquire linguistic meaning through socially scaffolded exchanges. Early social engagement is thus a necessary prerequisite for word learning, particularly for abstract concepts, which require continual participation in symbolic interaction and meaning negotiation.

A key mechanism emphasized in this framework is inner speech, understood as internalized dialogue originating in social communication. Fini et al. (2023) explain that inner

speech allows individuals to master complex meanings by reactivating the linguistic and dialogical experiences through which abstract concepts were learned. Unlike concrete concepts, which can be grounded through sensorimotor simulation of object interactions, abstract concepts often involve simulating dialogical experiences internally, “talking to oneself” to validate meaning, reduce uncertainty, or prepare to seek clarification from others. This supports the WAT claim that abstract knowledge acquisition is deeply tied to social metacognition, testimony, and the validation of cultural meaning (Borghi et al., 2019; Fini et al., 2023).

Information processing in ASD

Learners with ASD have limitations in their cognitive processing capacities. Studies show that they have weaker conceptual reasoning abilities than individuals with typical development of similar age and cognitive ability (DaCosta and Seok, 2010a). This section discusses the four major theories that describe how individuals with ASD process information: ToM, EDT, WCC, and EPF.

Theory of mind.

Individuals with ASD often experience difficulties in attributing beliefs, desires, and intentions to others, which makes navigating social interactions and understanding others’ perspectives particularly challenging (Sodian et al., 2015). This difficulty has been closely linked to deficits in ToM, a foundational cognitive ability that refers to the capacity to attribute mental states to oneself and others to explain and predict behavior in everyday social contexts (Frith & Happé, 1994; Sodian et al., 2015). ToM encompasses both implicit and explicit components. Implicit ToM involves an automatic, unconscious sensitivity to others’ mental states and is often measured through gaze-based tasks that assess anticipatory looking behavior. In contrast, explicit

ToM requires deliberate reasoning and the verbal articulation of another person's mental state, making it a more cognitively demanding process that is assessed through structured, language-based tasks (Sodian et al., 2015).

ToM plays a critical role in social cognition and typically develops throughout childhood into adulthood. Several factors, including language ability, cultural influences, and the quality of social relationships, shape its development. One advanced form of ToM, known as second-order false belief understanding, typically emerges between the ages of five and seven. This stage requires children to comprehend that one person could hold a false belief about another person's belief, reflecting a deeper level of recursive thinking. In addition to reasoning beliefs, ToM also supports the understanding of affective mental states, including emotions, feelings, and intentions. These affective processes are reliant on broader cognitive functions such as perception, attention, memory, and reasoning (Miller, 2022).

Research consistently identified ToM deficits as a core characteristic of ASD. Individuals with ASD demonstrate impairments in perspective-taking and in attributing false beliefs to others, which limits their ability to understand and respond appropriately in social situations (Sodian et al., 2015). Williams (2010) further notes that individuals with ASD also show reduced self-awareness, struggling to recognize their own thoughts and emotions. These deficits contribute to pervasive challenges in interpreting behavior, engaging in reciprocal communication, and maintaining joint attention with others.

As a result of these impairments, individuals with ASD face persistent difficulties in predicting others' behavior, understanding diverse perspectives, and acknowledging that others may hold different beliefs or knowledge. These challenges lead to disruptions in social interaction and communication. Moreover, ToM deficits also hinder higher-order reasoning

processes, including the ability to evaluate multiple viewpoints, consider alternative explanations, and appreciate differing emotional or cognitive states (Berenguer et al., 2018; Sodian et al., 2015).

Beyond ToM, individuals with ASD also exhibit differences in metacognition, or the ability to monitor and regulate their own cognitive and emotional processes. The study of Grainger et al. (2016) found that individuals with ASD often exhibit reduced accuracy when judging their own confidence, suggesting difficulties in metacognitive monitoring. Furthermore, although their overall cognitive control may remain largely intact, children with ASD tend to use monitoring information to guide or adjust control processes far less effectively than their neurotypical peers. At a broader level, reflexivity, or the capacity to reflect on one's own thoughts, assumptions, and context, adds a critical dimension to understanding cognitive self-awareness in ASD. Using ethnographic video observations of children with high functioning ASD, the study of Ochs (2015) found that children with ASD demonstrate corporeal reflexivity, or the awareness of one's own body as both a subjective, feeling entity and an object visible to others. Through subtle cues such as gaze direction, physical posture, movements, and quiet self-commentary, children demonstrated continuous, moment-to-moment reflexive engagement with their social surroundings. As ASD is often associated with repetitive self-regulatory movements, these behaviors can unintentionally expose children to misunderstanding or ridicule from peers, which further impairs their capability for socialization.

Executive dysfunction theory.

Executive dysfunction is a central challenge for many individuals with ASD, affecting their ability to manage, regulate, and coordinate everyday tasks. Executive functions include inhibitory control, working memory, cognitive flexibility, and planning, which enable people to

adapt their behavior to changing demands, organize information, and make goal-directed decisions. Research consistently shows that individuals with ASD experience difficulties across these domains, which often explains many of the daily struggles they face.

EDT provides a useful framework for understanding these challenges. EDT explains why many individuals with ASD struggle with planning, organization, inhibition, and task flexibility (Geurts et al., 2014). These difficulties directly affect their ability to initiate and complete multi-step tasks, particularly when routines are disrupted. EDT refers to the capacity to restrain responses (inhibition), manage and manipulate information in real time (working memory), adapt strategies (cognitive flexibility), and plan for the future (planning). People with ASD appear to face challenges in each of these areas. Damasio and Maurer (1978, as cited in Geurts, de Vries, & van den Bergh, 2014) further suggested that deficits in executive functions lie at the core of ASD, rooted in difficulties in exerting deliberate control in novel, complex, or ambiguous situations.

Inhibitory control, or the ability to stop or suppress certain actions, plays a key role in executive functioning. Individuals with ASD often find it difficult to inhibit behaviors, such as choosing appropriate responses in social situations or avoiding repetitive actions, even when these responses lead to negative outcomes. While early studies reported mixed findings, more recent research suggests that inhibitory control difficulties are persistent across development. These difficulties seem especially pronounced in tasks requiring resistance to distractions, rather than in stopping deeply ingrained or habitual responses (Joseph & Tager-Flusberg, 2004).

Working memory is another area where individuals with ASD often struggle, particularly when tasks demand holding and manipulating multiple pieces of information at once. This challenge can make it harder to follow multi-step instructions, remember sequences, or keep

track of social cues in real time. Both verbal and visual-spatial working memory are often affected. For example, remembering a string of spoken directions can be difficult, and recalling visual details may be challenging as well. Research suggests that providing external supports, such as visual aids, can reduce the working memory load and improve independence in daily routines (Geurts, de Vries, & van den Bergh, 2014).

Cognitive flexibility, or the ability to shift between tasks or adapt to changing circumstances, is another area of executive dysfunction in ASD. Many individuals find it difficult to adjust when routines change unexpectedly or when they are required to shift attention between unrelated tasks. Children with ASD, for instance, may become more stressed or confused when tasks switch at random. Studies indicate that performance can improve when instructions are made more explicit, highlighting the importance of structured and predictable environments (Geurts, de Vries, & van den Bergh, 2014).

Planning and organization, which require the integration of inhibitory control, working memory, and flexibility, are also commonly impaired in ASD. These difficulties can become evident in daily life, such as organizing homework, managing schedules, or handling household responsibilities. Because planning is closely tied to communication and social interaction, challenges in this area also impact participation in social and family activities. For example, family members often take over the responsibility of arranging social engagements due to the individual's planning difficulties. Research suggests that these challenges remain consistent across different age groups, emphasizing that planning impairments are not just developmental delays, but ongoing difficulties tied to executive dysfunction in ASD (Geurts, de Vries, & van den Bergh, 2014).

Executive dysfunction also appears to have important links with ToM deficits in ASD. Studies consistently highlight that difficulties in executive function skills, such as planning and cognitive flexibility, correspond with reduced performance on ToM tasks among high-functioning individuals with ASD (Ozonoff et al., 1991). This suggests that the ability to understand others' mental states may, in part, depend on core executive skills that are disrupted in ASD.

Weak central coherence theory.

WCC theory helps explain the distinctive cognitive style often observed in individuals with ASD. It describes a tendency to focus intensely on individual details while struggling to perceive the broader context or “big picture” (Happé & Frith, 2006). In other words, people with WCC excel at local or detail-focused processing but show reduced ability to integrate information into a global or holistic whole. This style of processing is closely linked to many social-communication and comprehension challenges associated with ASD (Sodian et al., 2015; Miller, 2022).

One of the clearest features of WCC is detail-oriented processing. Individuals with ASD often demonstrate exceptional ability to detect fine-grained features, notice subtle differences, or spot irregularities that others might miss. This strength can translate into success in tasks requiring precision, such as identifying objects within complex visual scenes or detecting small errors in patterns (Miller, 2002; Woodcock et al., 2020). However, this same strength can also create challenges when tasks demand global processing, such as integrating multiple cues into a coherent interpretation or recognizing the broader meaning of a situation. For example, while they may excel at recalling a specific fact from a conversation, they may miss the conversational context or underlying social intent.

This local processing bias contributes to difficulties in areas that require flexible interpretation and contextual understanding. Social cognition is one example: individuals with WCC often focus on specific words or gestures but may struggle to integrate them into the larger social context, making it more difficult to interpret humor, sarcasm, or implicit meanings (Berenguer et al., 2018; Loth, Gómez, & Happé, 2007). Similarly, WCC is associated with challenges in theory of mind (ToM), in which reduced global integration limits the ability to attribute mental states to others or to understand perspectives beyond one's own (Williams, 2010). Research has shown that high-functioning individuals with ASD who struggle with planning and cognitive flexibility also perform less effectively on ToM tasks, suggesting an overlap between WCC and broader executive function challenges (Ozonoff et al., 1991).

Another characteristic of WCC is piecemeal processing. Rather than synthesizing elements into a unified whole, individuals often perceive and store information as fragmented pieces. This affects not only social interactions but also episodic memory, making it more difficult to integrate diverse elements of events into a coherent narrative (Woodcock et al., 2020; Williams, 2010). The fragmented style of processing can also slow down problem-solving, as individuals may find it harder to shift perspectives, consider multiple interpretations, or adapt strategies when faced with novelty or ambiguity (Miller, 2002; Lecheler et al., 2020).

Because of these tendencies, individuals with WCC often prefer structure and predictability. Routines and familiar patterns reduce the need for global integration and allow them to rely on detail-focused strengths. Environments that are highly structured and provide clear cues can therefore feel more manageable and less overwhelming (Miller, 2002; Woodcock et al., 2020).

Importantly, WCC is not a deficit across the board but a distinct cognitive style that comes with both strengths and challenges. It provides advantages in tasks demanding attention to

detail but makes it harder to understand context, interpret social cues, or integrate complex information. The extent to which WCC is present varies among individuals with ASD, shaped by both genetic and environmental influences, leading to diverse manifestations of this processing style (Woodcock et al., 2020).

Enhanced perceptual functioning theory.

EPF theory provides an important perspective on the cognitive style of many individuals with ASD. Unlike theories that emphasize deficits, EPF highlights perceptual strengths, suggesting that individuals with ASD often excel at processing fine sensory details, particularly in the visual domain. This heightened sensitivity enables them to detect subtle features or patterns that others might miss, reflecting a locally oriented perception style that prioritizes details over global or contextual information (Mottron et al., 2006; Baron-Cohen, 2009).

Research on EPF describes several distinctive characteristics of perception in ASD that help explain this unique cognitive profile. Individuals with ASD frequently show a strong detail-focused bias, excelling in fine-grained perceptual discrimination such as distinguishing between similar sounds, shapes, or textures. Neurological evidence suggests that their brains rely more heavily on posterior regions, such as the occipital and parietal regions, during complex visual tasks, whereas neurotypical individuals engage frontal regions more (Mottron et al., 2006). This difference may help explain why people with ASD often perform exceptionally well with static stimuli, such as high-contrast images or repetitive patterns, but find dynamic or socially complex information more difficult to process. Interpreting facial expressions, gestures, or shifting social signals is particularly challenging because these require integrating rapidly changing cues into a broader context (Woodcock et al., 2020).

Another key aspect of EPF is the tendency to process sensory information in a more segregated way, often separate from higher-level reasoning. While this enhances attention to detail, it also reduces the ability to integrate information into a coherent whole, making it more difficult to draw on contextual cues during problem-solving or social interaction (Motttron et al., 2006). Importantly, the relationship between perceptual functioning and intelligence in ASD also differs from that of neurotypicals. Enhanced perceptual skills can sometimes give rise to unique talents or specialized interests, such as those observed in savant individuals, highlighting the diversity of autism and illustrating how perceptual strengths can contribute to both exceptional abilities and daily challenges (Motttron et al., 2006; Woodcock et al., 2020).

Vygotsky's sociocultural theory of learning

While cognitive and ASD-specific information processing theories explain how learners with autism perceive, attend to, and process instructional material, they do not fully capture the fundamentally social, relational, and culturally mediated nature of learning. For minimally verbal and neurodiverse learners, development does not occur in isolation, but through participation in meaningful activities with others, supported by communicative tools, scaffolding relationships, and culturally structured environments.

Vygotsky's sociocultural theory (SCT) emphasizes that learning and development originate in social interaction and are mediated through cultural tools, language, and shared activity. Rather than viewing development as a purely individual process unfolding in isolation, Vygotsky conceptualized child development as fundamentally historical, dialectical, and socially situated. Development progresses through qualitative transformations shaped by participation in culturally structured environments (Vygotsky, 2021).

Vygotsky argued that psychological development is not linear, but occurs through cycles of change in which new developmental formations emerge through contradictions, cultural demands, and evolving relations between the child and the environment (Vygotsky, 2021). He further emphasized that development involves the changing organization of psychological systems, where functions such as perception, memory, and speech become differentiated and reorganized over time (Vygotsky, 2019).

A central construct within sociocultural theory is the zone of proximal development (ZPD), defined as the developmental space between what a learner can do independently and what they can accomplish with guidance and support. Learning occurs most effectively when educators scaffold experiences that enable learners to function beyond their current developmental level through collaboration and mediation. In this view, disability is not only an individual limitation but also a relational condition shaped by the learner's access to supportive cultural participation (Myburgh et al., 2020).

Dialectical Misattunement theory

Dialectical approaches to development emphasize that cognition and selfhood do not emerge solely from internal processes within the individual, but through dynamic, reciprocal social interaction unfolding across multiple timescales. Bolis and Schilbach (2020) conceptualize the self as a historical product of dialectical attunement, arising through the interplay of internalization and externalization. Internalization refers to the reconstruction of social operations within the individual, while externalization reflects the transformation of the social environment through collective activity. These processes are mutually constitutive: individuals

develop expectations and regulatory capacities through interaction while simultaneously shaping the interpersonal world that structures those expectations.

Building on this framework, Bolis et al. (2022) propose the dialectical misattunement theory, which reconceptualizes autism and psychopathology as emerging not exclusively within single brains but also through relational mismatches in interactional expectations. Misattunement refers to disturbances in the reciprocal unfolding of social interaction, resulting in increasingly divergent prediction and communication styles over time. Such misattunement is not only interpersonal but is often reinforced by cultural and technological environments designed around dominant neurotypical standards. For example, a child with autism's stress-related responses may violate neurotypical expectations, producing spirals of misunderstanding that cannot be attributed solely to either interaction partner but instead emerge at the level of the dyadic system.

Importantly, dialectical misattunement aligns with relational accounts, such as the double empathy problem, by emphasizing that breakdowns in communication arise bidirectionally across neurotypes rather than being located solely in individuals with ASD (Bolis et al., 2022). Fini et al. (2023) also note that attunement develops over time - early embodied interactions lay the foundation for later cognitive and verbal exchanges. As a result, disruptions in early interactional synchrony can affect later meaning-making and abstract learning. From this perspective, autism interventions must move beyond individualistic deficit models toward approaches that support interactional alignment, the negotiation of shared meaning, and accessible communicative environments.

A learner-centered paradigm of education to support ASD learning

Given the deficits in the mind, executive functioning, the difficulty to integrate information, and a preference to process and perceive sensory and visual information of learners with ASD, the systems that aimed to teach and support them needed to consider these limitations beyond the standard information processing principles of dual coding, cognitive load, and cognitive multimedia. When leveraged to inform system and content design, information processing theories could facilitate learning by providing strategies that aimed to close the gap brought by these deficits.

LCE is an instructional approach that focuses on individual learners and their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs (Watson & Watson, 2011; Chang & Smith, 2008; McCombs & Vakili, 2005). It placed learners at the center of the educational process by actively involving them in setting learning goals, planning strategies, and monitoring progress (Msonde, 2023; Huh & Reigeluth, 2017; Chang & Smith, 2008). Emphasizing self-regulated learning skills such as goal setting, self-monitoring, and self-reflection, LCE empowered students to take ownership of their learning and become independent, lifelong learners (Huh & Reigeluth, 2017). Unlike traditional education, in which learners were passive recipients, LCE gave learners autonomy over what, when, and how they learned. Flexibility in access (i.e., anytime, anywhere) enabled learners to set the pace and rhythm of their learning, supported by active learning modules, student collaboration, and close teacher-student interaction (Verbeeten, 2001).

LCE is grounded in constructivism, humanism, and inductive learning principles, highlighting the importance of prior knowledge and experience (Smart et al., 2012; Msonde, 2023). It marked fundamental shifts from traditional teacher-centered paradigms, including

moving from time-based to competency-based progression, norm-referenced to criterion-referenced assessments, and standardization to personalization (Reigeluth et al., 2015). LCE incorporates best practices in learning and instructional methods, promotes interdisciplinary authentic projects, and shifts teachers' roles from knowledge providers to facilitators (Msonde, 2023; Reigeluth et al., 2015; Smart et al., 2012; Watson & Watson, 2011). The approach aims to balance power between learners and instructors, evaluating student work to support holistic learning (Richmond et al., 2018).

Alexander and Murphy (1998) identified five core learner-centered psychological principles of LCE. First, the knowledge base principle recognizes that existing knowledge forms the foundation for future learning by guiding how new information is organized and associated with it. Second, strategic processing or executive control highlights the critical role of learners' ability to reflect on and regulate their thoughts and behaviors. Third, motivation and affect encompass intrinsic motivation, personal goals, and task characteristics as key drivers in learning. Fourth, development and individual differences describe how learning progresses through stages influenced by inherited and environmental factors, with recognition of learner variability. Finally, the situation-or-context principle asserts that learning is both a socially shared and individually constructed activity, shaped by its environment.

Personalization and individualization are central to LCE. Instruction is tailored to learners' unique needs, backgrounds, talents, interests, and inherited or environmental factors such as culture and technology (Msonde, 2023; McCombs & Vakili, 2005; Watson & Watson, 2011; Alexander & Murphy, 1998). Recognizing diverse learning styles and paces, LCE emphasizes adapting learning experiences by accounting for individual goals, preferences,

abilities, and learning styles rather than relying solely on teacher-driven planning (Huh & Reigeluth, 2017; Aslan & Reigeluth, 2016; Reigeluth et al., 2015). This personalized approach grants learners greater control over pace, content, and resources (Huh & Reigeluth, 2018), including web-based instruction that uses multimedia resources and flexible pathways to accommodate diverse preferences (Verbeeten, 2001). LCE thus acknowledges the importance of organizing knowledge meaningfully and values both the social and individual contexts of learning (Alexander & Murphy, 1998)

Active engagement and participation are central in LCE, encouraging learners to take responsibility for their learning through hands-on activities, discussions, and collaborative projects that foster exploration and knowledge construction (Aslan & Reigeluth, 2016; Huh & Reigeluth, 2017, 2018; Smart et al., 2012). Learner-centered distance education supports these methods by integrating interactive modules and teacher-student collaboration to enhance engagement (Chang & Smith, 2008; Verbeeten, 2001). Furthermore, LCE promotes cooperative learning communities in which students work in groups, share teaching and learning responsibilities, and benefit from peer support, thereby creating a positive social learning environment (Richmond et al., 2018; Smart et al., 2012).

In this paradigm, teachers transition from being knowledge transmitters to facilitators and guides, supporting learners' journeys rather than solely delivering content (Reigeluth et al., 2015; Watson & Watson, 2011). This shift fosters inclusive, supportive learning environments where educators identify individual learner needs, provide tailored interventions, and view mistakes as growth opportunities (Aslan & Reigeluth, 2016; Huh & Reigeluth, 2017, 2018). In web-based instruction, teachers maintain this supportive role through feedback, guidance, and virtual engagement methods (Verbeeten, 2001).

Self-regulated learning is also fundamental to LCE, as learners are encouraged to engage in metacognitive reflection, articulate prior knowledge, monitor understanding, and connect new information (Msonde, 2023). Students develop critical thinking, problem-solving, and self-regulation skills by learning to set goals, monitor progress, and reflect on outcomes, fostering lifelong learning and autonomy (Watson & Watson, 2011; Huh & Reigeluth, 2018; Aslan & Reigeluth, 2016). This process enables authentic learning experiences closely linked to learners' lives and aspirations (Huh & Reigeluth, 2017).

Collaboration and interaction further enrich learning by fostering peer-to-peer engagement, group projects, discussions, and community building (Aslan & Reigeluth, 2016; Huh & Reigeluth, 2017, 2018). These interactions are facilitated through diverse communication tools, such as discussion forums, video conferencing, and email, thereby supporting the exchange of ideas and the development of social skills (Chang & Smith, 2008; Verbeeten, 2001).

Co-creation of knowledge is a key to LCE, where learners actively construct understanding through experience, problem-solving, and critical thinking rather than passively receiving information (Chang & Smith, 2008; Msonde, 2023; Smart et al., 2012; Watson & Watson, 2011). Teachers provide opportunities to fill knowledge gaps and learn collaboratively, reinforcing students' roles as active knowledge constructors (McCombs & Vakili, 2005).

Flexibility and choice characterized LCE's empowerment of learners through autonomy in decision-making related to what, how, and when learning occurred (Richmond et al., 2018; Aslan & Reigeluth, 2016). It recognized metacognitive skills such as planning, monitoring, and evaluating learning as essential for effective development (Alexander & Murphy, 1998). Flexibility extends to time, pace, and location, increasing motivation and engagement.

Continuous assessment and feedback guided learners' progress, offering timely, constructive information aligned with individual goals to support development (Aslan & Reigeluth, 2016; Huh & Reigeluth, 2017; Chang & Smith, 2008; Richmond et al., 2018). Authentic, criterion-referenced assessments replace norm-referenced comparisons, focusing on real-world application rather than memorization, thereby promoting meaningful learning (Reigeluth et al., 2015; Huh & Reigeluth, 2018). Learners develop coherent knowledge representations and higher-order reasoning strategies to achieve complex goals (McCombs & Vakili, 2005).

Intrinsic motivation played a significant role in LCE, with learners' emotional states, beliefs, interests, and curiosity driving engagement and persistence (Alexander & Murphy, 1998; McCombs & Vakili, 2005). Learner-centered distance education environments nurture motivation by creating supportive and stimulating contexts (Chang & Smith, 2008).

Finally, educational technology integration is pivotal in supporting LCE by providing personalized, flexible, and interactive learning experiences that facilitate communication, collaboration, and creativity (Aslan & Reigeluth, 2016; Huh & Reigeluth, 2017). Unlike traditional systems, LCE technology enables prioritization of personalization, allowing adaptation to individual learner preferences and pacing. It offers customization, giving learners control over their educational experiences. Tools for goal setting, progress monitoring, and reflection support self-regulated learning. Integration of various resources created cohesive environments that enhance engagement through interactive multimedia rather than passive instruction (Aslan & Reigeluth, 2016).

Theoretical framework to design a digital health solution for ASD

Learning for individuals with ASD is a lifelong journey, most especially in relation to life skills, necessary to equip them with the capabilities to live a safe, productive, and dignified life with some sense of autonomy. Educational approaches for these learners must be carefully tailored to align with how they view the world, process information, and learn, while considering their cognitive and physical constraints arising from co-occurring conditions. Each instructional encounter must be aligned with the capabilities and needs of the individual so that it becomes an effective vehicle for learning and also provides an opportunity for self-discovery, a better understanding of their surroundings, and of the people they interact with. The diagram below illustrates the theoretical foundation of a digital system for ASD, which aims to be a vehicle that learners can use as they learn about the world and themselves through their own eyes.

Figure 1

Theoretical Framework

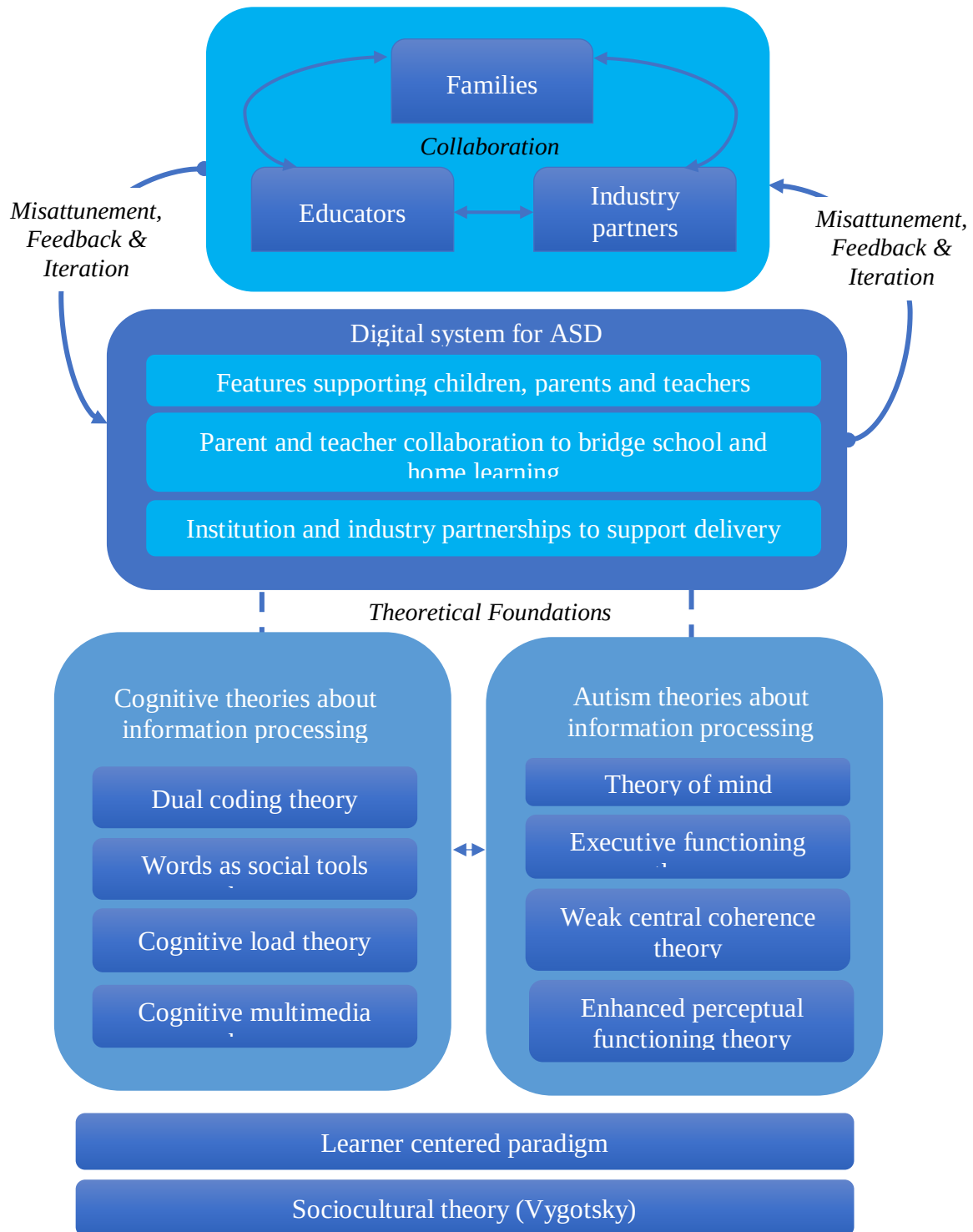


Figure 1 illustrates the conceptual and theoretical foundation of this research, demonstrating how stakeholder collaboration, learner-centered principles, and multidisciplinary theories converge to inform the development of a digital system for ASD. The framework integrates participatory design processes with cognitive, sociocultural, and autism-related theories of information processing to guide the design of a digital health solution that is accessible and meaningful for children, families, and educators.

At the top of the framework, families, educators, and industry partners represent the three primary stakeholder groups engaged in the system's collaborative development. Families contribute experiential knowledge of children's daily routines, strengths, communication needs, and behavioral contexts. Educators provide pedagogical expertise and insight into learning challenges and classroom-based support strategies. Industry partners contribute technical expertise to ensure the digital system remains scalable, usable, and sustainable in real-world implementation settings. The arrows among these stakeholders emphasize ongoing collaboration, shared decision-making, and iterative refinement throughout the design process.

The feedback loops surrounding the digital system reflect continuous cycles of input, misattunement, and adjustment, consistent with DMT. This highlights that effective autism interventions must account for interactional differences between learners and their communication partners. That design should support co-regulation, responsiveness, and shared understanding rather than placing demands solely on the child. Through repeated feedback and iteration, the digital health solution for ASD is shaped into a relational, context-sensitive system grounded in stakeholder experience.

At the center of the framework lies the digital system for ASD, which encompasses three interconnected design domains. First, the system includes features that directly support children, parents, and teachers through structured learning tools, communication supports, and life skills interventions. Second, it incorporates mechanisms that strengthen parent–teacher collaboration to bridge home and school learning environments. Third, institutional and industry partnerships are positioned as essential for supporting long-term delivery, accessibility, and integration into broader educational and digital infrastructures.

Beneath the digital system are the theoretical foundations that inform how learning content and supports are structured. The cognitive theories of information processing include DCT, CLT, CTML, and WST. Together, these theories explain how learners benefit from multimodal representations, reduced cognitive overload, and socially meaningful communicative tools. This grounding supports the design of visually structured routines, multimedia learning activities, and symbolic communication pathways that enable participation for minimally verbal learners.

In parallel with these cognitive theories, autism-specific theories of information processing provide additional insight into the neurodiverse learning experience. ToM informs the design of supports for social understanding, emotional interpretation, and reciprocal engagement. EDT highlights challenges in planning, inhibition, and attention regulation, reinforcing the need for structured scaffolds and predictable routines. WCC emphasizes detail-focused processing styles, guiding the presentation of learning materials in clear and segmented formats. EPF highlights visual and sensory strengths, informing the inclusion of visual modeling, sensory customization, and calming supports.

The bi-directional connection between these theoretical domains reflects their complementarity. Cognitive theories provide general principles for learning design, while autism theories contextualize these principles to better align with autistic learners' processing patterns, strengths, and support needs. Together, they form an integrated foundation for inclusive and accessible digital intervention design.

At the base of the framework, LCE and Vygotsky's SCT serve as overarching foundations. These emphasize that learning occurs through mediated participation, guided support, and meaningful activity within social contexts. LCE reinforces that the digital health solution for ASD must prioritize personalization, autonomy, and motivation by allowing families and educators to adapt interventions to each learner's interests, pace, and goals. Through customization, progress visibility, and responsive reinforcement, the system supports children and caregivers in making timely adjustments to learning routines and interventions.

Summary

This chapter covered a wide range of literature to provide a comprehensive understanding of the theoretical foundations, contextual challenges, and practical approaches relevant to designing digital health solution for life skills development in learners with ASD, particularly in low-resource settings. Cognitive theories, DCT, CLT, and CMLT, provided foundational insights into how learners process, store, and retrieve information. These frameworks guide designers in structuring content, integrating verbal and visual modalities, and managing cognitive load to optimize comprehension, retention, and skill transfer. Complementing these, autism-specific theories such as ToM, EF, WCC, and EFT described how learners with ASD uniquely process information, highlighting both deficits in cognitive capabilities and strengths related to visual

processing, sensory sensitivity, and detail-oriented tasks. By adding an autism-focused lens, these theories augment the principles of DCT, CLT, and CMLT, enabling the adaptation of learning components that capitalize on learners' strengths, address limitations, and ensure content accessibility, engagement, and meaningfulness. The combination of general cognitive theories with ASD-specific processing models informs the design of autism-focused digital health solution grounded in the unique cognitive profiles and needs of individuals with ASD.

Despite increasing global awareness of ASD, significant disparities remain in the availability and accessibility of autism services, particularly in LMICs, low-resource communities, immigrant populations, and indigenous groups. These inequities stem from systemic, structural, and cultural barriers, including lack of universal health coverage, service fragmentation, geographic isolation, diagnostic inequities, cultural and linguistic differences, social vulnerability, and caregiver burden, that limit timely diagnosis, reduce access to evidence-based interventions, and constrain caregiver support.

Parents and families face specific challenges that include language barriers, limited access to training and information, poor parent-teacher collaboration, systemic and financial obstacles, and emotional and social stressors. While individuals with ASD face physical, sensory, behavioral, social, emotional, communicative, academic, and financial challenges, educators contend with behavioral diversity, communication difficulties, insufficient training, large class sizes, resource constraints, cultural attitudes, poor parental engagement, and systemic policy barriers.

In response to these challenges, alternative intervention models in low-resource settings have emerged, including parent-mediated interventions, task-sharing with non-specialist providers, community engagement, and opportunities for systemic policy reform. Digital health

solution offers significant potential to bridge service gaps by providing accessible, scalable solutions aligned with industry standards, best practices in design and development, and robust data privacy and regulatory frameworks.

Digital health solutions for ASD life skills development could include structured, content-supported interventions that employ digital tools grounded in established frameworks, such as the TEACCH model, which emphasizes structured teaching and parent-implemented interventions to enhance learning outcomes. The co-creation of such digital health solution could leverage various approaches, such as content analysis, field-based exploratory research, focus groups, iterative design, a mixed-methods approach, and participatory design processes, ensuring solutions are contextually relevant, culturally appropriate, and responsive to stakeholder needs.

Chapter III: Methodology

The study used an exploratory single-case study approach, employing multiple embedded units of analysis, with participatory design, design thinking, and requirements engineering, and iterative design and development with industry partners and master's students.

According to Creswell (2013), qualitative research is appropriate for complex issues or problems that require in-depth exploration, such as studying an unrepresented group or population, to understand their perspectives and stories whose voices are seldom addressed in existing literature. Qualitative research also seeks to empower individuals, enabling them to share their narratives within their specific settings or contexts, recognizing that their responses are influenced by their environments, such as home, family, or work.

As the study aimed to answer the central question: “what are the essential requirements to design a digital health solution for life skills development of learners with moderate to severe ASD in low resource populations?”; the study delved into the lives of children, their parents and teachers in a low resource area in the Philippines, to know about their day-to-day lives, needs and challenges and to envision with them solutions that can be implemented in a digital technology. A qualitative methodology is well-suited to answering this central question, as it enabled the study to identify the tacit knowledge, subjective understanding, and interpretations of parents and teachers regarding the lives of learners with ASD, as well as their own experiences in supporting them. The day-to-day knowledge and practices of learners with ASD and their support systems are often overlooked in formal programs or policies. Yet they play a crucial role in shaping effective strategies for teaching life skills. Through methods such as qualitative surveys, interviews, and feedback sessions within a participatory design approach, the study uncovered tacit knowledge, personal insights, and practical adaptations that reflect both

individual and cultural contexts. This approach ensured that the requirements identified for a digital health solution were grounded in the realities of those who support children with ASD in resource-constrained environments.

The study adopted a constructivist epistemology, where knowledge is constructed through individual experience and reflection (Patton, 2015; Guba & Lincoln, 1994), specifically, social constructivism, where individuals construct meaning through their interactions and experiences (Creswell, 2014; Patton, 2015; Guba & Lincoln, 1994).

Constructivism is the philosophy that explains reality as based on multiple intangible, socially and experientially grounded, and locally and specifically held mental constructions (Guba & Lincoln, 1994). Constructivism holds that people build their understanding of the world through experiences and interactions rather than passively receiving information. It highlighted the role of active engagement and personal interpretation in the learning process, recognizing that different individuals may construct different meanings from the same experiences (Patton, 2015). In addition, the epistemology of constructivism assumes that the investigator and the object of investigation are “interactively linked so that the findings are literally created as the investigation proceeds” (Guba & Lincoln, 1994, p. 111).

Social constructivism further explained that reality is shaped through social processes and interactions, and that knowledge and meaning are created collaboratively within cultural contexts rather than being inherent or objective. This emphasized the importance of language, relationships, and societal norms in forming our perceptions of reality (Creswell, 2014; Patton, 2015). It is with this respect that constructivism’s methodology is hermeneutical and dialectic in nature, because “individual constructions can be elicited and refined only through interaction between and among investigators and respondents” (Guba & Lincoln, 1994, p. 111).

In this study, constructivism guided the entire research process by recognizing that knowledge about the learning and developmental experiences of children with severe ASD was co-constructed through the lived experiences, reflections, and interactions of parents, teachers, and the researcher. Data collection involved qualitative surveys and semi-structured interviews where parents and teachers shared their daily experiences with learners, describing moments of progress, behavioral challenges, and strategies that motivated engagement. These narratives served as the primary means of knowledge construction, illustrating that meaning emerged not from detached observation but from participants' personal accounts and interpretations of their realities.

Because learners could not participate directly due to communication constraints, their realities were interpreted through the socially constructed narratives of parents and teachers. These adults acted as proxies, not merely reporting observable behavior but interpreting meaning based on their emotional attunement and lived relationship with each child. This interpretive layer exemplified the constructivist stance that researcher, participants, and context are inseparably linked; findings were co-created through dialogue, reflection, and iteration rather than extracted as objective data.

Finally, in a cyclical data analysis approach, the researcher continuously refined interpretations through iterative design and development with the project team and through collaborative validation of the design with select participants. The resulting design features for the digital intervention were thus based on socially constructed meaning that reflected multiple realities, diverse experiences, and the co-created understanding of what best supports learning and development for children with moderate to severe ASD.

Research design

This study adopted a single exploratory case study (Creswell, 2014; Yin, 2018), employing multiple embedded units of analysis, using a participatory design approach (Dreesen & Schepers, 2018; Frauenberger, Makhaeva, & Spiel, 2017; Frauenberger, Makhaeva, & Spiel, 2016) to investigate a real-world problem in-depth while maintaining contextual complexity. An iterative and participant-centered research process guided Creswell's (2018) qualitative framework. The design thinking approach (Nielsen & Norman Group, 2025; Altman, Huang & Breland, 2018; Patton, 2015) supported the research through iterative cycles of empathy, definition, ideation, prototyping, and testing. This methodology was combined with requirements engineering to systematically capture the business and functional needs of the technology (Sharp, Rogers & Preece, 2019; Sebastian-Coleman, 2012; Meyer, 2002) and iterative design (Robinson et al., 2020). The study evolved through multiple cycles of data collection, analysis, and refinement, aligning with agile and user-centered design principles.

Case study based participatory design

According to Creswell (2013), a case study is appropriate for studies that require an in-depth exploration of a specific instance or phenomenon in its real-life context, and it focuses on a single case or a small number of cases for detailed analysis. An exploratory case study aims to identify research questions or procedures for subsequent research. This type of case study primarily lays the groundwork for future investigations. It is characterized by its flexibility and adaptability across various contexts, enabling researchers to explore phenomena in depth and gather preliminary insights. In addition, a single case study involves an in-depth exploration of one specific case. It allows for the inclusion of additional data collected from other methods, such as surveys or quantitative analyses, enhancing the richness of the study (Yin, 2018). Case

studies include multiple data sources, such as interviews, documents, and observations, to provide a comprehensive understanding. Survey interviews, or interviews using a structured questionnaire, could also be used in a case study (i.e., a survey within a case study) to gather quantitative data for statistical analysis. This data can serve as part of the overall evidence in a case study, enhancing the robustness of the findings (Patton, 2015).

According to Yin (2018), an exploratory case study is typically a prelude to a subsequent study. The exploratory case study design is well-suited to this research, as it enables in-depth investigation of co-designing solutions for life skills development for children with moderate-to-severe ASD in low-resource settings, a complex, under-researched issue. This research design uncovered the nuanced needs and challenges faced by children, parents, and teachers, providing rich context and detailed insights, and determined how a digital health solution can help address those needs.

Prior studies justified the use of a PD approach within a case study methodology by demonstrating how these methods supported meaningful involvement of children with complex needs, particularly those with moderate to severe autism or severe intellectual disabilities.

Frauenberger, Makhaeva, and Spiel (2016, 2017) and Dreesen and Schepers (2018) employed PD through iterative phases that involved understanding users, conducting workshops that incorporated drawing, writing, and crafts, developing prototypes, and evaluating design outcomes. Design activities were tailored to contextual factors, each child's characteristics, designers' prior experience, and the tools and techniques available or appropriate for each case. Visual tools were used to facilitate a structured, strength-based design approach within case studies, allowing adult participants, such as parents or caregivers, to assume critical roles in the design and evaluation process. These roles included acting as facilitators, motivators, caregivers,

proxies for the child, co-designers, playmates, or friends, thereby enhancing both the depth and richness of data collected.

Findings from these studies were often presented through design exposés, which offered concise, case-specific narratives that described the participatory processes used. While single-case studies provided deep, individualized insights, they yielded findings limited to the specific child involved. In contrast, multiple case studies provided broader insights but required substantial effort and customization, especially when visual tools needed to be adapted to each child's abilities and background.

Robinson et al. (2020) further exemplified how an iterative co-design methodology could be implemented effectively within a single-case study involving a non-verbal child with severe intellectual disabilities. Their approach emphasized ongoing participatory evaluation, in which weekly adaptations to the prototype were made based on direct feedback from parents about their child's use of the application. Weekly meetings were held with both the child and the parents, incorporating unstructured interviews and observations in their home setting. This method enabled a user-led design process that evolved through lived experiences and joint decision-making. This study presented a strong model for engaging children with moderate to severe disabilities in the design process. It introduced "method stories," narrative accounts of the design journey, as a way to document design decisions. Although promising, the authors acknowledged the need to investigate further whether this approach would be transferable to children with diverse cognitive and communicative profiles, given that it was implemented with only one participant.

In this study, case study using participatory design was done through focusing on the case of learners with moderate to severe ASD aged between 5 to 30 years old within Metro Manila,

Philippines, with their parents and teachers as proxies who participated in qualitative surveys and interviews, to have an understanding of the learners' capabilities, challenges and needs, that are needed to envision the requirements of a digital health solution for ASD life skills development. The case focused on the support system for these learners to determine their challenges and needs, which were used to inform the ideation of requirements for a digital health solution for ASD life skills development.

Qualitative survey and interviews

Qualitative survey and interviews enabled the researcher to gather both qualitative and quantitative data. According to Braun and Clarke (2013 as cited in Braun et al. (2021), qualitative surveys “consist of a series of open-ended questions, crafted by a researcher and centered on a particular topic. They are self-administered with questions presented in a fixed and standard order to all participants” (p.641). In addition, Braun et al. (2021) maintained that qualitative surveys can produce rich accounts of “subjective experiences, narratives, practices, positionings and discourses” (p.641). Qualitative surveys were used to capture information about the child's routines, likes and dislikes, and general activities, as well as the parents' and teachers' demographics, needs, and challenges. At the end of the qualitative survey, participants were asked if they were willing to participate in a short interview. Those who agreed were booked for a 30–45-minute interview.

To conduct the interview, the researcher used a standard open-ended interview. According to Patton (2015), this type of interview follows the “exact wording and the sequence of questions are determined in advance. All interviewees are asked the same basic questions in the same order. Questions are worded in a completely open-ended format” (p.866). Open-ended interviews enabled the researcher to delve into in-depth conversations informed by participants'

responses and to explore individual experiences and perceptions more deeply. This further informed the requirements to build a contextually relevant digital health solution that addresses the challenges they face in supporting life skills development for children with moderate to severe ASD.

Design thinking

The study also used design thinking to implement a human-centered approach, from ideation through design and development, ensuring the solution evolves to meet real-world needs. It incorporates insights from each iterative phase (Nielsen and Norman Group, 2025). According to Altman, Huang, and Breland (2018), design thinking (DT) is an approach that prioritizes user empathy, multi-disciplinary team collaboration, and rapid prototyping of solutions. DT is iterative, undergoing multiple cycles of prototyping and testing, and is normally used to solve complex problems. DT focused on a user-centered approach to problem-solving, ensuring that the digital health solution is anchored in empathy and tailored to the specific needs of children, their parents, and teachers. This approach promoted ideation, prototyping, and testing, ensuring that the solution evolves in line with the users' feedback (Patton, 2015).

Empathy maps and user personas are tools within the design thinking framework used in the study. According to Melo et al. (2020A), an empathy map is a canvas divided into sections based on users' wishes and demands. Typically, these sections are what the users see and hear, along with their pain and needs. It also has sections on what they think and feel, and what they say and do. The goal of the empathy map is to provide the designer with an understanding of users' perspectives, enabling the insights needed to design interfaces aligned with user expectations.

On the other hand, a user persona is a hypothetical representation of an archetype of a real user or user group. Personas describe the goals, interests, and capabilities of these users, and they are a useful tool for designers because they help provide a better understanding of a group's characteristics and give the design team a human face, bringing them closer to the users. There is typically no format for a user persona, though it typically focuses on demographic, psychological profiles, and experiences and skills (Melo et al., 2020B).

In this case study, design thinking was used to create empathy maps and user personas, initially based on a literature review and subsequently updated following qualitative surveys and interviews. The user personas were used as input to envision the requirements for a digital health solution for ASD and to inform the design of the digital health solution through a prototype.

Requirements engineering

Requirements engineering was used in conjunction with design thinking, iterative design, qualitative surveys, and interviews to envision requirements initially based on the information provided in the empathy map and user personas.

Requirements engineering is the structured process of identifying, analyzing, documenting, and managing the needs, constraints, and expected outcomes of a system. It represents the foundational stage of system development, ensuring that what is ultimately designed and implemented aligns with organizational objectives and stakeholder expectations (Bruel, Ebersold, and Naumcheva, 2025; Cox, 2022).

Cox (2022) defines requirements in the context of software systems as “all of the capabilities and constraints a (software) product must meet in the real world that help address the customer's opportunity” (p. 60). This definition emphasizes two essential elements: capabilities (what the system must be able to do) and constraints (the limitations or conditions under which it

must operate). Requirements engineering, therefore, is the disciplined activity of identifying and structuring these capabilities and constraints to guide development effectively.

Bruel, Ebersold, and Naumcheva (2025) frame requirements engineering as a critical early phase of the development lifecycle. They define a requirement as “a relevant statement about a project, environment, goal, or system property” (p. 15). This broader conceptualization underscores that requirements extend beyond system functionality. Instead, they may relate to four interrelated dimensions: Project, Environment, Goals, and System, collectively known as the Project–Environment–Goals–System (PEGS) framework. Within this structure, requirements engineering encompasses the identification and organization of statements across these dimensions to ensure completeness, clarity, and traceability.

These requirements evolved as qualitative surveys, interviews, and iterative design and development unfolded, providing richer information about the challenges and needs of children, parents, and teachers.

Types of requirements.

According to IEEE, as cited in Meyer (2002), a requirement is a “statement that identifies a product or process operational, functional, or design characteristic or constraint, which is unambiguous, testable or measurable, and necessary for product or process acceptability (by consumers on internal quality assurance guidelines)” (p.ix). Two types of requirements were gathered and progressively updated as the research progressed: business requirements and functional requirements.

Business requirements

According to Sebastian-Coleman (2012), business requirements are business needs expressed as statements that describe what a system must have or do. Business requirements are typically discovered through asking questions and leveraging various methodologies.

Business requirements express the outcomes an organization seeks to achieve through the development or enhancement of a system. They define the intended results rather than the technical means of achieving them. Cox (2022) describes business requirements as statements that identify the business's wants to achieve after a new system has been implemented. These statements are typically framed in terms of productivity improvements, strategic objectives, financial performance, regulatory compliance, or service enhancement. Importantly, they do not describe software behavior or system functions. Instead, they articulate organizational goals and performance expectations.

Similarly, Bruel, Ebersold, and Naumcheva (2025) position business-level concerns within the category of goals. In the PEGS framework, goals represent the system's concerns that must be addressed. They are not descriptions of system features but expressions of desired organizational results. Within this structure, business requirements are documented in the Goals component of the requirements plan, which establishes context, overall objectives, and expected benefits. In this sense, business requirements define the project's strategic rationale.

Business requirements, therefore, operate at a high level of abstraction. They are outcome-oriented, value-driven, and independent of specific technical implementation. Their primary purpose is to clarify why a system is needed and what organizational benefit it must deliver.

Functional requirements

On the other hand, functional requirements express what a system or product must do to support users and fulfill business objectives (Meyer, 2002; Sharp, Rogers & Preece, 2019).

Cox (2022) defines functional requirements as statements that describe the activities or processes that the software must perform to achieve user requirements and business rules. These requirements specify the system's behavior at its interfaces, including how it responds to inputs and produces outputs.

In the PEGS classification, functional requirements are considered a specific type of behavioral requirement. Bruel et al. (2025) define them as statements describing what the system must do. They focus on the system's operational properties and are typically documented in the System component of the requirements structure. Functional requirements are therefore closely tied to system functionality, user interaction, and verifiable behavior.

Unlike business requirements, functional requirements are implementation-oriented. They are sufficiently detailed to guide design, development, and testing. Because they specify observable system behavior, they can be validated through verification procedures and test cases.

In this case study, requirements engineering was used to systematically capture and envision user requirements informed by the results of the qualitative survey and interviews. The envisioned requirements based on the DT approach were listed in a table, along with a high-level definition of their capabilities and features. These were mapped to the data sources, which included the literature review, qualitative surveys and interviews, and design feedback sessions. This provided the traceability of requirements needed to demonstrate the alignment of user requirements with actual needs, as informed by scholarly data and end-user inputs.

Iterative methodology

The integration of the iterative methodology introduced a flexible and agile approach to project management. According to Goodman and Kuniavsky (2012), iterative methodology refers to continual refinement through trial and error. Instead of aiming for a perfect vision at the start of the project, an iterative methodology enabled continuous refinement toward its goal through a series of cycles that repeat the same steps. Each cycle leverages information from the previous cycle to enable the incremental development and examination of solutions until business needs are met consistently. On the other hand, agile refers to the techniques that allow a team to track rapid changes in people, technology, and business. Agile is effective and maneuverable, using light yet sufficient rules of project behavior alongside human- and communication-oriented rules (Cockburn, 2001, as cited in Laanti, et al., 2013). Agile supports iterative design and development, allowing the research team to continuously refine the digital health solution based on feedback and real-time data, ensuring the final product is optimized and closely aligned with user expectations (Schwaber & Sutherland, 2012).

The iterative nature of this research ensures that the digital health solution is not static but evolves as new information comes in and user feedback is received. This iterative cycle through input and feedback loops with parents and teachers, informed by adjustments and improvements, ensures the final solution addresses the needs of its actual end users.

In this case study, the iterative methodology was used to continuously refine the Figma designs based on emerging requirements arising from qualitative surveys and interviews, as well as design feedback sessions. The research had produced three versions (i.e., Alpha, Beta, and Charlie), which demonstrated the major iterations that were done both on the Figma prototype

and Android prototype that were done in collaboration with Master of Digital Transformation and Innovation (MDTI) students and the industry partner, Agile Creative Labs (ACL).

Context and boundaries of the case

This study focused on designing a digital health solution for learners with moderate-to-severe autism, along with their parents and teachers from low-resource families in Manila, Philippines.

The case is bounded by:

- **Timeframe:** A 20-month design cycle covering user research, iterative prototyping, and proof of concept.
- **Participants:** The study engaged a total of 17 participants, comprising 7 parents or primary caregivers of learners exhibiting moderate-to-severe ASD and 10 special education teachers teaching learners with moderate-to-severe ASD.
- **Outputs:** Creation of user personas, functional and business requirements, Figma prototypes, and proof of concept.

Research questions

This case study aimed to answer the central question: *What are the essential requirements for designing a digital health solution to support the life skills development of learners who exhibit characteristics and behaviors similar to those of moderate-to-severe ASD in low-resource populations?* Specifically, the study aims to answer the following sub-questions:

- What specific capabilities, interests, challenges, and needs do learners demonstrate in relation to life skills development?

- What are the challenges and needs of parents and teachers in teaching life skills to learners?
- What capabilities, features, and processes are essential for developing a digital health solution that effectively supports learners, parents, and educators in teaching, enhancing, and maintaining life skills in low-resource populations?

The study was divided into three workstreams (a) a literature review to identify commonly used features and capabilities of digital health solution for life skills development of learners with ASD to begin the ideation stage of design thinking; (b) qualitative surveys and interviews with parents and teachers, to have a deeper understanding on the challenges faced by parents and their children, along with educators in the learning overall care of learners which were used to inform the determination of requirements; and (c) creation of medium to high fidelity prototypes using iterative design and development to build the core foundation of the digital health solution, including feedback sessions on the design prototypes.

Sampling

The participants of this study were selected using purposive and snowball sampling. According to Miles, Huberman, and Saldana (2020), purposive sampling is a type of sampling strategy that focuses on a participant's unique characteristics. Purposive sampling is appropriate for this study because it aims to gain in-depth knowledge of teachers' and parents' teaching approaches, and the learning experiences of people with moderate-to-severe ASD. Learners with moderate to severe ASD typically have more unique characteristics in the sense that they have different ways of processing information and experience limitations to their executive

functioning; their communication capabilities are also limited to gestures, words, and phrases, and often face sensory and behavior challenges (American Psychiatric Association, 2013).

Purposive sampling is also “theory-driven, either upfront or progressively” (Miles, Huberman, and Saldana, 2000, p.46). For this study, this meant that the criteria for selecting participants were based on the research question and literature used to define the scope of the study. Snowball sampling, in which additional study participants were identified based on recommendations from interviewees, was also conducted by asking parents and teachers to recommend others within their networks to join the study.

Participants

This study focused on parents or caregivers of learners aged 5 to 30 years who exhibit behaviors and characteristics consistent with moderate to severe ASD, as well as their teachers. Participants were recruited through the Philippine Department of Education district superintendent, who facilitated engagement with parents from Paranaque Elementary School Central (PESC). Snowball sampling was also used, with participating parents and teachers recommending others within their networks who met the study criteria.

Parent inclusion criteria were: (1) being a parent or caregiver of a learner aged 5 to 30 who exhibits characteristics and behaviors of moderate to severe ASD, and (2) willingness to complete qualitative surveys and participate in follow-up interviews. Parents of learners exhibiting behaviors more consistent with high-functioning ASD or those over 30 years old were excluded.

Teacher inclusion criteria were: (1) currently teaching learners who exhibit characteristics and behaviors of moderate to severe ASD, and (2) willingness to complete qualitative surveys and participate in follow-up interviews.

The table below summarizes the overall participant characteristics,

Table 5

Summary of participant information

Participant characteristic	Parent participants	Teacher participants
Participant role	Primary caregivers of learners with ASD	Special education teachers in public schools
Learners supported	Learners aged 5–30 years that exhibit characteristics and behaviors similar to moderate to severe ASD	Learners with moderate to severe ASD in school settings
Age range	Mostly 31–40, others in 40s; one caregiver 61–70	Mostly early 40s to late 50s
Marital status	Majority married; others common-law or separated	Majority married
Educational attainment	High school to college; one postgraduate	Mostly bachelor's; some graduate-level studies
Professional background	Private sector, self-employed, government, full-time caregiving	Special education educators
Socioeconomic context	Low-resource; most households CAD 6,000–12,000/year	Not reported
Years of experience	Not applicable	6 years to nearly 40 years
Teaching load	Not applicable	From 1 class to 10–11 classes
Class size	Not applicable	Specialized: 3–10 students; larger: 19–26 students
Survey completion	All completed qualitative surveys (online or in person)	All completed qualitative surveys online
Interview participation	2 parents completed follow-up interviews	1 teacher completed a follow-up interview
Participation constraints	Time, workload	Time, workload, internet connectivity

Methodological and practical considerations shaped the delimitations of this study. The study focused on parents of learners aged 5 to 30 who exhibit behaviors consistent with moderate

to severe ASD. This extended age range was intentionally selected to capture lifelong learning and support needs that often continue beyond adolescence, as individuals with higher support needs frequently require sustained caregiver involvement and educational or life-skills interventions into adulthood. Including participants up to age 30 enabled examination of challenges across key transition stages, from school-based programs to adult services, and strengthened design insights for digital health solution that support individuals across the lifespan.

The study also focused on learners with moderate-to-severe support needs because this population remains underrepresented in digital intervention research, particularly in low-resource contexts, despite facing significant barriers to communication, daily living, and independence. This focus allowed for richer qualitative insights from parents and teachers, consistent with the study's constructivist and participatory design approach.

Finally, the scope was narrowed due to feasibility constraints. Conducted by a single researcher within a 20-month design cycle, the intensive requirements of data collection, prototyping, and iterative analysis necessitated a manageable participant group while maintaining methodological rigor and relevance to digital health solution design.

Research team and their roles

In this study, a clear distinction was made between the research participants and the research team. The study participants were parents and teachers who contributed their lived experiences, insights, and feedback during the participatory design activities. Their contributions, gathered through qualitative surveys, interviews, and design feedback sessions, formed the primary data for analysis, which consequently informed the capabilities, features, and overall

design of the digital health solution. While participants directly shaped the design decisions, they were not responsible for the technical development.

The research team developed prototypes, particularly digital mock-ups in Figma, and subsequently mobile application iterations on Android. The research team comprised the project lead, the researcher, the designers, MDTI students from the University of Ottawa, and software engineers from ACL. The research team's role was to translate participants' ideas and requirements into tangible design artifacts and software prototypes, and to incrementally adapt them based on the results of the participatory design process. This distinction helped ensure clarity between participant input and the research team's facilitation and technical responsibilities.

In this study, the researcher assumed the roles of survey administrator, interviewer, designer, and project leader.

Researcher's positionality

With a background in supporting children with moderate to severe ASD as a family member, the researcher held an insider position. According to Bukamal (2022), an insider is someone who shares significant characteristics or experiences with the group being studied, thereby enhancing participants' trust and openness. This insider perspective provided unique advantages, such as greater empathy and rapport with participants, as well as a deeper understanding of the nuanced needs of children with moderate to severe ASD and their families.

To maintain objectivity and manage the potential influence of personal preconceptions, the researcher engaged in reflexivity practices throughout the study. Reflexivity, or a critical self-examination of one's biases and influence on the research, was maintained through

structured self-reflection and proactive monitoring of actions and decisions during data gathering, synthesis, and evaluation (Creswell & Poth, 2018). The researcher also kept a research journal to document interactions with participants, the research team, design decisions, and design evaluations. This record served as an ongoing check for personal biases and helped maintain transparency.

To further enhance objectivity and reduce potential bias arising from the insider role, the researcher sought external feedback from her thesis advisor and thesis advisory committee. This external input was particularly valuable for ensuring balanced perspectives in data analysis, for validating design choices, and for testing approaches. These advisors reviewed key stages of the research process, providing critical insights that helped mitigate any unintended influence of the researcher's personal experiences on the study outcomes.

In addition, the researcher took steps to minimize bias by ensuring that participant responses and interactions were evaluated objectively. By incorporating triangulation through feedback from teachers and parents involved in the study, the researcher ensured that design and testing processes remained user-centered, with minimal influence from her personal insights or expectations.

This combination of reflexivity practices and external feedback contributed to the research's trustworthiness and credibility, addressing potential challenges and ethical considerations arising from the researcher's insider status. Through these measures, the researcher leveraged the advantages of her insider role, such as empathy and contextual knowledge, while remaining committed to objectivity and rigor.

Data sources

This study employed an exploratory case study design using a participatory design approach, drawing on related data sources to implement data triangulation and enhance the validity and depth of the findings (Denzin, 2012). First, the study used a literature review to have an initial understanding of the needs and gaps of learners with autism, along with features of digital technologies that can be used to address those areas. Second, the research used design thinking, particularly the creation of empathy maps and user personas, to adopt a user-centered approach to envision and sketch the initial design. Third, requirements engineering was employed to develop business and functional requirements, including determining high-value use cases to serve as the blueprint for the solution. These requirements define what needs to be built, how it should function, and what the product would look like. Fourth, the research used qualitative surveys, interviews, and design feedback sessions to provide contextual information to inform iterative improvements to the features of a digital health solution for life skills development in children with moderate-to-severe ASD. Fifth, the iterative methodology following the Agile framework was used to design and iterate on a medium-fidelity prototype in Figma and a high-fidelity prototype for Android. Both the medium and high-fidelity prototypes underwent iterative refinements based on feedback received from parents and teachers.

Data collection

The data collection research was divided into three workstreams – design thinking, qualitative survey, and interviews, along with iterative design and development.

Design thinking

A literature review was conducted to identify digital health solution aimed at teaching life skills to children with ASD; the types of interventions used; and how parents and teachers collaborated to build, test, and use these prototypes. From this, commonly used features and capabilities of digital health solution for life skills development in children with ASD were identified through thematic analysis. The literature review informed the initial empathy maps and user personas, which, in turn, informed the development of the feature requirements. Based on this preliminary information, the first design prototype was developed in Figma. Figma is a web-based application that provides an intuitive interface for creating, sharing, and testing designs for websites, mobile apps, and various digital products (Figma, 2025).

Qualitative surveys and interviews

This workstream involved qualitative surveys and interviews with parents and teachers to gain a contextualized understanding of the capabilities, needs, and challenges of children with ASD, as well as of parents' and teachers' needs and challenges. The data gathered in this stage refined the design features identified in the literature review and validated their context relevance and applicability to the needs of children, parents, and teachers within their local and cultural context. In this workstream, the learner, parent, and teacher user personas were also updated, along with feature requirements.

Member checking was conducted by reviewing transcripts. After interviews were transcribed, participating parents and teachers were allowed to review their transcripts to confirm accuracy, clarify meanings, and request corrections or removals where necessary. This process occurred before final thematic coding, ensuring that the data used for analysis accurately reflected participants' intended meanings.

In addition to transcript verification, participant feedback during subsequent participatory design interactions also served as an informal validity check on emerging interpretations and design implications. While transcript review focused on accuracy and consent, later feedback helped refine the interpretation and practical relevance of themes during design synthesis

Iterative design and development

The iterative design and development workstream was conducted using iterative and design-thinking approaches. In this stage, the researcher partnered with MDTI students at the University of Ottawa to design and build the core capabilities and features of a digital health solution to teach life skills to children with ASD. The researcher also leveraged industry partnerships through a start-up in which she is a co-founder, called ACL.

Continuing the work after design thinking's empathize stage from workstreams 1 and 2, the third workstream focused on design thinking's define and ideate stage, where the researcher updated the designs and medium fidelity prototype, which reflected participants' experiences, specific challenges, priorities, along with desired outcomes in children's life skills development from the qualitative surveys and interviews.

In this workstream, the researcher used iterative development to build proof of concepts (PoC). Each PoC was tested by the researcher and iterated upon to align with evolving feedback from select participants' feedback sessions. This approach provided the flexibility to adjust functional design and requirements based on information and feedback from children, parents, and teachers.

Instrument and materials

This case study was guided by Yin (2018), Creswell (2018), Braun and Clarke (2006), and design thinking (Nielsen and Norman Group, 2025) to inform data collection and procedures and general rules for iterative design and prototyping.

Parents were asked to provide basic information about them and their child followed by a qualitative survey (see Appendix 16) with open-ended questions that asked about their child's strengths, routines, and their experience teaching their child at home. The information and qualitative survey forms were created in MS Word and printed for those who would prefer to answer them by hand, and in Survey Monkey for those who would prefer to do it digitally. SurveyMonkey is an online platform for surveys, forms, and market research. It enables the creation and distribution of survey forms, as well as the collection of information and feedback (Survey Monkey, 2025). To align with parents' availability, they were asked to complete them whenever they have the time. In the same manner, teachers were also asked to provide information about their demographics and teaching background; and a qualitative survey was done to understand their teaching approach, along with their challenges and needs (see Appendix 17).

After completing the information form and surveys, parents and teachers were asked whether they were available to participate in a brief interview to delve deeper into their responses and ask follow-up questions. Parents and teachers who agreed to be interviewed were interviewed remotely via MS Teams. The time was set by the participants based on their availability, and the researcher aligned with their schedule. The schedule was booked using Microsoft Outlook and through direct communication.

The interview protocol (see Appendix 18 and 19) followed a standardized open-ended interview format. According to Patton (2015), this type of interview determined “the exact wording and sequence of questions in advance. All interviewees were asked the same basic questions in the same order. Questions were worded in a completely open-ended format” (p. 438). This approach was chosen to provide a more defined structure for how interview questions were asked. The types of questions asked included knowledge, experience, behavior, opinion, and values (Patton, 2015). The interview protocol was also delivered in Filipino-English, which is a standard way of communication in the Philippines. Participants were also asked to provide a pseudonym that the study would use to protect their privacy.

The results of the information form, qualitative survey, and interview were used to update the user personas, functional requirements, and design prototypes. Miro was used to develop the empathy map and user personas. Miro is a digital workspace where groups can collaborate on a canvas by adding shapes, sticky notes, or files (Miro, 2025). At the same time, Figma was used to design the medium-fidelity prototype based on the information from the SLR, qualitative interview, and surveys.

Data analysis procedure

Thematic analysis

Data analysis was done using the thematic analysis approach of Braun and Clarke (2006) to identify both theoretical and emerging themes in the data. According to Braun and Clarke (2006), “thematic analysis is a method for identifying, analyzing and reporting patterns (themes) within data” (p. 79). Thematic analysis was done using both deductive and inductive methods.

The deductive approach was conducted through theoretical studies on the learner-centered paradigm, cognitive theories of learning, and autism theories. In addition, the research questions also guided the coding to classify specific needs, challenges, capabilities, strengths, and interests of people with moderate to severe autism in low-income families; specific needs, challenges, capabilities, strengths, and interests of people with moderate to severe autism in low-income families; and approaches that parents or caregivers take a more active role in the life skills development of their child.

An inductive approach, on the other hand, was used to identify emerging themes that are not captured by the deductive approach. This was done through a bottom-up approach, in which themes were identified based on patterns emerging from qualitative surveys, interviews, and feedback from the design. The inductive approach was used to determine the types of challenges, capabilities, and needs of children, parents, and teachers, and to determine the approaches used by both parents and teachers to support learning.

Quantitative analysis

Quantitative analysis was also conducted to provide a clear summary of the demographic characteristics of children, parents, and teachers who participated in the study. This included variables such as age, gender, educational background, and other relevant indicators that helped describe the composition of the participant group. According to Lim (2024), quantitative analysis focuses on measurable variables and quantifiable data, making it a suitable approach for presenting demographic information in a structured and systematic way. By organizing these details numerically, the study was able to provide context for the qualitative findings, highlight patterns within the participant population, and demonstrate the diversity or commonalities. While the primary aim of the research was to explore experiences and perspectives through qualitative

methods, the addition of quantitative analysis ensured that the demographic profile of participants was documented with precision and could support the interpretation and transferability of the study's results.

Within case analysis

Within-case analysis (Miles, Huberman, & Saldaña, 2014) was employed to examine the data gathered from multiple qualitative sources, including surveys, interviews, literature review, and user feedback. This method provided a systematic way to explore each bounded case, parents, teachers, and children (through parents as proxies), as distinct yet interconnected contexts. According to Miles, Huberman, and Saldaña (2014), within-case analysis involves “describing, understanding, and explaining what has happened in a single bounded context” (p. 101). This approach allowed the study to move beyond surface-level descriptions and to identify patterns, meanings, and unique perspectives within each participant group.

By applying within-case analysis, the study captured the nuances of lived experiences, highlighted contextual challenges in low-resource settings, and traced how these informed the participatory design process. For example, insights from parents revealed how daily routines can help shape children's opportunities for life skills development, while teacher perspectives provided critical information on classroom constraints and instructional strategies. User feedback further contributed to refining design features, ensuring the digital health solution responded to both individual needs and collective priorities. This iterative process of analyzing, reflecting, and applying findings within each case was essential to guiding the development of the autism solution in a way that was both contextually grounded and practically relevant.

Document analysis

Document analysis was used to scrutinize the empathy maps, user personas, and use cases, as well as the business/functional specifications. According to Gross (2018), document analysis involves repeatedly reviewing, examining, and interpreting data to derive meaning and knowledge. When used in triangulation, it aids in corroborating and expanding findings, helping address bias.

Pattern matching

Pattern matching was used in the analysis chapter to assess how well the research findings support existing knowledge on co-designing digital health solution for autism, and how user feedback influenced the iterative development of the hybrid mobile application. Pattern matching is the approach in which the findings of the case study are compared to a predicted outcome, which can be a single prediction or a set of rival predictions (Yin, 2018).

Logic models

Finally, logic models were used to systematically analyze the data gathered from various sources (qualitative surveys, interviews, systematic literature review, document analysis) and demonstrate how each phase of research and data collection directly influenced the prototype's iterative design and development. A logic model was created to systematically explain the process the researchers used in designing a digital health solution for learners with moderate to severe autism in low-resource areas, using participatory design. Logic models refer to the specification and operationalization of a chain of events (Yin, 2018).

Participatory design focused analysis

Finally, a participatory design lens was also incorporated into the analysis chapter to provide a deeper reflection on how the digital health solution for autism was developed, iterated,

and validated through engagement with key stakeholders (parents, teachers, and industry partners). The “tool to think with for designers” of Frauenberger et al. (2015) was used to provide a structured, critical process for analyzing the epistemology, values, outcomes, and stakeholders of the case study.

Ensuring trustworthiness

To ensure trustworthiness, the researcher used triangulation to validate information, drawing on data from the literature review, qualitative surveys, interviews, iterative design and development, and a protocol for a single holistic case. The researcher also performed member checking by showing the data to the parent and the teacher, who evaluated and scrutinized it to identify any inconsistencies or incorrect information. A researcher’s journal was also kept to record interactions and decisions with participants and the project team. At the same time, the researcher always sought to produce a thick description of the data, allowing her to justify and trace the information synthesized, analyzed, and used for design and development within the case study (Creswell, 2014). In addition, Frauenberger et al.’s (2015) “tool-to-think-with,” which guides designers through structured, critical inquiry during participatory design to effectively explain decisions and judgements that need to be made during the design process, will also be referenced. This tool comprises four lenses: epistemology, values, stakeholders, and outcomes. This approach enhanced research trustworthiness by fostering transparency in the design, aligning design choices with stakeholder needs, and supporting reflexivity by making underlying assumptions and value judgments explicit, thereby strengthening the credibility and coherence of the design process.

Figure 3

A tool to think with for the designers - guide questions

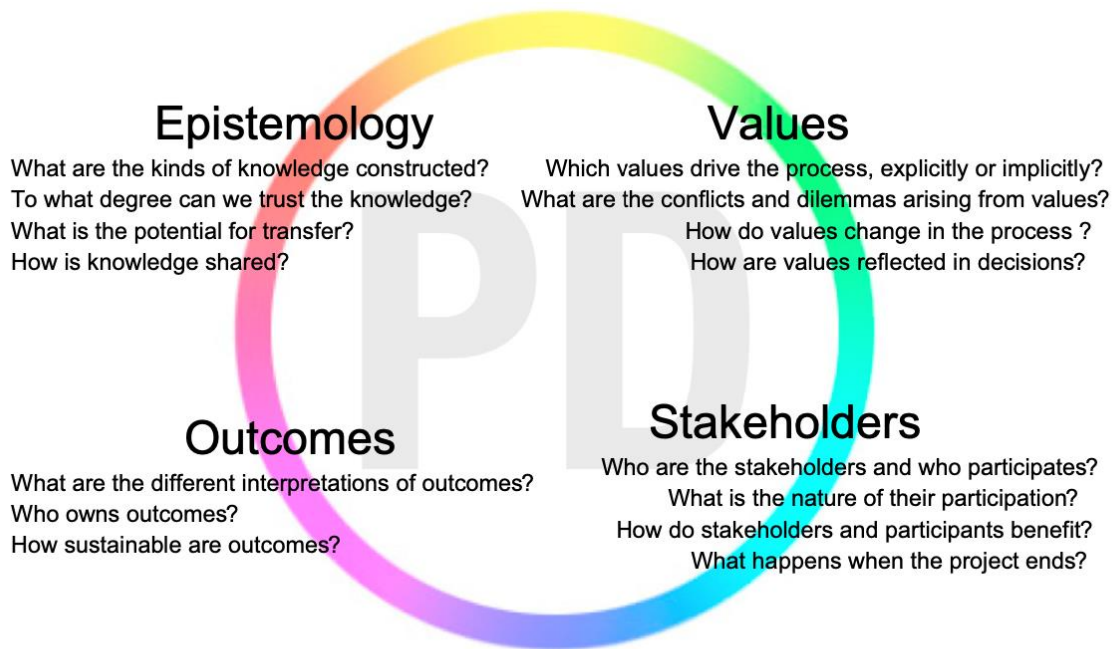


Fig. 2. Summary of the four lenses and starter questions in the conceptual framework.

Source: Frauenberger et al., 2015, p.98

Ethical considerations

As this study was conducted with a vulnerable population, the researcher ensured that appropriate measures were taken to ensure ethical research conduct.

The researcher acquired ethics board approval before starting the study. Afterward, she obtained written informed consent from parents and teachers. Participants were also informed of the potential risks of participating and the approaches to mitigate them. For example, at any point during the study, participants may withdraw if they feel uncomfortable or have changed their minds.

The privacy and confidentiality of participants were also protected by not using any personally identifiable information and by using pseudonyms to protect their identities. All data collected was used only for the study and would be discarded after the thesis was completed.

Table 6

Summary of instruments, data collection, analytical procedures, trustworthiness, and ethical approaches taken

Approach	Component	Description / Purpose	Outputs / Role in Study
Data Collection	Design thinking	Conducted a literature review to identify existing digital life-skills interventions for children with ASD, including features and collaboration approaches.	Informed empathy maps, user personas, and initial feature requirements; first prototype developed in Figma.
	Qualitative surveys & interviews	Collected contextual insights from parents and teachers about needs, challenges, and strengths of children with ASD.	Refined and validated features, updated personas, and ensured local/cultural relevance.
	Member checking	Participants reviewed interview transcripts for accuracy and consent before coding. Informal feedback also supported interpretation validity.	Strengthened credibility and ensured participant meanings were accurately represented.
	Iterative design & development	Partnered with MDTI students and industry start-up (ACL) to design and build core solution features through iterative prototyping.	Developed proof-of-concepts (PoCs), updated prototypes, aligned requirements with evolving stakeholder feedback.
Instruments & materials	Information forms	Parents and teachers completed demographic/background forms.	Provided participant context for analysis and persona refinement.

	Qualitative surveys	Open-ended surveys captured routines, strengths, teaching strategies, and challenges. Delivered via paper or SurveyMonkey.	Generated qualitative data supporting needs assessment and design priorities.
	Interviews (Remote)	Follow-up semi-structured interviews via MS Teams, scheduled based on participant availability.	Deepened understanding of survey responses and contextual learning experiences.
	Standardized open-ended interview protocols	Following Patton (2015), all participants received the same open-ended questions in consistent order. Conducted in Filipino-English.	Ensured structured yet flexible qualitative inquiry; supported comparability across participants.
	Design tools	Miro used for empathy maps/personas; Figma for medium-fidelity prototypes.	Enabled participatory design synthesis and iterative feature development.
Data analysis procedures	Thematic analysis	Braun & Clarke (2006) used to identify patterns/themes across qualitative data.	Produced theoretical + emerging themes guiding design implications.
	Deductive coding	Guided by learner-centered paradigm, cognitive learning theories, autism theory, and research questions.	Classified predefined needs, challenges, and learning support approaches.
	Inductive coding	Bottom-up identification of themes emerging directly from surveys, interviews, and feedback.	Captured unanticipated contextual insights shaping feature refinement.
	Quantitative analysis	Descriptive statistics summarized participant demographics (Lim, 2024).	Documented group composition and supported transferability of findings.
	Within-case analysis	Based on Miles et al. (2014), where each bounded case (parents, teachers, learners) was examined separately and interconnectedly.	Highlighted nuanced lived experiences informing participatory design decisions.

	Document analysis	Reviewed empathy maps, personas, use cases, and specifications (Gross, 2018).	Supported triangulation and reduced interpretive bias.
	Pattern matching	Compared findings against predicted outcomes and existing autism co-design literature (Yin, 2018).	Assessed how results aligned with or extended prior knowledge.
	Logic models	Modeled links between data collection phases and iterative prototype development (Yin, 2018).	Demonstrated systematic progression from evidence → design outcomes.
	Participatory design lens	Applied Frauenberger et al. (2015) “tool-to-think-with” framework (epistemology, values, stakeholders, outcomes).	Supported critical reflection on co-design process and stakeholder alignment.
Ensuring trustworthiness	Triangulation	Used multiple data sources: literature, surveys, interviews, prototyping feedback.	Strengthened validity through corroboration across methods.
	Member checking	Transcript review + participatory feedback ensured accuracy and relevance.	Increased credibility and participant-centered interpretation.
	Researcher journal	Recorded decisions, reflections, and interactions throughout the study.	Supported transparency and auditability of research process.
	Thick description	Detailed contextual reporting (Creswell, 2014).	Improved traceability and transferability of findings.
Ethical considerations	Ethics approval & Informed consent	Ethics board approval was obtained prior to study initiation. Written informed consent was collected from parents and teachers.	Ensured ethical compliance when working with a vulnerable population.
	Participant rights & risk mitigation	Participants were informed of potential risks and mitigation strategies. They could withdraw at any point without penalty.	Protected participant autonomy and wellbeing throughout the research.
	Privacy & confidentiality	No personally identifiable information was used.	Maintained confidentiality and

		Pseudonyms protected participant identities.	reduced risk of harm or exposure.
	Data use & disposal	Data was used only for research purposes and will be discarded after thesis completion.	Ensured responsible data handling and limited long-term privacy risks.

Summary

This study aimed to identify the essential requirements for designing a digital health solution to support the development of life skills in learners with moderate-to-severe ASD in low-resource settings. A qualitative methodology was adopted to capture the tacit knowledge, subjective interpretations, and experiential insights of parents and teachers, and to examine the complex processes involved in teaching life skills to children with moderate to severe ASD.

The research was grounded in social constructivism, recognizing that meaning is co-created through social interaction, cultural context, and individual reflection. These perspectives emphasized the collaborative nature of knowledge construction while acknowledging the active, interpretive role of learners and stakeholders in shaping understanding.

A single exploratory case study design was employed, using a participatory design approach to investigate the problem in its real-world context while preserving its complexity. The process was informed by Creswell’s qualitative framework and guided by design thinking principles of empathy, definition, ideation, prototyping, and testing. This was integrated with requirements engineering to systematically capture business and functional needs, and iterative design to refine concepts through multiple cycles of data collection, analysis, and stakeholder engagement. The methodology aligned with agile and user-centered design principles, ensuring that development was both contextually relevant and collaboratively shaped

Chapter IV: Findings

Research findings were grouped per research sub-questions which were: (1) what specific capabilities, interests, challenges and needs do learners with moderate to severe ASD exhibit in relation to life skills development; (2) what are the challenges and needs of parents and teachers in teaching life skills to learners with moderate to severe ASD; and (3) what capabilities, features, and processes are essential for developing a digital health solution that effectively supports learners with moderate to severe ASD, parents, and educators in teaching, enhancing, and maintaining life skills in low-resource populations.

To answer each research sub-question, the study adopted an incremental, iterative approach across three workstreams: literature review and design thinking; qualitative surveys and interviews; and iterative design and development. Workstreams were executed in parallel and continuously adapted to the latest available information as the research progressed.

RQ1: What are the capabilities, interests, challenges and needs of learners with moderate to severe ASD

To determine the capabilities, interests, needs, and challenges of learners, three workstreams were conducted using an incremental, iterative approach to answer the study's research questions. The first workstream leveraged a literature review to conduct preliminary design ideation, while the second workstream focused on primary data collection through qualitative surveys and interviews. The third workstream synthesized both secondary and primary data to develop a child user persona that guided the ideation of features, processes, and designs for a digital health solution for life skills development for learners with moderate to severe ASD autism.

Findings from workstream 1: literature review research and design thinking

In the first workstream, learner needs, challenges, capabilities, and interests related to life skills development were identified through a literature review and presented as an empathy map and user persona, following the design thinking framework.

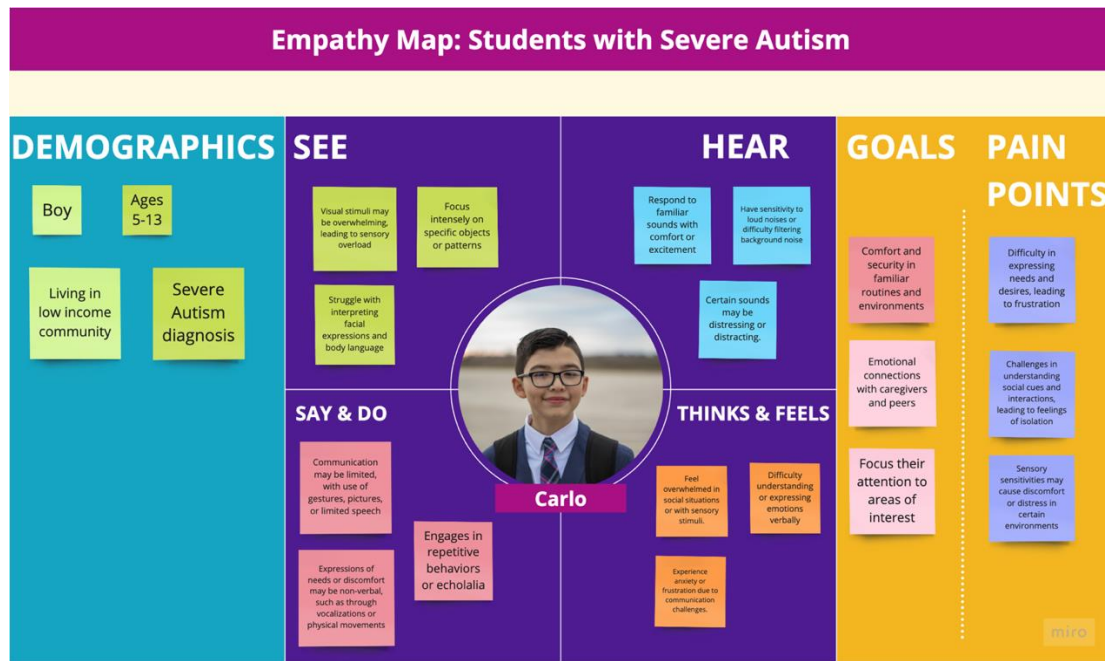
Empathy map of learners

The empathy map below describes what students with moderate-to-severe ASD typically see, hear, think, feel, and say, and what they do. It also described their goals, pain points, and demographics.

The empathy map below was represented by a male learner named “Carlo” aged between 5 and 13 years old and living in a low-income family. He had a severe autism diagnosis and experienced sensory overload and struggles with focus and socialization. His communication was limited to gestures, sounds, and a few words, and he expressed his discomfort through physical movement and vocalizations. Carlo found certain sounds distressing and distracting, but familiar ones, like his favorite songs or melodies, brought him excitement. His learning goals focused on building routines that would provide him with comfort and security and leveraging his current interests to teach him basic life skills.

Figure 4

Empathy map of learners



User persona of learners

Based on the empathy map, an initial user persona for a child with moderate-to-severe autism was created. The user persona below provides more information about Carlo, including his behavior and habits, pain points and frustrations, needs and goals, and main motivations. This user persona was used as a guide to begin ideation and design of a universal user interface and experience with personalization and customization capabilities.

Figure 5

User persona of learners

 Child Persona  Carlo Demographics Name: Carlo Reyes Age: 10 Occupation: SPED Student Location: Quezon City, Philippines Background: Carlo is a young boy living in a low-income community in the city. He has severe autism, which presents challenges in his daily life and learning.	Behaviors & Habits Daily Routine: - Relies on grandparents for care as parents work night shifts. - Has inconsistent hygiene and toileting skills. - Struggles with maintaining a regular sleep pattern. - Displays selective eating habits, prefers familiar and favorite foods. - Prefers solitary play with toys like Lego, enjoys watching vehicles pass by. - Becomes agitated by loud noises and sudden changes in the environment. - Tends to be aggressive when hungry or overwhelmed. Social Interaction: - Rarely engages in play with other children, prefers to observe from a distance. - Shows affection and becomes sweet when wanting something. - Has trouble making friends, often remains isolated.
---	--

Findings from workstream 2: qualitative surveys and interviews

In the second workstream, qualitative surveys and interviews were conducted with parents to determine the children’s backgrounds, capabilities, interests, needs, and challenges. As the primary caregivers, parents served as proxies for their children at this stage, providing valuable insights into their children's everyday activities.

Demographics.

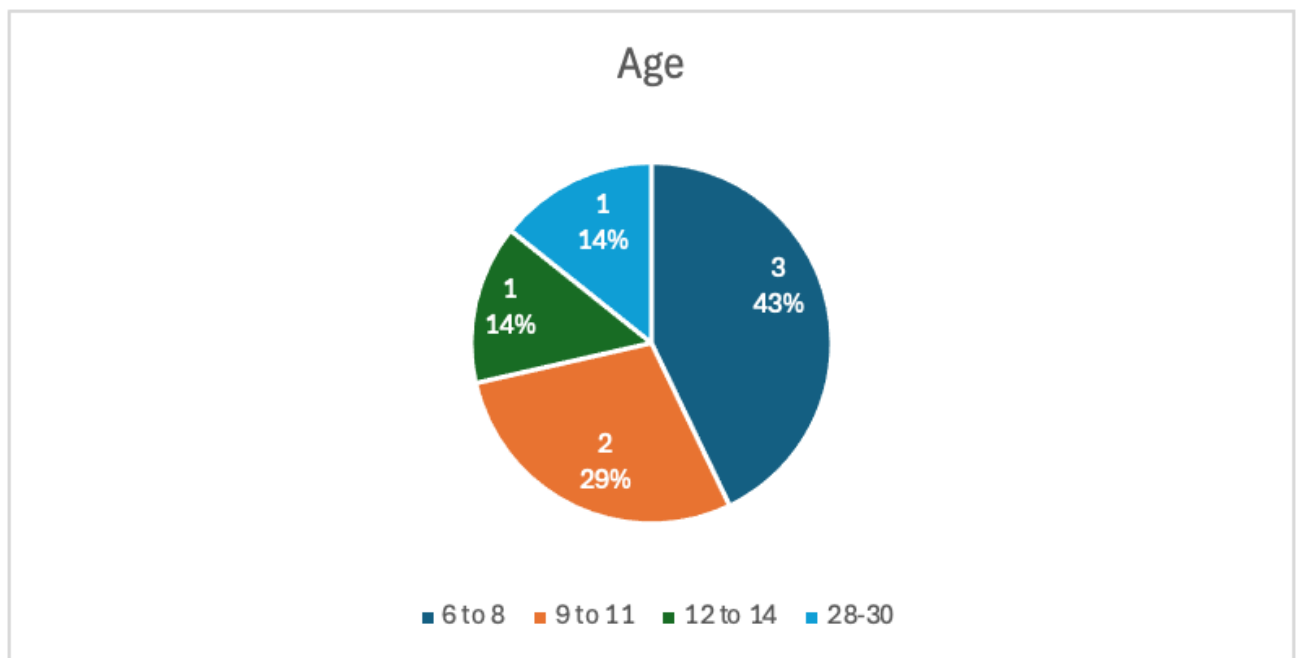
This section describes the learner’s age, gender, family composition, autism diagnosis, along with information about the education and therapies they received.

Age of learners

The children who participated in this study varied in age, but most were in the early school years, around 6 to 8 years old. A few were slightly older, in the range of nine to eleven. One child was entering adolescence, while another was already an adult. This range reflected a mix of developmental stages, with most learners at an age when foundational life skills were still forming, while a few were navigating more complex transitions into adulthood.

Figure 6

Age of learners

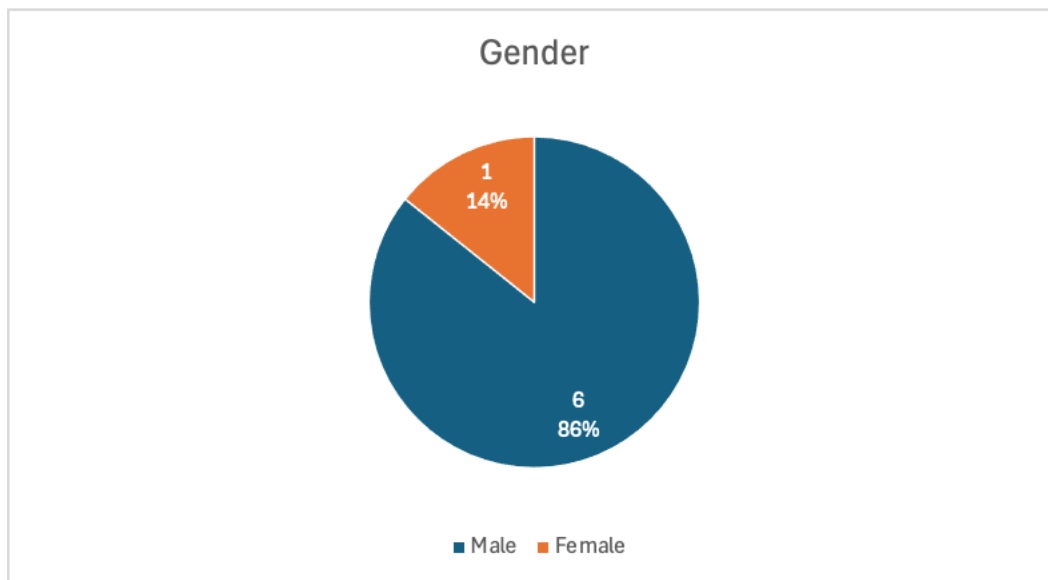


Gender of learners

Among the learners, there are more boys than girls. In fact, only one of the children is female.

Figure 7

Gender of learners

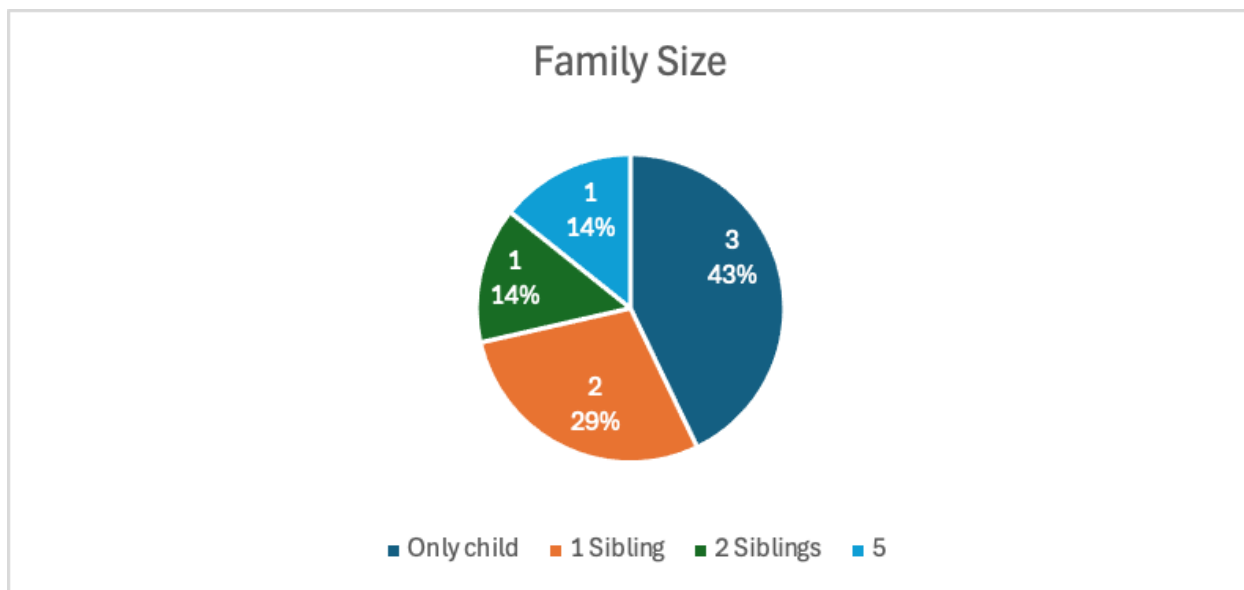


Siblings of learners

When it comes to family structure, many of the children do not have siblings and were raised as only children. A few live with one or two siblings, while one child came from a larger family with several brothers or sisters.

Figure 8

Siblings of learners

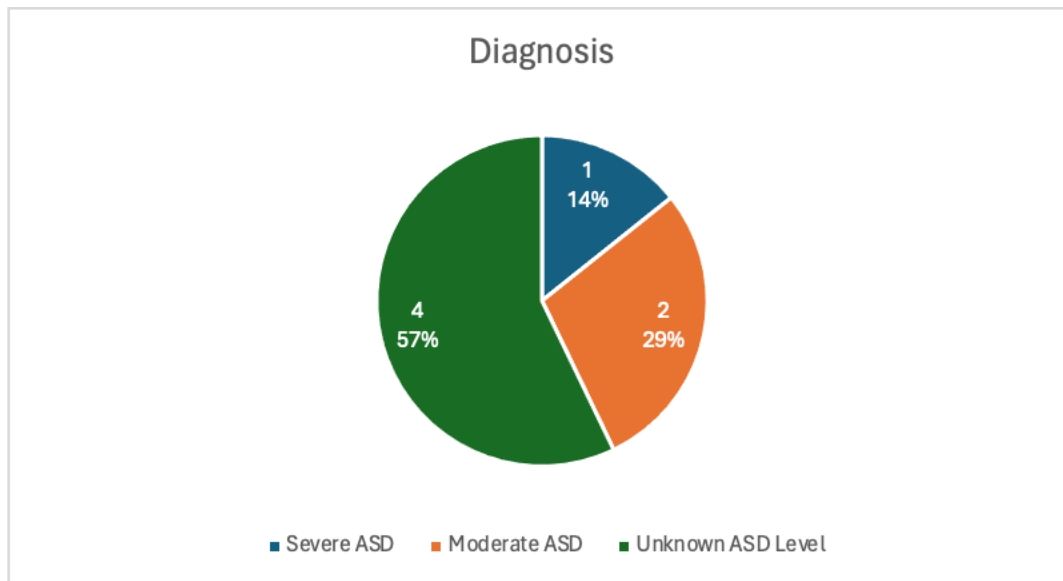


Diagnosis of learners

Some parents reported not having received a formal diagnosis for their child. Others reported that their child had been diagnosed with moderate autism, and one parent described their child as having severe autism. These responses suggested that formal assessment is not always accessible or prioritized, even when developmentally needed.

Figure 9

Diagnosis of learners

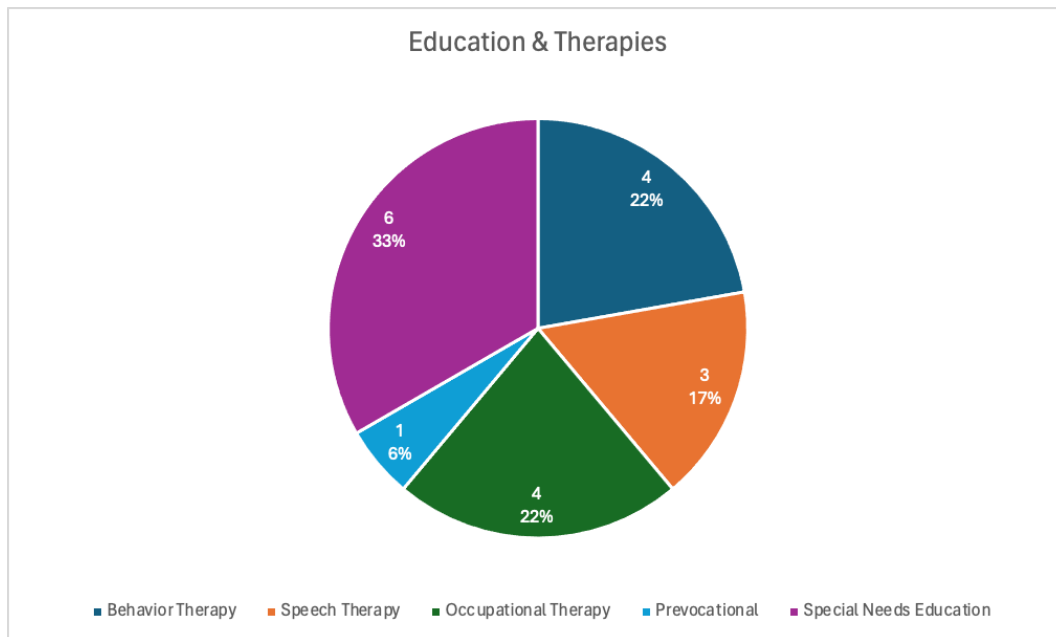


Education and therapies for learners

In terms of education and therapy, most of the children attended special education classes in a public school. For families with greater financial resources, learners received therapies, particularly occupational and behavioral therapy, which parents paid out of pocket. A few children were also attending speech therapy sessions, and one child was enrolled in a program focused on pre-vocational skills. This variety in educational and therapeutic experiences reflected how families navigated available resources, balancing their child's needs with what was accessible and affordable.

Figure 10

Education and therapies for learners



Capabilities of learners.

The learners involved in this study demonstrated a wide range of emerging capabilities across creative, physical, cognitive, self-help, and communication domains. These capabilities reflected their individual interests, learning profiles, and areas of developmental strength, offering insight into how life skills education could be designed to build upon what each child was already able to do.

In terms of creative skills, several learners showed interest and ability in expressive and tactile activities. Ann, Ken, Greg, and Chris enjoyed drawing and coloring. At the same time, a broader group, including Reg, Roy, Anthony, Alfie, and Greg, engaged in clay molding and crafting, indicating a strong inclination toward hands-on creativity. Rex, who is the father of Reg and Roy, said: *“They love playing with clay and robots, although we limit clay play since it can be messy”*. Similarly, activities involving construction, such as building with Legos, were

avored by Reg, Roy, Alfie, and Greg. Music and performing were also favorite activities among learners, particularly Reg, Roy, Ken, and Chris, who have developed a skill in singing and dancing. Edward, Ken's father, said: *“He sings his favorite parts of songs, like We Built This City and Livin' on a Prayer by Bon Jovi. If he likes a song, he keeps repeating it.”* Aside for music, other learners such as Chris, were fond of digital arts, and often use built-in computer applications for drawing and picture editing; which suggested emerging digital literacy and visual communication skills.

The learners also displayed diverse, expressive physical and motor skills that reflected their energy and interests. Ann and Alfie enjoyed active outdoor movement such as running and chasing, while Anthony showed skills in both biking and basketball. Ken, Anthony, and Alfie could swim, and Ken could also skateboard. Fine motor coordination was observed in Alfie's ability to stack toys and blocks, indicating focus and control.

In the area of cognitive and problem-solving skills, learners demonstrated abilities that supported foundational academic and life skills. Ann and Anthony showed interest in puzzle-solving, while Alfie demonstrated memorization skills. Greg exhibited competence in tracing, cutting, and designing activities that required planning and precision. Anthony was also able to follow instructions, which is a crucial cognitive skill tied to task completion and adaptability.

The learners had also begun to acquire essential daily living and self-help skills, showing progress in areas critical for independence. Ann and Alfie achieved toileting, while Ann, Reg, Roy, and Alfie practiced dressing up. Bathing was part of the routine of Ann, Reg, Roy, and Anthony; while eating independently was regularly practiced by Ann and Anthony. Several children, Ann, Anthony, Ken, and Alfie, were introduced to cooking. Ken, who practiced

cleaning and household chores in particular, demonstrated further independence by preparing his own meals and washing his own dishes.

In terms of communication and social skills, learners used a variety of strategies to interact with others. Anthony used hand gestures to express his needs, a common nonverbal communication method for children with limited verbal abilities. Alma, Anthony’s mother, said, *“He can follow simple instructions, and he can communicate through hand leading.”* On the other hand, Ken, Reg, and Roy used words and phrases to communicate. At the same time, Ann and Alfie often engaged in role-play, reflecting their ability to participate in imaginative, socially interactive scenarios.

The table below summarizes all children's capabilities, as reported by their parents, grouped by category. Most children have basic daily living and self-help skills, followed by creative skills and physical and motor skills. Children have the means to communicate using various modalities, and only a few demonstrated emerging social skills.

Table 7

Capabilities of learners

Category	Capabilities	Children
Creative skills	Drawing and coloring	Ann, Ken, Greg, Chris
	Clay molding and crafting	Ann, Reg, Roy, Anthony, Alfie, Greg
	Lego and building structures	Reg, Roy, Alfie, Greg
	Singing and music	Reg, Roy, Ken, Chris
	Dancing	Reg, Roy, Chris
	Digital arts and picture editing	Chris
Physical and motor skills	Running and chasing	Ann, Alfie
	Biking	Anthony
	Skateboarding	Ken
	Swimming	Ken, Anthony, Alfie
	Basketball	Anthony, Chris
	Stacking toys and blocks	Alfie

Cognitive and problem-solving skills	Puzzle-solving	Ann, Anthony
	Memorization	Alfie
	Tracing, cutting, and designing	Greg
	Following instructions	Anthony
Daily living and self-help skills	Toileting	Ann, Alfie
	Dressing up	Ann, Reg, Roy, Alfie
	Bathing	Ann, Reg, Roy, Anthony
	Eating on their own	Ann, Anthony
	Cooking and learning to cook	Ann, Anthony, Ken, Alfie
	Cleaning and household chores	Ann, Ken, Alfie
	Preparing own meals	Ken
	Washing own dishes	Ken
Communication and social skills	Expressing needs using hand leading	Anthony
	Words and phrases	Ken, Reg, Roy
	Engaging in role play	Ann, Alfie

Overall, this range of capabilities highlighted each child's individuality, strengths, and readiness for targeted support. These abilities can be utilized as a foundation for learning, to reinforce existing skills while gradually extending their developmental potential.

Interests of learners.

Learners' interests were identified to inform the development of reinforcement strategies and naturalistic interventions. Children have a wide range of interests, mostly creative in nature, related to physical and outdoor activities, toys and pretend play, video games and digital play, and watching TV and cartoons. Parents also encouraged their children to engage in cognitive and problem-solving games and activities, as well as sensory and relaxation activities to help them relax and calm down.

The children in this study demonstrated a diverse and vibrant range of interests, many of which reflected their unique personalities, developmental stages, and sensory preferences. These interests, as reported by their parents who acted as proxies in the research process, provided valuable insight into the kinds of activities that engaged and motivated them.

Several children showed strong creative inclinations. Drawing, coloring, and crafting with clay or building materials were common activities enjoyed by many, including Ann, Ken, Reg, Roy, Anthony, Alfie, Greg, and Chris. These activities offered outlets for self-expression and allowed the children to explore shapes, colors, and textures in ways that suited their individual abilities. Music also emerged as a prominent interest, with some children enjoying singing and dancing, often combining rhythm and movement in playful and joyful ways. Chris, in particular, had a notable interest in digital art and photo editing, suggesting an early appreciation for visual technology.

Physical and outdoor activities also held significant appeal. Children such as Ann, Alfie, and Anthony were drawn to running, swimming, and biking. For example, Anthony's mother said: *"He loves to go to the beach, he can stay in the pool for five hours straight. He likes to play on the sand"*. Playground activities, basketball, and skateboarding were other favorites that encouraged movement and supported the development of coordination and social interaction skills. These interests reflected a desire for exploration and sensory input that physical play typically provided.

Cognitive and problem-solving activities such as puzzle-solving, tracing, cutting, and stacking captured the attention of some learners, indicating emerging strengths in logical thinking and fine motor skills. Alfie displayed notable memorization abilities, while Greg was particularly drawn to design-related tasks. These interests reflected an inclination toward structured challenges and task completion.

Pretend play revealed the children's imaginative capacities. Dolls, robots, stuffed animals, and dramatic plays, such as pretending to be ghosts, were enjoyed by several learners. These forms of symbolic play served as a window into how they made sense of the world around them

and the roles they envisioned for themselves. Rex said: “*After meals, they usually play, often tinkering with their robots*”. Video games and digital play, particularly popular titles like Roblox, Minecraft, and basketball-themed games, offered digital spaces for creativity, sensory stimulation, and, at times, social engagement. Watching videos on platforms like YouTube and enjoying familiar TV shows and characters (such as Blippi or Jollibee) provided comfort and entertainment, with preferences often centered on vibrant visuals and catchy sounds.

Several children also exhibited a preference for sensory and relaxation activities. These included listening to calming music, watching ASMR or breathing videos, and exploring textures through playdough or Lego bricks. Such activities appeared to support emotional regulation, reduce anxiety, and provide comfort during overstimulating or stressful moments.

Table 8

Interests of learners

Category	Interests	Children
Creative interests	Drawing and coloring	Ann, Ken, Greg, Chris
	Clay molding and crafting	Ann, Reg, Roy, Anthony, Alfie, Greg
	Lego and building structures	Reg, Roy, Alfie, Greg
	Music and singing	Reg, Roy, Ken, Chris
	Dancing	Reg, Roy, Chris
	Digital arts and picture editing	Chris
Physical and outdoor activities	Running and chasing	Ann, Alfie
	Biking	Anthony
	Skateboarding	Ken
	Swinging and playing in the playground	Ann
	Swimming	Ken, Anthony, Alfie
	Basketball	Anthony, Chris
Cognitive and problem-solving interests	Puzzle-solving	Ann, Anthony
	Stacking toys and blocks	Alfie
	Tracing, cutting, and designing	Greg

	Memorization	Alfie
Pretend play and toys	Dolls and dollhouses	Ann
	Toy cars and robots	Reg, Roy, Greg, Ken
	Building robots	Reg, Roy
	Stuffed toys and babying play	Chris
	Pretending to be a ghost	Alfie
Video games and digital play	Roblox and Subway Surf	Ken
	Basketball mobile game	Anthony
	Minecraft and ASMR videos	Greg
Watching TV, cartoons and YouTube	Cartoons (Bluey, Gregby's Dollhouse, Peppa Pig, Minions, etc.)	Ann, Reg, Roy, Anthony, Alfie, Ken
	YouTube browsing and music videos	Chris, Greg
	Favorite personalities (Blippi, Jollibee, Raffy Tulfo, etc.)	Chris, Greg
Sensory and relaxation activities	Listening to music and sounds	Chris, Greg
	Watching calming videos (ASMR, breathing exercises, etc.)	Greg
	Exploring sensory textures (Lego, Playdough, etc.)	Alfie, Greg

Altogether, these interests can be leveraged to design learning activities and life skills interventions that align with what the children already find meaningful, enjoyable, and engaging.

Favorite games

The learners showed a diverse range of favorite games, reflecting their unique interests and developmental needs. To determine activities and games that can be used as part of the children's positive reinforcement during their learning, parents were asked to list all their children's favorite activities and games.

Many enjoyed physical activities, such as running and chasing, which were favorites for Ann and Alfie. Ann also liked swinging and playing hide-and-seek, while Anthony enjoyed biking and bowling, and Ken took pleasure in skateboarding. Basketball was popular with Anthony and Chris, encouraging teamwork and coordination.

Building and stacking games captivated several children, with Reg, Roy, Greg, and Alfie showing enthusiasm for playing with Lego and building robots. Alfie also enjoyed stacking toys and blocks, which likely helped develop fine motor skills and spatial awareness.

Pretend play was another area of interest, with Ann engaging in doll and dollhouse play, while Reg, Roy, Ken, and Greg preferred cars and other toy vehicles. Chris enjoyed babying a stuffed toy, and Alfie expressed creativity by pretending to be a ghost, highlighting the imaginative play that supports social and emotional growth.

Puzzle and strategy games attracted learners like Ann and Anthony, who enjoyed working on puzzles, while Alfie liked memory games such as “what’s missing.” Greg showed interest in Jenga, a game that challenges problem-solving and hand-eye coordination.

Digital and mobile games also featured prominently, especially for Ken and Greg. Ken enjoyed popular games like Roblox and Subway Surfer, while Greg was fond of Minecraft, ASMR videos, sensory-play apps, and mobile basketball games, integrating technology into their play.

Sensory and interactive games engaged Greg and Chris, with Greg playing therapy ball games and Chris enjoying interactive family games like “teddy bear-teddy bear” and “I have two hands,” supporting sensory integration and social bonding.

Lastly, shopping and exploration games were favored by Greg, who enjoyed going to the store, taking variety walks, and participating in grocery store role play, reflecting real-world learning opportunities through play.

Table 9*Favorite games of learners*

Category	Games	Children
Physical games	Running and chasing	Ann, Alfie
	Swinging	Ann
	Hide and seek	Ann
	Biking	Anthony
	Skateboarding	Ken
	Bowling	Anthony
	Basketball	Anthony, Chris
Building and stacking games	Playing with Lego and building robots	Reg, Roy, Greg, Alfie
	Stacking toys and blocks	Alfie
Pretend play games	Playing with dolls and dollhouses	Ann
	Playing with cars and toy vehicles	Reg, Roy, Ken, Greg
	Stuffed toy babying	Chris
	Pretending to be a ghost	Alfie
Puzzle and strategy games	Playing with puzzles	Ann, Anthony
	Playing “what’s missing” (memory game)	Alfie
	Jenga	Greg
Digital and mobile games	Roblox	Ken
	Subway Surf	Ken
	Minecraft	Greg
	ASMR videos and sensory play apps	Greg
	Mobile basketball game	Anthony
Sensory and interactive games	Therapy ball game	Greg
	Interactive family games (e.g., teddy bear-teddy bear, I have two hands)	Chris
Shopping and exploration games	Going to the store and variety walks	Greg
	Grocery store role play	Greg

Together, these varied game preferences demonstrated how the learners engaged with play that supported their physical, cognitive, social, and emotional development, and how these games can also be effectively used as part of positive reinforcement strategies to encourage desired behaviors and skills.

Favorite foods

To support positive reinforcement strategies effectively, the learners' favorite foods were identified and categorized. Many of the children showed a strong preference for protein and meat dishes such as fried chicken, burger patties, hot dogs, and nuggets. These protein-rich foods, enjoyed by Ann, Reg, Roy, Anthony, Alfie, Ken, Greg, and Chris, were important for growth and development during childhood, providing essential amino acids for brain function and muscle development. However, some of these options, especially fried and processed meats, were less nutritious if consumed frequently and needed to be balanced with healthier alternatives. Pasta and noodle dishes like spaghetti, carbonara, pancit canton, sotanghon, and Korean noodles were also popular among Ann, Reg, Roy, Anthony, Ken, and Greg. While these carbohydrate-rich meals provided much-needed energy for active children, they were often high in refined carbohydrates and fats, requiring moderation to maintain a balanced diet.

Traditional rice-based and Filipino dishes, such as beef nilaga, sinigang, lugaw, arroz caldo, tilapia, and galunggong, favored by Anthony, Ken, and Chris, tended to offer more balanced nutrition through a mix of protein, vegetables, and carbohydrates. These culturally familiar meals were both comforting and nourishing, which was particularly meaningful for children with autism who often benefited from routine and familiar sensory experiences during mealtimes.

Vegetables and healthy options, though less commonly selected, included pumpkin, a nutrient-dense choice rich in vitamins and fiber, which Ann particularly enjoyed. Including such options was critical given that many children with autism had restricted diets or sensory sensitivities that limited their acceptance of diverse foods.

Bread and baked goods, including bread, tuna sandwiches, pizza, and chocolate cake, were liked by Reg, Roy, Greg, and Chris. While these foods provided quick energy and enjoyment, they were also high in sugar and fat, so their consumption needed to be balanced with more nutrient-dense choices.

Snack and finger foods such as French fries, eggs, sliced apples, matcha treats, and seaweed appealed to Ann, Alfie, Greg, and Chris. These foods ranged widely in nutritional value, from nutrient-rich eggs and apples to less nutritious fried items like French fries. For children with autism, who often had selective eating habits, offering a variety of textures and flavors in snacks helped gradually expand their diets.

Ken, Greg, and Chris favored beverages such as iced tea, hot chocolate, and Nestea juice. While these drinks were enjoyable, they often contained added sugars, which needed to be moderated to support overall health.

Table 10

Favorite food of learners

Category	Favorite Foods	Children
Protein and meat dishes	Fried chicken, chicken, burger patties, hotdog, nuggets	Ann, Reg, Roy, Anthony, Alfie, Ken, Greg, Chris
Pasta and noodles	Spaghetti, Carbonara, Pancit Canton, Sotanghon, Korean Noodles	Ann, Reg, Roy, Anthony, Ken, Greg
Rice and Filipino dishes	Rice, Beef Nilaga, Sinigang, Lugaw, Arroz Caldo, Tilapia, Galunggong	Anthony, Ken, Chris
Vegetables and healthy options	Pumpkin	Ann
Bread and baked goods	Bread, Tuna Sandwich, Pizza, Chocolate Cake	Reg, Roy, Greg, Chris
Snacks and finger foods	French Fries, Egg, Sliced Apples, Matcha Treats, Seaweed	Ann, Alfie, Greg, Chris
Beverages and drinks	Iced Tea, Hot Chocolate, Nestea Juice	Ken, Greg, Chris

Considering the unique sensory preferences and feeding challenges common among children with autism, this detailed understanding of favorite foods helped caregivers and educators select appropriate reinforcers that were both motivating and nutritionally supportive. Incorporating more wholesome options alongside preferred treats encouraged healthier eating habits, supported developmental needs, and maintained the children's engagement in learning activities.

Favorite cartoons and personalities

To further support positive reinforcement strategies, the learners' favorite cartoons and personalities were identified, recognizing that these preferences could be powerful motivators. Each child showed distinct interests, which were grouped into several categories.

Among the learners, superheroes and action-themed characters like Spiderman and Superman were favorites for Reg and Roy, highlighting an affinity for adventurous and heroic figures. Animal and fantasy shows such as Bluey, Gregby's Dollhouse, and My Little Pony appealed to Ann, Reg, and Roy, indicating a fondness for imaginative and friendly animal characters. For younger learners focused on early education, preschool, and learning shows like Cocomelon, Ms. Rachel, and Blippi, Anthony and Greg preferred these shows, demonstrating engagement with content designed to teach foundational skills.

Classic cartoons and comedy series, including Mickey and Friends, SpongeBob, Minions, and We Bare Bears, were enjoyed by Ann and Ken, suggesting an appreciation for humor and familiar animated personalities.

Adventure and vehicle-themed shows such as Lightning McQueen, Thomas and Friends, and Tayo the Bus attracted Alfie and Greg, reflecting interests in travel, movement, and

exploration. Additionally, animated and digital characters such as Angry Birds, 10 Indians, and Dino the Dinosaur captivated Anthony and Alfie, illustrating their engagement with digital and game-related media.

Lastly, some learners, notably Chris, showed preferences for TV personalities and hosts such as Raffy Tulfo, Willie Revillame, Amy Perez, and Kris Aquino, indicating an interest in popular figures known for their distinct personalities and media presence.

Table 11

Favorite cartoons and personalities of learners

Category	Favorite Cartoons and Personalities	Children
Superheroes and action	Spiderman, Superman	Reg, Roy
Animal and fantasy	Bluey, Gregby's Dollhouse, My Little Pony, Cocomelon, Blippi, Angry Birds, 10 Indians, Dino the Dinosaur, Mickey and Friends, Spongebob, Minions, We Bare Bears	Ann, Reg, Roy, Ken, Greg, Alfie
Vehicles and adventure	Lightning McQueen, Thomas and Friends, Tayo the Bus	Alfie, Greg
TV personalities and hosts	Miss Rachel, Raffy Tulfo, Willie Revillame, Amy Perez, Kris Aquino	Chris, Anthony

These varied preferences provide valuable insights for tailoring positive reinforcement approaches, enabling caregivers and educators to use each child's favorite cartoons and personalities as effective motivational tools.

Needs and challenges of learners.

The needs and challenges of each child were identified to determine the areas requiring the most support. Parents reported that emotional and behavioral difficulties were the primary challenges their children faced. For instance, Rose Ann's mother said, *"The challenge that I face is her behavior. She cannot control her madness. My family and I are more patient to understand*

her.” Similarly, Rex, the father of Reg and Roy, said: *“They’re very particular; if they want something, they want it immediately. They have frequent tantrums, and calming them down can be difficult. We have to keep our promises; otherwise, they will get disappointed”*. These were followed by challenges related to daily living and self-help skills, highlighting the importance of fostering practical independence. For example, Rex said, *“Bathing is the most challenging. They tend to push each other and are hyperactive”*.

Cognitive and attention difficulties were also prevalent. Some children, such as Ann and Anthony, had difficulty improving sitting tolerance, while Ken and Greg found it difficult to sustain focus and attention. For instance, Joy, who is Greg’s mother, said: *“This is the biggest challenge. When we stopped his therapy sessions, he regressed and wouldn’t focus on table activities”*. Several learners, including Alfie, Anthony, and Ken, had trouble with tasks, indicating the need for structured and scaffolded learning approaches tailored to their cognitive processing abilities.

Communication and social interaction also presented additional challenges. Anthony experienced difficulties in expressing needs and emotions, while Greg is facing difficulty developing his language skills. On the other hand, Ken faced challenges in improving social interactions, indicating the necessity of targeted interventions to develop communication and social skills.

Most of the children face challenges in daily living and self-help. Ann and Alfie required assistance with toileting and hygiene. Dressing independently was a challenge for Ann, Reg, Roy, and Alfie, while bathing independently was difficult for Ann, Reg, Roy, and Anthony. For instance, Rex, the father of Reg and Roy, said: *“Bathing is the most challenging. They tend to push each other and are hyperactive”*.

Furthermore, Anthony and Chris needed support to eat properly and independently. While learning to cook and prepare meals was a challenge for Ann, Anthony, Ken, and Alfie. Cleaning and household chores also presented difficulties for Ann, Ken, and Alfie.

Emotional and behavioral challenges were commonly reported. Ann, Reg, Roy, Ken, and Greg had difficulties managing frustration and meltdowns. Tantrums were particularly notable in Reg and Roy, while Greg exhibited aggression and destructive behaviors, indicating a need for behavioral management strategies.

Sensory and food-related challenges included picky eating among Reg, Roy, and Chris, as well as sensory sensitivities, such as touch, experienced by Chris and Greg. These issues require careful consideration to create supportive and comfortable learning environments.

Safety and awareness challenges were identified in Alfie, who lacked a sense of danger and was prone to becoming lost easily, emphasizing the need for targeted safety interventions.

Finally, academic challenges were evident, with Anthony demonstrating difficulty following instructions, suggesting that clear, consistent learning support was necessary.

Table 12

Challenges of learners

Category	Needs and challenges	Children
Cognitive and attention challenges	Improving sitting tolerance	Ann, Anthony
	Improving focus and attention span	Ken, Greg
	Learning multi-step tasks	Alfie, Anthony, Ken
Communication and social challenges	Expressing needs and emotions	Anthony, Greg
	Improving social interactions	Ken
Daily living and self-help challenges	Toileting and hygiene	Ann, Alfie
	Dressing independently	Ann, Reg, Roy, Alfie
	Bathing independently	Ann, Reg, Roy, Anthony

	Eating properly and independently	Anthony, Chris
	Learning to cook and prepare meals	Ann, Anthony, Ken, Alfie
	Cleaning and household chores	Ann, Ken, Alfie
Emotional and behavioral challenges	Managing frustration and meltdowns	Ann, Reg, Roy, Ken, Greg
	Controlling tantrums	Reg, Roy
	Aggression and destructive behaviors	Greg
Sensory and food-related challenges	Picky eating	Reg, Roy, Chris
	Sensory sensitivities (sound, touch, etc.)	Chris, Greg
Safety and awareness challenges	Lacking a sense of danger	Alfie
	Getting lost easily	Alfie
Learning and academic challenges	Following instructions	Anthony
	Developing patience and perseverance	Ken

Overall, these diverse challenges highlighted the multifaceted support needs of learners with severe autism to promote their development in daily living, social interaction, emotional regulation, and academic skills.

Morning routine and needs

The morning routines of the learners were explored through their parents' observations, which could be beneficial to identify natural opportunities for embedding health-focused interventions in their day-to-day routines. Most children followed a structured sequence of activities to start their day, particularly those in special-needs classes. These routines typically included waking up early, personal hygiene, eating breakfast, and preparing for school. For instance, Ken and Alfie were noted to wake up early and begin their day promptly, while Alfie sometimes engaged in play immediately after waking. Meanwhile, children not enrolled in special-needs education had more flexible morning schedules. They often spent their time

watching TV, using phones, or accompanying parents on errands, such as morning walks or grocery trips.

Breakfast was an essential part of the morning routine for most learners, with children such as Ann, Reg, Roy, Anthony, Ken, Greg, and Chris starting their day with them. Ken even showed some independence by preparing his own meal. Hygiene practices varied among the children: Ann, Reg, Roy, Ken, and Anthony regularly took baths or showers, while Chris focused on brushing teeth and washing the face, and Anthony also managed toileting and drinking water.

School preparation was another common aspect, involving activities such as dressing for school and getting ready to leave, which were mainly carried out by Ann, Ken, Anthony, and Alfie. Several children, including Ann, Reg, Roy, Anthony, and Alfie, were observed attending school as part of their morning routine. Beyond these necessary tasks, some children engaged in cognitive and creative activities, such as Ken drawing or pursuing artistic pursuits, and Ann reading books. Physical activity was also incorporated, with Greg often going for a morning walk to the store.

Table 13

Morning routine and needs of learners

Category	Morning Routine Activities	Children
Waking up and morning activities	Waking up early and starting the day	Ken, Alfie
	Playing immediately after waking up	Alfie
	Watching TV or using a phone	Ken, Chris
Preparing meals and breakfast	Having breakfast	Ann, Reg, Roy, Anthony, Ken, Greg, Chris
	Preparing own meal before eating	Ken

Hygiene and grooming	Taking a bath/shower	Ann, Reg, Roy, Ken, Anthony
	Brushing teeth and washing face	Chris
	Going to the toilet and drinking water	Anthony
Preparing for school	Getting dressed for school	Ann, Ken, Anthony, Alfie
	Preparing for school	Alfie
	Going to school	Ann, Reg, Roy, Anthony, Alfie
Cognitive and creative activities	Drawing or engaging in artistic activities	Ken
	Reading books	Ann
Physical activities	Going for a morning walk to the store	Greg

Overall, the morning routines reflected both structured and flexible elements tailored to each child's schooling and individual preferences, highlighting areas where health and life skills interventions could be integrated seamlessly.

Afternoon routines and needs

The children's afternoon routines were generally more relaxed than the structured activities earlier in the day, allowing them ample time to engage in play and leisure immediately after lunch. Most children participated in having lunch together, with Anthony demonstrating the ability to eat independently. Playtime was a significant part of their afternoons and took various forms: Ann, Reg, and Roy often played with siblings or family members, while many children enjoyed playing with toys such as cars, dolls, and robots. Outdoor play was also common, especially for Ann and Alfie, who engaged in activities like running, swinging, and chasing.

Some children preferred screen time in the afternoon, with Ken and Greg watching TV or YouTube, while others, like Anthony, Greg, and Ken, played mobile games. Hygiene routines

such as bathing or showering were part of the afternoon schedule for Ann, Reg, and Roy, and a few children, including Reg, Roy, and Ken, took naps.

Therapeutic and learning activities were integrated into the afternoon routine for some learners. Alfie attended therapy sessions, while Greg participated in table activities to enhance focus and skills development. Additionally, Greg was involved in errands, such as walking to the variety store and grocery shopping, multiple times a week, indicating some participation in family routines outside the home.

Table 14

Afternoon routine and needs of learners

Category	Afternoon Routine Activities	Children
Lunch	Having lunch	Ann, Reg, Roy, Anthony, Ken
	Eating lunch on their own	Anthony
Play and leisure activities	Playing with siblings or family members	Ann, Reg, Roy
	Playing with toys (cars, dolls, robots, etc.)	Ann, Reg, Roy, Greg
	Outdoor play (running, swinging, chasing)	Ann, Alfie
	Playing mobile games	Anthony, Greg, Ken
	Watching TV or YouTube	Ken, Greg
Shower and taking a nap	Taking a bath/shower	Ann, Reg, Roy
	Taking a nap	Reg, Roy, Ken
Learning and therapy	Attending therapy sessions	Alfie
	Doing table activities	Greg
Errands and outdoor activities	Walking to the variety store	Greg
	Grocery shopping (3x a week)	Greg

Overall, the afternoon routines reflected a balance of rest, play, learning, and family involvement tailored to each individual's needs.

Evening routines and needs

Evenings for the learners generally revolved around winding down after the day, focusing on dinner, relaxation, and preparing for sleep. Most children had dinner as a central part of their evening, with Ann, Reg, Roy, Anthony, Ken, Greg, Alfie, and Chris regularly eating together. Alfie sometimes ate dinner again when a parent arrived home, highlighting the importance of family presence in the routine.

Relaxation and play remained important, with several children, notably Ann, Ken, Greg, and Chris, engaging in activities such as watching TV or YouTube. Playtime also included more tactile or interactive experiences, such as Greg and Alfie playing with toys, Ken and Greg enjoying mobile games, and Anthony spending time with pets, specifically cats. These varied activities catered to the children's need for both stimulation and comfort in the evening.

Learning activities were less frequent but still present, with Ann dedicating time to school assignments in the evening. The transition to bedtime was marked by a range of preparatory habits: Reg and Roy prepared their beds, Chris practiced brushing his teeth and washing his face, and Greg listened to calming sounds to ease into sleep. Alfie actively prepared for sleep, though some children, including Alfie, Greg, and Chris, tended to go to bed late, often after 10:30 PM to midnight.

Table 15

Evening routine and of learners

Category	Evening Routine Activities	Children
Dinner and evening snacks	Having dinner	Ann, Reg, Roy, Anthony, Ken, Greg, Alfie, Chris
	Eating dinner again when a parent arrives	Alfie
Relaxation and play	Watching TV or YouTube	Ann, Ken, Greg, Chris
	Playing with toys	Greg, Alfie
	Playing with mobile games	Ken, Greg

	Playing with pets (cats)	Anthony
Learning	Doing school assignments	Ann
Bedtime preparation	Preparing the bed	Reg, Roy
	Brushing teeth and washing face	Chris
	Listening to calming sounds before bed	Greg
	Getting ready for sleep	Alfie
	Sleeping late (after 10:30-12:00 AM)	Alfie, Greg, Chris

Overall, the evening routines illustrated a balance of nourishment, relaxation, play, and learning, all framed by personalized habits that helped each child move smoothly toward rest, while also reflecting family dynamics and individual preferences.

Findings from workstream 3: Iterative design and development

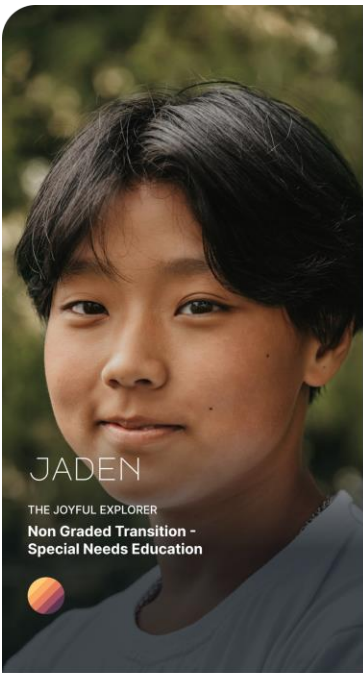
Based on the capabilities, interests, needs, and challenges identified in the qualitative survey and parent interviews, the user persona of a learner with autism was updated.

Updated user persona of learners

The updated persona integrated key aspects of the background, behavior, routines, challenges, and capabilities of factual learners who participated in the study, as reported by their parents. This comprehensive user persona was developed to represent learners' experiences and was instrumental in guiding and refining subsequent designs for the digital health solution.

Figure 11

Updated learner user persona



JADEN
THE JOYFUL EXPLORER
Non Graded Transition -
Special Needs Education

PERSONALITY

CURIOUS PLAYFUL PERSISTENT

SENSITIVE ROUTINE ORIENTED

AFFECTIONATE

INTERESTS

CREATIVE ACTIVITIES SENSORY PLAY

TECHNOLOGY OUTDOOR EXPLORATION

MUSIC

FAVORITE GAMES

PUZZLES INTERACTIVE APPS

WATER PLAY BUILDING BLOCKS

PHYSICAL GAMES HIDE & SEEK

FAVORITE FOOD

SNACKS COMFORT FOOD

TREATS SOFT & SMOOTH FOODS

REJECTS STRONG FLAVORED OR TEXTURED FOOD

FAVORITE CARTOON CHARACTERS



Bluey



Spongebob



Cocomelon



Spiderman



Paw Patrol



Sesame Street

Jaden Miguel Santos

Age: 7 **Education:** SNED, Occupational & Speech Therapy

Diagnosis: Severe Autism **Location:** Quezon City, Philippines

Background

Jaden is a creative, active, and curious child who enjoyed activities like drawing, building with LEGO, and imaginative play. Despite challenges with sitting tolerance, managing meltdowns, and communication, Jaden was progressing steadily in acquiring life skills such as toileting, dressing, and following instructions. His support network included teachers, therapists, and his family, who were integral to his developmental journey.

Behavior & Habits

Daily Routine:

Morning:

- Wakes up early and plays with clay, draw, or watch cartoons before starting his day.
- Eats breakfast and prepares for school with support from his mom.
- Attends a class for children with special needs, within a publicly funded school

Afternoon:

- After lunch, he watches his favorite cartoon show, and then takes a nap.
- Upon waking up, he engages in structured tasks such as playing with lego and drawing; or practice daily living skills, like preparing his afternoon snack.
- During weekends, his father takes him out to enjoy outdoor play like running, swinging, or biking.

Evening:

- Once his father gets home, he eats his dinner with family, watches TV, and completes any simple schoolwork or practice tasks.
- He then prepares for bed with assistance of his mother and falls asleep while listening to calming music or favorite stories.

Social Interaction:

- Prefers structured interactions with close family members and teachers.
- Finds comfort in predictable routines and visual cues.
- Challenges include limited verbal communication and difficulty understanding social cues, though non-verbal methods like hand leading or picture exchange communication system are effective.

Pain Points & Frustrations

- Low tolerance for frustration leading to meltdowns or shouting.
- Difficulty with transitions between activities or unfamiliar environments.
- Limited sitting tolerance, which impacts participation in longer activities.
- Picky eating and aversions to certain textures or foods.
- Challenges in recognizing danger or navigating unfamiliar spaces independently.

Needs & Goals

Short-Term Needs:

- Tools to regulate emotions, such as calming exercises or sensory-friendly activities.
- Visual schedules to provide structure and predictability.
- Interactive tools for learning self-care tasks like dressing and bathing.

Long-Term Goals:

- Improved independence in daily living skills, such as cooking, cleaning, and managing personal hygiene.
- Enhanced communication skills, using speech or augmentative communication tools.
- Greater ability to manage frustration and adapt to new situations.

Main Motivations

- Enjoyment of engaging activities like drawing, building, and imaginative play.
- Positive reinforcement through gamified rewards, cheering characters, or stickers.
- Connection with favorite characters from cartoons or shows, which spark joy and motivation to learn.
- A desire for security and comfort found in familiar routines, people, and environments.

Key Insights

- Thrives with visual supports, such as step-by-step guides, social stories, or video modeling.
- Gamified learning and task completion, incorporating his favorite characters or themes, is highly effective.
- Parent and teacher collaboration is essential to ensure consistency across home and school environments.
- Emotional regulation tools, like breathing exercises or calming music, help reduce meltdowns and improve focus.
- Digital interventions, tailored to interests, can make learning and skill acquisition more engaging and sustainable.

Jaden Miguel Santos is a vibrant and imaginative 7-year-old boy from Quezon City, Philippines, who is currently enrolled in a special needs education class and receives occupational and speech therapy to support his development. Diagnosed with severe autism, Jaden navigated daily life with curiosity and creativity, finding joy in drawing, building with LEGO, and engaging in imaginative play. Despite facing challenges with sitting tolerance, emotional regulation, and communication, he was steadily making progress in acquiring essential life skills such as toileting, dressing, and following instructions.

Jaden's daily routine reflected a balance of structured activities and play that catered to his needs and interests. Mornings often begin early with calming, preferred activities like clay modeling, drawing, or watching his favorite cartoons, including Bluey, SpongeBob, Cocomelon, Spider-Man, Paw Patrol, and Sesame Street. With the support of his family, teachers, and therapists, he prepared for school or therapy sessions, during which he worked on communication and daily living skills. Afternoons offer opportunities for outdoor play, running, swinging, biking, and quieter, structured tasks such as puzzles and building blocks. Evenings were spent with his family enjoying dinner, watching TV, and completing simple homework or practice tasks before bedtime, when he finds comfort in calming music or stories.

Socially, Jaden preferred predictable and structured interactions primarily with close family members and familiar therapists. He benefited greatly from visual supports such as step-by-step guides, social stories, and the picture exchange communication system to communicate his needs and understand his environment. He experienced frustration due to limited verbal skills and difficulty with transitions, which sometimes led to outbursts or shouting. His limited tolerance for sitting and challenges with sensory sensitivities, especially with certain food textures and strong flavors, require thoughtful accommodations.

Jaden thrived when provided with consistent routines, visual schedules, and interactive, gamified learning tools that incorporate his favorite characters and themes. These digital and sensory-friendly interventions helped him regulate emotions, maintain focus, and stay motivated. His short-term needs focused on tools for emotional regulation and learning self-care tasks. At the same time, his long-term goals emphasize independence in daily living, improved communication, and better adaptation to new situations.

The collaboration among Jaden's family, teachers, and therapists was vital in creating a cohesive, supportive environment that fosters his growth and nurtures his affectionate, sensitive personality. Through a combination of creative activities, sensory play, technology, and outdoor exploration, Jaden continues his journey as a joyful explorer, making steady strides towards greater independence and well-being.

RQ 2: What are the challenges and needs of parents and teachers in teaching life skills to learners with moderate to severe ASD

To determine the needs and challenges of parents and teachers, the same workstreams were executed using an incremental and iterative approach. The first workstream conducted preliminary design ideation through a literature review, while the second workstream focused on primary data collection via qualitative surveys and interviews. The third workstream synthesized both secondary and primary data to develop parent and teacher user personas, which guided the ideation of features, processes, and designs for a digital health solution to support the life skills development of learners with moderate to severe ASD autism.

Findings from workstream 1: literature review research and design thinking

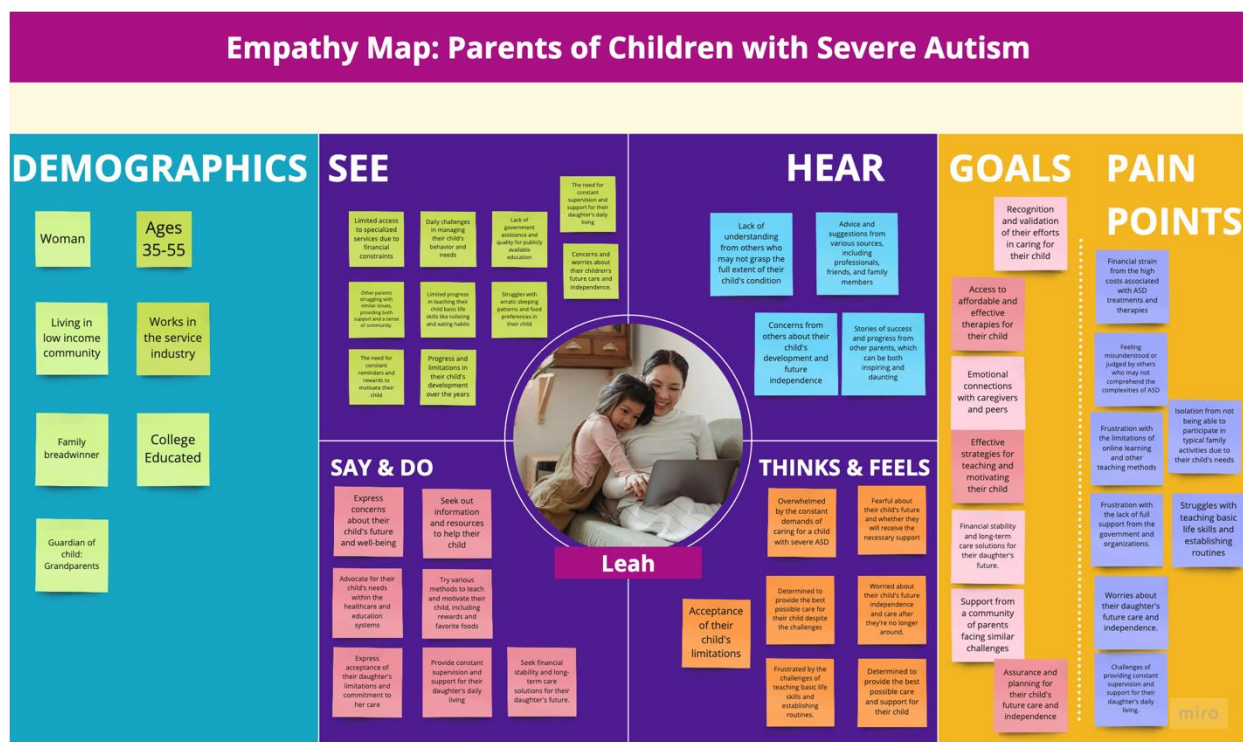
In the second workstream, parent challenges related to life skills development were informed by the literature review and presented as an empathy map and user persona, following the design thinking framework.

Empathy map of parents

The empathy map below shows what parents typically see, hear, think, feel, and say, as well as what they do. It also showed their goals, pain points, and demographics.

Figure 12

Parent empathy map



User persona of parents

From the empathy map, a user persona was created. The user persona below was used as a guide to envision and design a universal user interface and experience for parents of children,

and to determine the capabilities they would need to teach their child at home, track their progress, and collaborate with educators.

Figure 13

Parent user persona

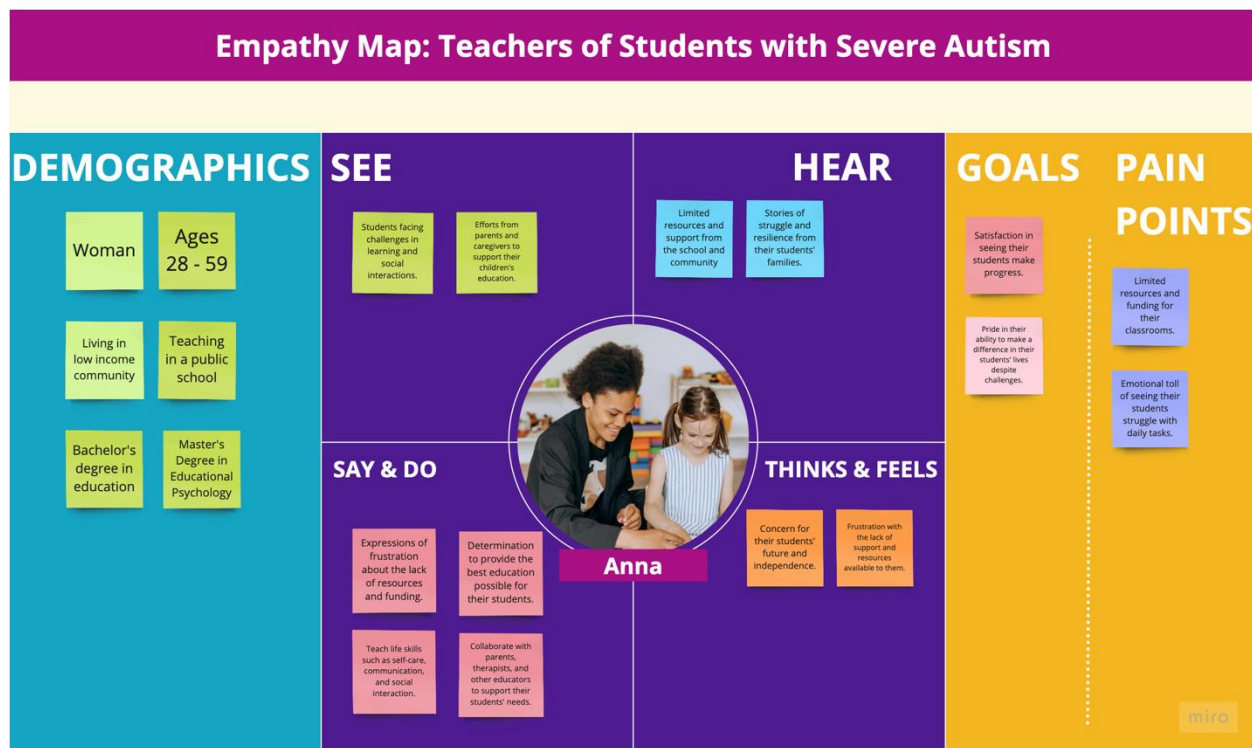
Parent Persona  Demographics Name: Leah Santos Age: 38 Occupation: Call Center Agent (Night Shift) Location: Quezon City, Philippines Background: Leah is a dedicated mother who works night shifts at a call center to provide for her family. She and her husband have one child, a son with severe autism. Leah's mother helps care for her son while she is at work. Demographics: • Female • Married with one child • Lives in a low-income community in Quezon City	Behaviors & Habits • Leah is patient and understanding with her son, recognizing the challenges he faces. • She strives to create a structured routine for her son, but finds it difficult due to her work schedule. • Leah often feels overwhelmed and exhausted, but remains determined to provide the best care for her son. • She seeks advice and information online about autism and parenting strategies.
Pain Points & Frustrations • Limited resources and support for children with autism in their community • Balancing work and caregiving responsibilities • Challenges in teaching her son basic life skills like toileting and eating independently • Limited time to spend with her son due to working night shifts • Balancing work and caregiving responsibilities • Inconsistent sleeping patterns for both herself and her son	Needs & Goals • Provide the best possible care and education for her son • Help her son develop essential life skills and independence • Ensure her son feels loved and supported
Parenting Style • Uses modelling and positive reinforcement to teach life skills • Struggles with consistency and replicating techniques used by professionals • Faces challenges in finding effective therapies and educational approaches for her son	Key Insights: • Recognizes the importance of patience and understanding in teaching children with autism • Struggles with the lack of support and resources available for her son's needs • Seeks guidance and information on how to best help her child learn and grow

Empathy map of teachers

The same ideation and design process was also applied to the teachers, resulting in an empathy map based on a literature review. The empathy map describes basic demographic information, what they typically see, hear, say, and do, along with what they think and feel. Their goals and pain points were also identified.

Figure 14

Teacher empathy map



User persona of teachers

Based on the empathy map, the initial user persona for the teacher was created, which served as the basis for user interface and experience design. The user persona below was also used to determine the capabilities needed to teach life skills to children using digital technology, teach parents how to continue their children's learning at home, and build ongoing communication with parents.

Figure 15

Teacher user persona

Teacher Persona  Demographics Name: Anna Cruz Age: 42 Occupation: SPED Teacher Location: Quezon City, Philippines Background: Mrs. Cruz is a dedicated special education teacher with over 15 years of experience working in public schools. She holds a Bachelor's degree in Special Education and is passionate about making a positive impact on the lives of her students. Anna lives in a modest neighborhood in Manila with her husband and two children.	Behaviors & Habits • Uses a variety of teaching methods, including visual aids, hands-on activities, and technology-assisted learning. • Implements positive reinforcement and individualized instruction plans. • Focuses on creating a structured and predictable classroom environment. • Collaborates with other teachers and specialists to develop effective teaching strategies.
Pain Points & Frustrations • Lack of adequate teaching materials and tools specific to special education. • Insufficient funding for classroom improvements and necessary equipment. • Heavy workload and administrative tasks that take time away from direct teaching. • Managing a diverse classroom with varying needs and abilities. • Difficulty in maintaining consistent routines and progress due to external factors such as family issues or lack of support at home.	Needs & Goals Primary Goals: • To help her students develop essential life skills and achieve greater independence. • Access to specialized teaching materials and tools tailored to the needs of students with severe autism. • Continuous professional development opportunities to stay updated with the latest special education strategies and techniques. • Access to a network of specialists, including therapists and psychologists, for collaborative problem-solving and support. • Reduction in administrative workload to allow more time for direct teaching and student interaction. • Effective communication channels with parents and caregivers to ensure consistency in teaching methods and reinforcement at home. • Workshops and resources for parents to better support their child's learning and development.
Main Motivations • Passion for teaching and making a difference in her students' lives. • Commitment to professional development and staying updated with the latest teaching strategies. • Desire to advocate for better resources and support for special education.	Key Insights: • Believes that empathy and patience are crucial in understanding and addressing the unique needs of each student. • Recognizes the importance of building strong relationships with students and their families. • Values collaboration with parents, caregivers, and other educators to provide a holistic support system for her students. • Understands that consistent communication and cooperation are essential for student progress.

Findings from Workstream 2: qualitative surveys and interviews

Similar to the approach used with children, qualitative surveys and interviews were conducted with parents and teachers, with a particular focus on their backgrounds, experiences, and challenges.

Parent demographics.

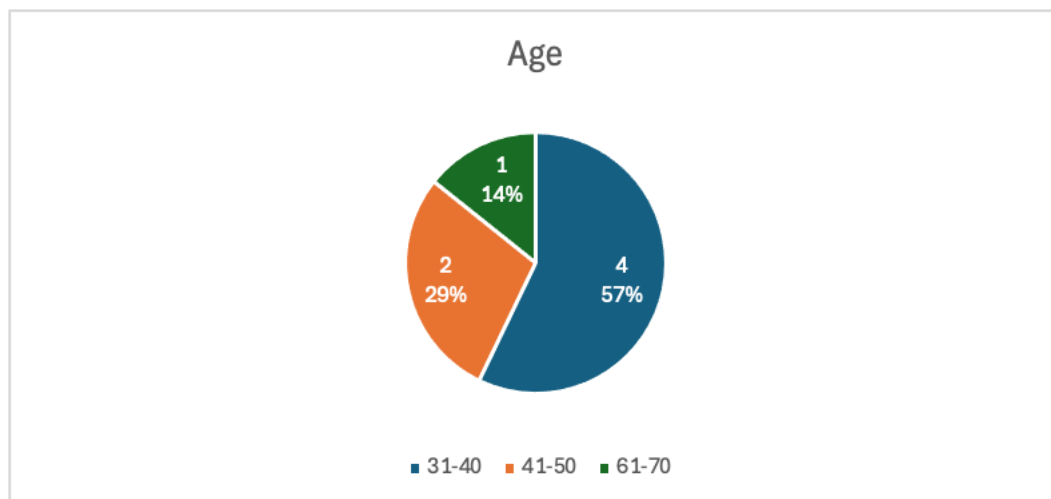
Understanding the demographic profile of primary caregivers provided context for interpreting their caregiving experiences, needs, and challenges in supporting children with autism. This section presented an overview of the age, marital status, educational attainment, professional background, and household income of participating parents.

Age of parents

The primary caregivers of children with autism in this study represent a diverse demographic profile. Most parents fell within the age range of 31 to 40 years old, indicating a relatively young-to-mid-aged group actively engaged in caregiving. A notable portion were in their 40s, with one caregiver identified as a senior, aged between 61 and 70 years, reflecting a broad age span among those responsible for daily care.

Figure 16

Age of parents

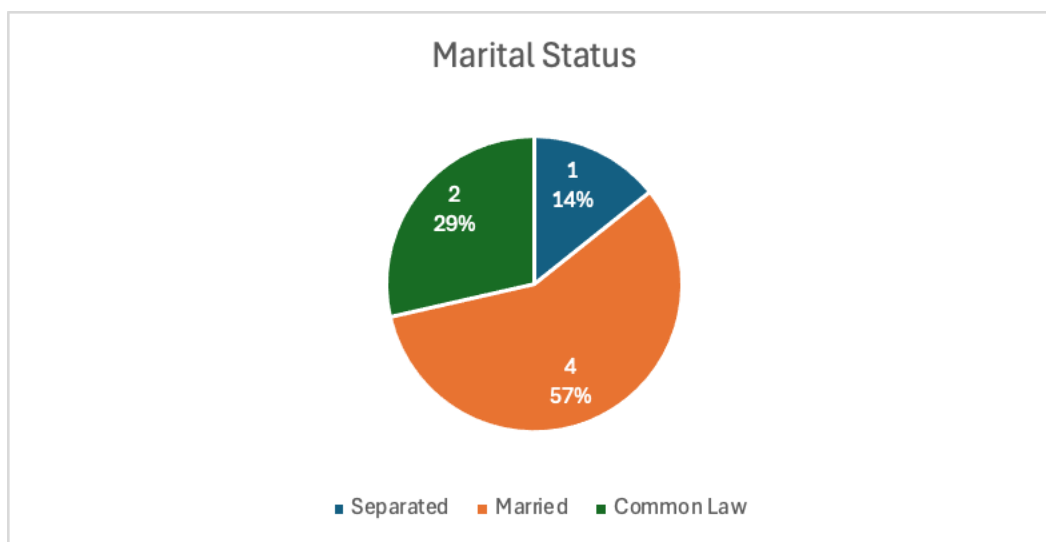


Marital status of parents

In terms of marital status, most primary caregivers were married, highlighting a traditional family structure in many cases. Additionally, two caregivers were in common-law relationships, and one was separated, highlighting some variation in family dynamics among participants.

Figure 17

Marital status of parents

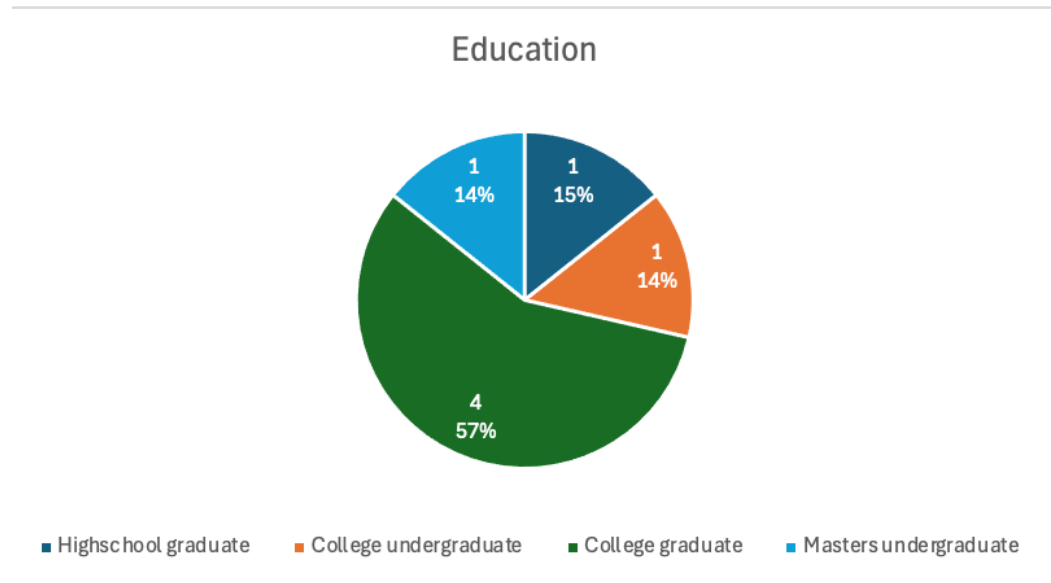


Educational attainment of parents

Regarding educational background, the majority of parents have completed college education, suggesting a generally high level of formal education among caregivers. However, there were instances of varied education and varying educational attainment: one parent had completed only high school, another had not completed a college degree, and one parent had pursued a master's degree but had not yet completed it.

Figure 18

Educational attainment of parents

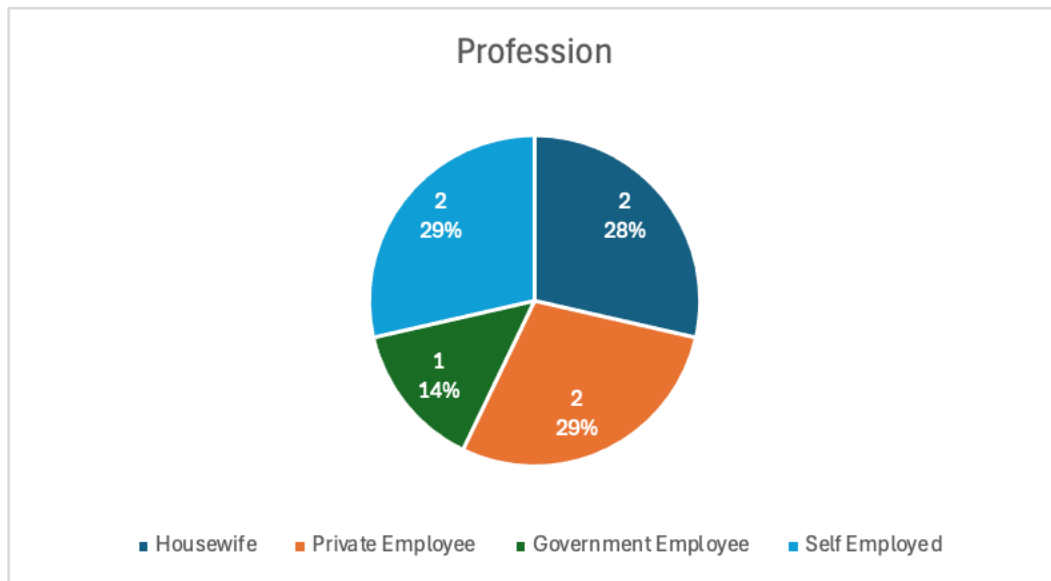


Profession of parents

The professions of these caregivers were diverse. Some work in the private sector, while others were self-employed or full-time homemakers, indicating a range of occupational roles and commitments. There was also representation from the local government workforce, demonstrating involvement across different employment sectors.

Figure 19

Parents' profession

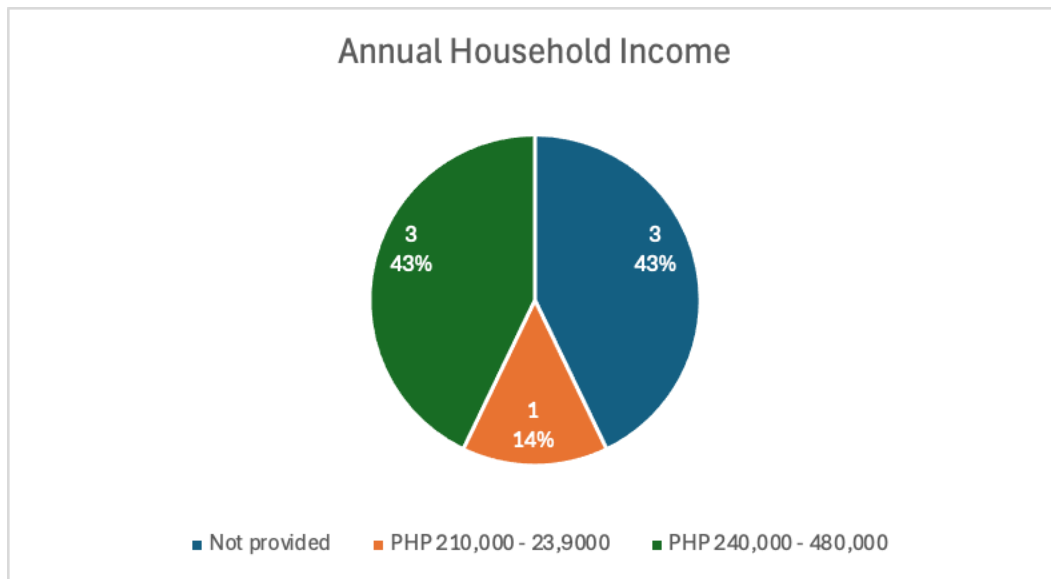


Annual household income

Household income varied among participants, with the average annual household income reported between CAD 6,000 and 12,000 (approximately PHP 240,000 and 480,000). This income range fell below the national average for Filipino households, and it was more closely aligned with the lower-income bracket, particularly in urban areas with significantly higher living costs.

Figure 20

Annual household income



Parenting styles.

Parenting approaches identified among the participants can be broadly categorized into three interconnected styles: nurturing and proactive, structured and routine-based, and interest-driven and adaptive. These styles reflected the parents' efforts to respond to their child's individual needs, maintain stability in daily life, and leverage personal interests as developmental opportunities. While unique circumstances shaped each parent's approach, these three styles offered insight into the diverse strategies used to support children with autism in home environments.

The nurturing and proactive parenting style revealed a deep commitment to understanding, supporting, and advocating for their children's unique needs. Lyane demonstrated a responsive, emotionally attuned approach, actively engaging with her son, Chris, and continuously adapting to his behaviors and preferences. Her involvement reflected a hands-on parenting style grounded in care and attentiveness. She said:

“My son taught himself to speak by breaking phone messages into song lyrics, with the aid of a computer mouse. He learns to do things by observing his dad and me. His teacher keeps on repeating words and explaining the concepts and meanings. He stores them in his mind. We would just be surprised when, one day, he would use the word appropriately. The key is acceptance and love. He grows in knowledge if he feels loved and accepted”.

Edward fostered independence in his child, Ken, by encouraging self-care routines such as cooking and hygiene, nurturing autonomy while remaining closely involved. His approach revealed both trust and support, empowering his child while maintaining a reassuring presence. Similarly, Rex emphasized shared responsibility, working collaboratively with his wife to maintain a balanced caregiving dynamic. His nurturing style was rooted in partnership and teamwork, ensuring that caregiving decisions are made with mutual understanding and emotional support.

Rose actively sought solutions and worked closely with the extended family to provide consistent care. Her efforts reflected a deep desire to meet her child’s needs, even in the face of behavioral challenges. She demonstrated emotional investment by remaining engaged and open to trying new approaches. Similarly, Donna managed the dual pressures of work and caregiving with perseverance, relying on her sister for support while staying involved and attentive to her child’s needs. Her ability to maintain emotional engagement amid competing responsibilities reveals a quiet but strong form of nurturing. Joy’s full-time dedication to her son’s development showed a profound emotional commitment. Her caregiving is defined by presence, sacrifice, and an unwavering focus on her child’s growth.

Amy, on the other hand, exemplified proactive parenting through her continuous search for evidence-based strategies and alignment between home and school practices. Her dedication to applying research to her daily routines highlights a thoughtful, intentional caregiving style.

Together, these parents exemplified diverse expressions of nurturing and proactive parenting, marked by emotional sensitivity, perseverance, and a continuous drive to support their children in ways that are grounded in love, knowledge, and advocacy.

Parents also believed that following a structured routine and being firm about adhering to it is essential for the learning of children with autism, as they thrive on performing a set of daily activities. A structured, routine-based style for them involves setting up a schedule of activities that children need to follow daily, and most parents strive to have their children follow it. For instance, Edward said:

“It’s essential to be consistent with the routines and instructions. Using simple, clear methods, such as video modeling or fun, interactive apps, could really make a difference. Just giving them the tools to succeed and helping them grow at their own pace is key.”

In terms of interest-driven and adaptive parenting, each parent tailored their approach to their child’s preferences, strengths, and evolving needs. Interest-driven and adaptive parenting style leverages students’ natural inclinations to teach them life skills, such as music, the arts, food, educational games, and travel. Lyane, for example, creatively incorporated Chris’s love for pop music and artistic expression into daily interactions, using these as motivating tools to keep him engaged and emotionally regulated. For instance, she said:

“He would benefit greatly from more outdoor activities that align with his interests and stimulate his senses in enjoyable ways. For instance, going to the mall provides

opportunities for social exposure, navigating public spaces, and practicing real-world routines in a familiar yet stimulating environment. Attending a music concert, especially one featuring pop music, which he genuinely enjoys, could be particularly meaningful for him. His natural response to music, such as dancing and showing excitement, indicates that musical settings are highly engaging and motivating.”

Edward also embraced his child’s interests, such as drawing and cooking, to foster autonomy and learning, seamlessly blending these preferred activities into his everyday routines. Rex took a practical and motivational approach by using outings and rewards as learning opportunities, recognizing that adaptive strategies rooted in positive reinforcement can be highly effective. Rose showed willingness to continuously adjust and experiment with new interventions as her child’s challenges shift, reflecting an open and responsive attitude toward evolving needs. Amy’s parenting style stood out for being both strategic and highly individualized; she customized her approaches to match her child’s developmental profile, aiming for meaningful progress through tailored support. Meanwhile, Donna demonstrated flexibility out of necessity, juggling work and caregiving demands means adapting her strategies in real time, often relying on support from her sister to implement changes. Joy, whose full-time caregiving role anchors her routine, engaged her son through interest-based play such as Lego building and sensory games, which serve both as developmental tools and as emotional connection points.

Collectively, these parents illustrated a spectrum of adaptive parenting practices that harnessed their children’s interests as entry points for learning, communication, and daily functioning, showing how attentiveness to personal preferences can create meaningful, individualized pathways to development. Some parents also adapted their parenting styles to

support the intervention or therapy that is being provided to their child. For instance, Edward said:

“What I’m saying is also based on what the doctor told us. When you have a child like that, you really need to study and understand them, almost like you have to master how they think and behave. But I’m not an expert; I do what I can, based on what I understand. I try to apply whatever makes sense for my child. Over time, it becomes more natural to understand children with autism”.

Across caregivers, behavioral management emerged as a central concern, with each parent approaching it based on their capacities, experiences, and available support. Most parents faced difficulty managing challenging behaviors such as tantrums, meltdowns, aggression, and other difficult behaviors arising from sensory sensitivities. For example, Ray said:

“They’re very particular;; if they want something, they want it immediately. They have frequent tantrums, and calming them down can be difficult. We have to keep our promises; otherwise, they will be disappointed”.

Lyane took a sensory-aware approach, carefully managing Chris’s environment by minimizing exposure to triggers like bright lights and loud noises. Similarly, Edward emphasized maintaining calm settings to prevent meltdowns, using Ken’s interest in drawing and cooking to redirect attention when needed. Rex demonstrated a more adaptive style, working with his wife to balance caregiving and adjust routines to manage tantrums better. Rose, despite being collaborative and open to trying new interventions, continued to face difficulties with her child’s self-regulation and behavioral challenges, reflecting the ongoing complexities of managing autism-related behaviors at home. Amy, on the other hand, leaned on evidence-based strategies

and ensured consistency across school and home settings, taking on behavioral management largely on her own. Donna's situation revealed the strain of managing behavior while juggling work. However, with her sister's help, she maintains structure; she still expresses a need for support in consistently monitoring and managing behaviors cohesively. Joy, who was deeply committed to her son's development, struggled with managing aggression and emotional regulation, often facing these challenges alone due to her full-time caregiving responsibilities. These varied experiences emphasized the need for tailored behavioral supports that align with each family's context, capabilities, and emotional bandwidth.

Table 16

Parenting styles

Parent name	Nurturing and proactive	Structured and routine-based	Interest-driven and adaptive
Lyane	Actively engaged and adapted to Chris's needs	Adjusted routines based on mood	Used Chris's love for pop music and creative activities
Edward	Encouraged Ken's autonomy in cooking and hygiene	Firm and consistent in routines	Used Ken's interests (drawing, cooking)
Rex	Collaborative with his wife for balanced caregiving	Relied on structured routines	Used outings and rewards to encourage learning
Rose	Sought solutions and collaborated with family	Ensured consistent care and structure	Adapted to her child's challenges with new interventions
Amy	Proactive in seeking evidence-based strategies	Ensured consistency between school and home	Used customized approaches based on developmental needs
Donna	Balanced work and caregiving responsibilities	Maintained structured routines with sister's help	Flexible and adaptive due to work constraints
Joy	Fully dedicated to her son's growth	Managed strict schedules due to full-time caregiving	Used play (Lego, sensory games) to engage Greg

Pain points.

The narratives of the seven parents, Lyane, Edward, Rex, Rose, Amy, Donna, and Joy, paint a vivid and multifaceted picture of the lived realities of caregiving for children with moderate-to-severe autism. While each parent faced distinct challenges, their stories were interwoven by common themes of emotional exhaustion, limited systemic support, and the continuous search for accessible educational tools and interventions.

Parents' pain points were driven by the challenges their children faced and their effects on their overall well-being and ability to cope. Most parents found it challenging to manage difficult behaviors and sensory sensitivities. In addition, the lack of personal time added to their fatigue and poor work-life balance. Financial difficulty due to limited resources and high cost of therapy and specialized education was another major concern, and the lack of financial support from the national government further exacerbates their situation. Parents also experienced limited support from their families and communities. Although extended family members tried their best to help, they were also limited by their time and resources. Parents also expressed a lack of support and tools to help them teach basic life skills to their children, manage their children's behaviors, and implement basic interventions on their own.

Table 17*Pain points*

Parent name	Behavioral challenges and sensory sensitivities	Caregiving fatigue and work-life balance	Financial constraints and limited access to services	Limited support system and community involvement	Educational and learning challenges
Lyane	Managing sensory sensitivities (noise, bright lights)	Physical and emotional fatigue	Limited resources for Chris's transition to adulthood	No direct involvement from family in daily care	Needed tools for hygiene, eating and chores
Edward	Managing meltdowns and frustration	No time for personal activities	High therapy and special education costs	Occasionally assisted by relatives	Needed structured routines and learning tools
Rex	Frequent tantrums, difficulty with routine changes	Balancing work, family, and caregiving	Limited access to specialized education	Relies on grandfather for help	Struggled with teaching life skills (bathing, eating)
Rose	Severe behavioral issues require ongoing intervention	Struggles to balance responsibilities	High financial strain	Relies on extended family for caregiving	Needed behavioral management strategies
Amy	Constant effort needed to manage behavioral issues	Handles caregiving alone with no support	Lacks access to financial/comm unity aid	No family support	Needed professional guidance for home interventions
Donna	Child required constant monitoring	Hard to find a job that allows flexibility	Needs financial stability for caregiving	Sister provides support	Needed structured interventions and skill-building
Joy	Managing aggression and destructive behaviors	No personal time, struggles with 24/7 caregiving	Struggled to afford therapies and caregiving help	Relied only on occasional financial help	Needed strategies for communication and independence

Lyane navigated the complexities of raising Chris, who had severe autism and pronounced sensory sensitivities to stimuli such as noise and bright lights. She was also worried about Chris's future, particularly his transition into adulthood, given the scarcity of existing services and resources. She expressed the need for digital tools and supports to help Chris build foundational life skills, especially in hygiene, eating, and household chores, which are difficult to teach without structured guidance. She said:

“In my child’s learning, I believe it is important to prioritize developing compliance with daily routines and establishing regular eating habits. Currently, some of the most pressing challenges my child is facing include difficulties with hygiene and maintaining healthy nutrition, which I feel should be addressed as soon as possible. One aspect of my child’s daily routine that I would like to change is the tendency to scatter clothes, toys, and food, which disrupts order and makes it harder to maintain a clean, structured environment. Looking ahead, my aspiration is for him to learn practical and employable skills, such as folding linens and making a bed, so that he can one day become part of a housekeeping team in an inn or hotel, allowing him to live with dignity and contribute meaningfully to society”.

Edward’s daily life was shaped by the need to closely manage Ken’s day-to-day activities due to his severe autism. This left little time or space for personal care or leisure, contributing to chronic caregiving fatigue. Despite occasional help from relatives, the high cost of therapies and special education programs limits the consistency and quality of interventions available. Edward expressed a need for an app that would help his son manage his daily activities and behavioral challenges. He said:

“I think having more structured tools or a clearer plan for daily tasks would help. Apps that could guide him through tasks or help him manage his emotions would be useful, especially if tailored to his interests. If I had more resources to help with that, I think it would make managing his behavior and learning easier. He’s learning, but having support would definitely make things smoother for both of us”.

Rex, another parent, also struggled with his child’s frequent tantrums and a strong resistance to changes in routines. These behavioral issues are particularly difficult to manage alongside the demands of full-time work and family responsibilities. Rex has limited access to specialized educational services and leans on his child's grandfather for intermittent support. He also needs help teaching life skills; basic tasks such as bathing and eating remain difficult to instill without structured, engaging tools tailored to his child’s needs. He said:

“Bathing is the most challenging. They tend to push each other and are hyperactive. One of them is also a picky eater, and they have very different personalities; one is quite talkative, while the other is quieter”.

For Rose, the intensity of her child’s behavioral issues demanded continuous monitoring and frequent intervention, often at the cost of her own well-being. Balancing caregiving with other household and personal responsibilities has become a daily struggle, compounded by a heavy financial burden. She relied on members of her extended family to assist with caregiving duties. Rose urgently needed behavior management strategies and practical tools for use at home to support her child’s development while alleviating some of the constant demands placed on her.

Amy, as a full-time housewife, was mainly responsible for managing her child's ongoing behavioral challenges. Without access to financial or community-based assistance, the demands

of caregiving were unrelenting. What Amy most needed was professional guidance, intervention plans, and skill-building activities that could be implemented at home to reduce stress and promote her child's autonomy.

Donna's child required constant supervision, and she relied heavily on her sister to care for him so she could work full-time. Donna expressed a strong need for structured interventions and skill-building programs that can reduce her child's dependence and open space for her to regain balance in her personal and professional life.

Lastly, Joy managed the dual challenges of her child's behavior while providing round-the-clock care and working full-time. With no consistent access to professional caregivers, Joy was left emotionally and physically exhausted. Her core need was to find effective strategies to enhance her child's communication skills and foster independence.

Taken together, these narratives expressed intersecting dimensions of behavioral, emotional, social, and financial strain experienced by caregivers of children with moderate to severe autism. The lack of reliable support systems and the limited accessibility of affordable educational and therapeutic resources deepen their vulnerability. What emerged clearly was the urgent need for holistic, accessible, and customizable interventions that not only address learners' educational needs but also help caregivers regain a sense of agency, support, and balance in their lives.

Needs and goals.

The needs and goals of parents were a combination of what they hope their children to achieve and what they aspire to gain. Most parents aimed to give their child a certain degree of autonomy by teaching basic life skills such as hygiene, self-care, emotion regulation, and simple

household tasks. The limited support from the national government was another gap that caused parents to experience financial strain to afford education and therapies, which must be paid out of pocket. There were also no programs to transition child-adult individuals with autism so they can improve their self-determination and achieve some sense of autonomy, learn vocational skills, or learn to live with minimal supervision. There was also no work accommodation given to parents of children with special needs, despite the importance of providing hands-on care to them. Parents also called for the need to take care of their well-being through emotional and social support, more help from their extended family, and for establishing a support system to help them balance a full-time job and caregiving.

Table 18

Needs and goals

Parent name	Child's independence and life skills	Financial and government support	Parental well-being and support system	Educational and behavioral support	Future readiness and vocational skills
Lyane	Hygiene, eating, chores	Accessible programs for adult transition	Rest, self-care, spiritual support	Tools for daily living skill-building	Equip child with employable skills
Edward	Cooking, hygiene, autonomy	Needed more income sources	Stronger family support system	Structured tools for learning routines	Increased collaboration with educators
Rex	Bathing, dressing, eating	Limited access to specialized education	Balance caregiving with work	Assistance with behavioral management	Improved adaptability to new environments
Rose	Eating, dressing, routines	Financial strain in therapies	More collaboration with family	Strategies for behavior management	Community integration for child
Amy	Self-regulation, independence	Needed community and financial aid	No extended family support	Professional behavioral strategies	Maximize child's learning potential

Donna	Skill-building and routines	Flexible work opportunities	Emotional and social support	Support for structured interventions	Long-term continuous learning
Joy	Communication, toileting	Needs additional income	Struggles with 24/7 caregiving	Managing aggression and daily structure	Help child discover talents

Lyane focused on building her child Chris's independence through hygiene routines, eating, and basic chores. She emphasized the importance of having accessible programs to support Chris's transition into adulthood, indicating past concerns about the lack of structured post-school services. For her own well-being, Lyane sought rest and self-care and drew strength from spiritual support. She had needed practical tools to support Chris's daily living skills and ultimately hoped to equip him with employable abilities so he could participate meaningfully in the workforce. She said:

“The care and education of my child is primarily shared between my husband and me, with our extended family offering emotional support and prayers. My child requires a high level of supervision, approximately 80% of the time, which places significant demands on our daily lives. As a result, my husband and I struggle with fatigue, and I have periods of depression. To cope, I believe that rest, self-care, and maintaining a strong spiritual life are essential for our well-being. In terms of government support, I hope to receive assistance that includes pre-vocational education, programs that support the transition to adulthood and independent living, and access to home facilities or dormitories staffed with special education teachers who can provide continued support for adults with autism”.

Edward prioritized teaching his child cooking, hygiene, and general autonomy. He recognized the financial strain caregiving imposed and noted the need for additional sources of

income. Edward also emphasized the importance of a stronger family support system for sharing caregiving responsibilities. He had sought structured tools to teach routines and life skills and hoped for increased collaboration with educators to ensure consistent, goal-oriented support for his child's independence.

Rex had worked with his child to develop basic self-care skills such as bathing, dressing, and eating. He expressed concern about limited access to specialized education options, which had restricted his child's learning opportunities. Rex faced ongoing challenges balancing caregiving with work responsibilities and had highlighted the need for external support. He had sought assistance in managing behavioral challenges and aspired to help his child become more adaptable in new environments, an essential skill for future transitions. He said:

“If there were a resource designed for my children's learning and therapy, I would want it to focus on building their character and confidence. It would be really helpful if it included tools to keep them calm, especially when they're close to a tantrum. As a parent, I would appreciate features like that because managing their emotions can be challenging, and having support to prevent or de-escalate tantrums would make a big difference in our daily routine”.

Rose had emphasized the importance of routines, eating, and dressing in fostering her child's independence. She faced financial strain due to the cost of therapies, which had limited access to consistent care. Rose believed that more collaboration with family members would have eased her caregiving burden. She had needed a more effective behavior management strategy and envisioned a future where her child could better integrate into the community, both socially and functionally.

Amy had focused on her child's self-regulation and independent functioning. However, she lacked support from extended family and had expressed a need for both community engagement and financial assistance. The absence of a support system had contributed to emotional strain. Amy had sought professional behavioral strategies to support her child better and hoped to maximize her child's learning potential through sustained developmental progress.

Donna concentrated on structured skill-building and life routines. She emphasized the importance of flexible work opportunities that would accommodate her caregiving role. Emotional and social support had been critical needs for her own well-being, as caregiving often led to isolation. She had sought structured interventions to implement at home and envisioned long-term, continuous learning opportunities for her child, reflecting a strong commitment to ongoing development.

Joy focused on improving her child's communication and toileting skills. She experienced financial difficulties and needed additional income to sustain the demands of caregiving. Joy struggled with the intensity of 24/7 caregiving, which affected her physical and emotional health. She had needed strategies for managing aggression and creating daily structure. Looking toward the future, she hoped to help her child discover his talents, showing a desire to nurture his individuality and support personal growth. She said:

“My child with autism requires constant, 24/7 care and a lot of my support and attention. One of the biggest challenges I face is juggling work while taking care of him, which can be overwhelming. To ease this burden, having more income to hire a caregiver would make a significant difference and provide relief. In terms of skills, I would like to see my child gain daily living abilities, especially toileting, which is an important milestone for us. He also has behavioral challenges, including aggression and destructive behavior.

While I feel I can manage his aggression, his destructive behavior is much harder for me to handle. Ultimately, I hope he can develop essential life and everyday skills that will help him become more independent.”

Teacher demographics.

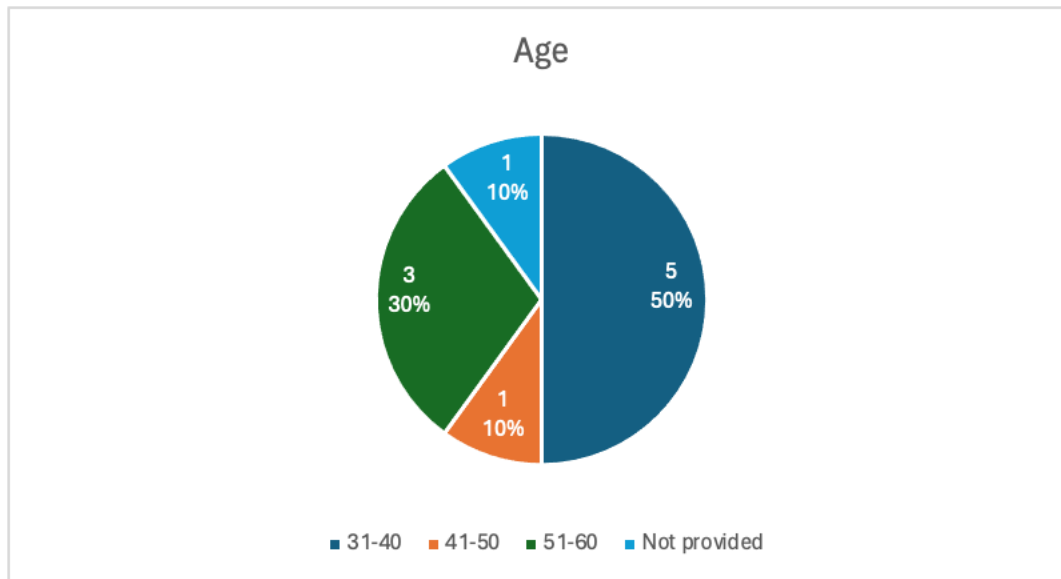
The teacher demographics provided an overview of the participants' age, marital status, educational background, years of teaching experience, teaching load, and class size. This information offered insight into the diversity of personal and professional contexts in which the teachers work, highlighting variations in experience levels, academic qualifications, and classroom responsibilities.

Age of teachers

The teachers who participated in the study were aged between 42 and 50, indicating that many were in the mid-stage of their careers with substantial experience in the field. This group formed the majority, suggesting a workforce with a mature perspective and a wealth of practical knowledge. A smaller cluster fell within the 51 to 60 age range, representing more seasoned educators who brought decades of insight and adaptability to their practice. Only one teacher reported being in their 40s, and additionally, one respondent chose not to disclose their age.

Figure 21

Age of teachers



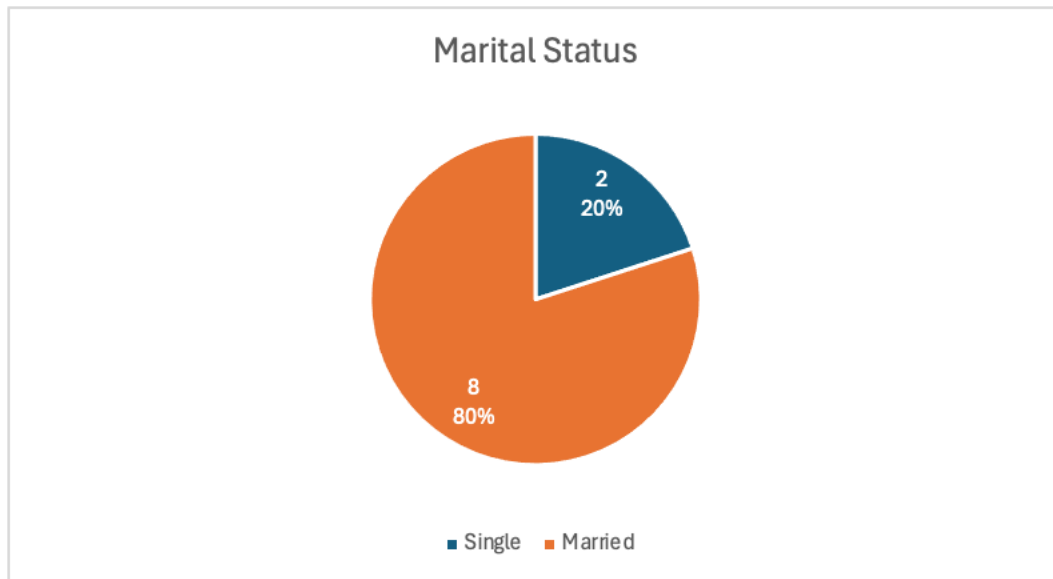
Marital status of teachers

The majority of teachers in the study reported being married, while only two identified as single. For most teachers, balancing work responsibilities with personal or family commitments is an ongoing aspect of their daily lives.

\

Figure 22

Marital status of teachers

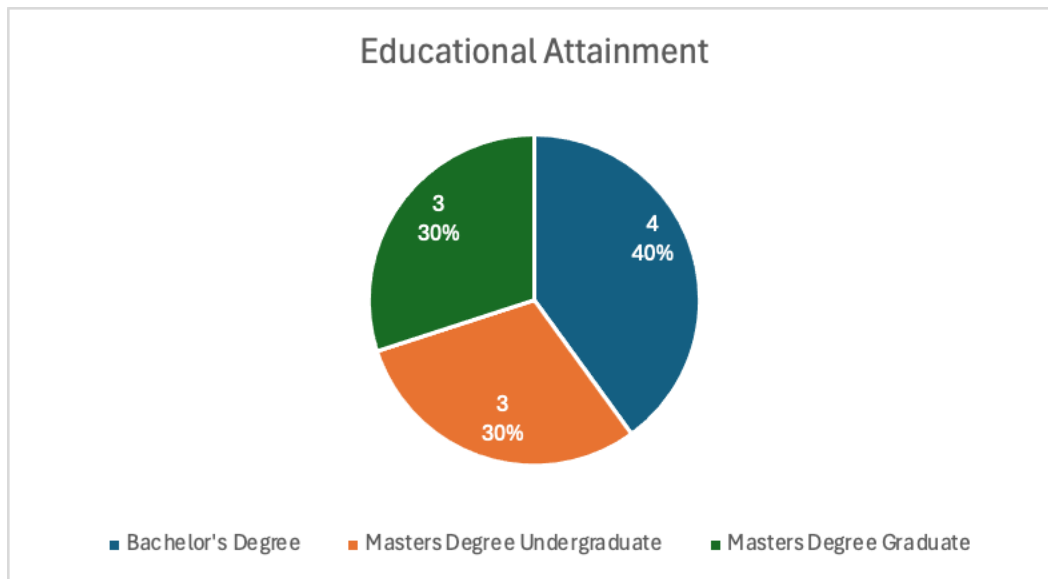


Educational attainment of teachers

The teachers' educational backgrounds showed that most have completed a bachelor's degree, reflecting the standard qualification for entry into the teaching profession. A smaller number of teachers have pursued and completed graduate studies, indicating a commitment to further professional development and specialization. This range of educational attainment highlights both a strong foundational knowledge among the teaching group and a presence of advanced academic preparation that may enhance instructional strategies and classroom practices.

Figure 23

Educational attainment of teachers

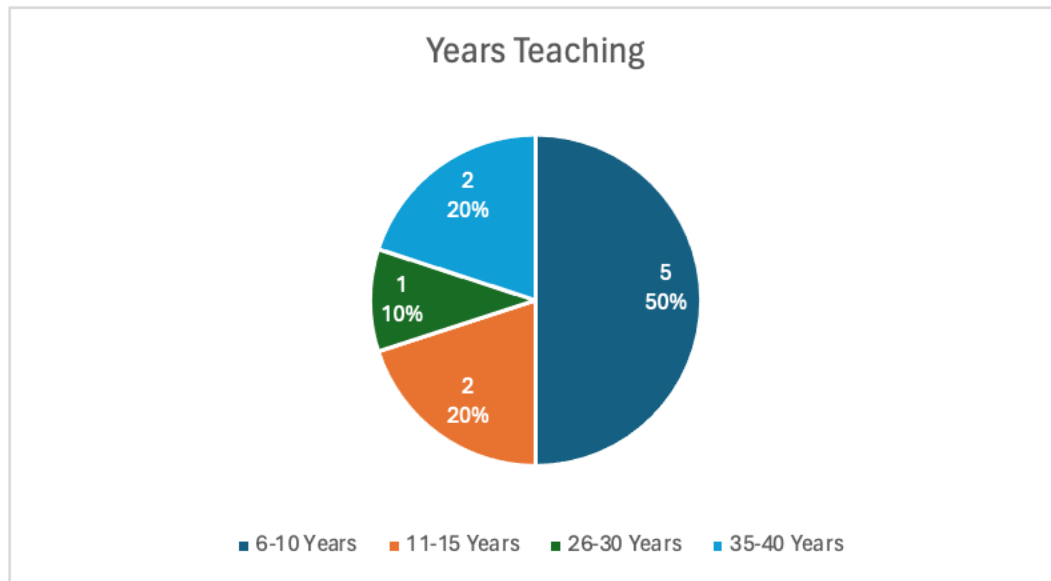


Years of teaching

The educators' teaching experience spanned a wide range, with most having taught for six to ten years, indicating a solid base of classroom experience and familiarity with their learners' needs. A smaller group had been in the profession for 11 to 15 years, representing a more seasoned segment of the teaching force. Notably, a few educators stood out as highly experienced, with two having nearly four decades of teaching behind them and others reporting 26 to 30 years in the field. This diversity in teaching tenure reflected a blend of emerging and veteran perspectives, enriching the group's collective expertise.

Figure 24

Number of years teaching

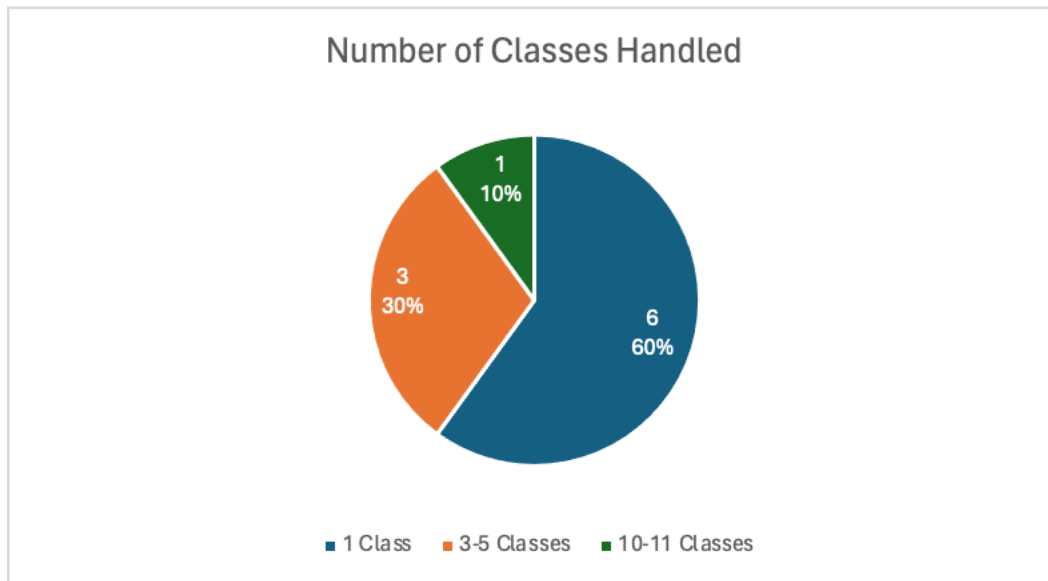


Number of classes handled

The distribution of teaching loads among educators in the study revealed a notable pattern linked to experience levels. Most senior teachers typically manage a single class, which may allow for a more focused and in-depth approach to instruction. In contrast, more junior educators often handled multiple classes, ranging from three to five, reflecting a broader teaching scope early in their careers. One teacher stood out for managing an exceptionally high load of 10 to 11 classes, highlighting the varying demands placed on individual educators. This variation in teaching assignments illustrated the diverse responsibilities across experience levels and potentially differing school contexts.

Figure 25

Number of classes handled

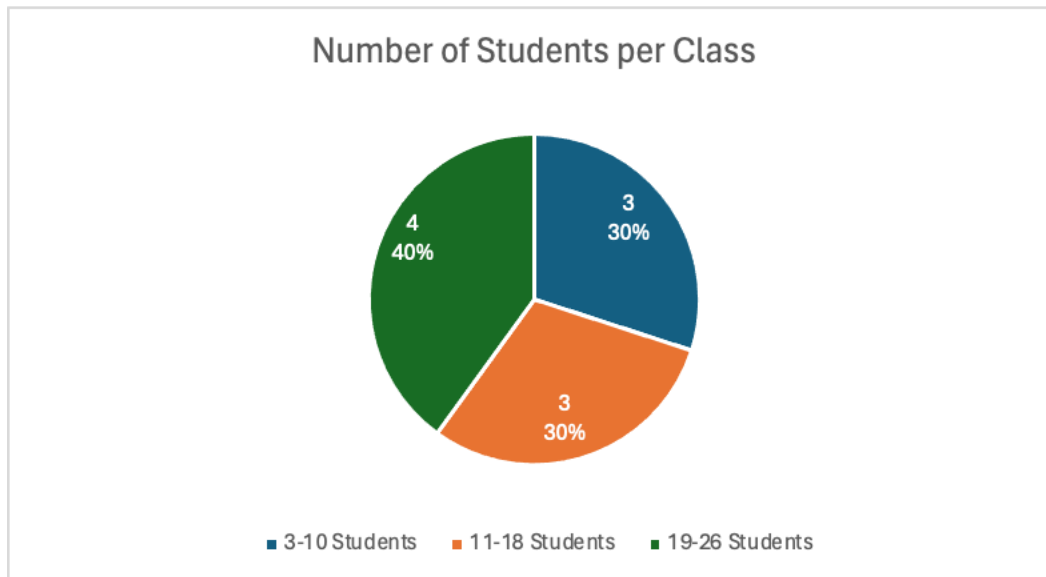


Students per class

Class sizes among the teachers in the study vary widely, reflecting differences in school settings, student needs, and possibly resource availability. Most teachers taught classes of 19 to 26 students, suggesting a standard classroom size that allowed group-based instruction while still providing individual attention. Others teach smaller groups of 11 to 18 students, potentially enabling more personalized instruction. A few educators worked with very small groups of three to ten students, which was often necessary in specialized settings, such as special education, where learners may require more intensive, individualized support. This range in class size emphasized the diversity of teaching contexts represented in the study.

Figure 26

Students per class



Teaching styles.

Educators' teaching styles were diverse, ranging from structured to adaptive. Visual schedules, routines, organized learning environments with limited distractions, and step-by-step directions and explicit instructions characterized structured, routine-based teaching. For example, Cherry said: *“Explicit teaching helps me slowly teach the skill, followed by regular repetition of the skill by the learner”*. Closely related to this were life-focused and practical training sessions in which daily living activities are taught through step-by-step methods, routines, and hands-on exercises. Teachers also collaborated with parents to support home-based learning using visual schedules and to teach parents how to set routines at home. For instance, Michelle said: *“Repetition of teaching the daily living skills is important for children to master them. We also teach and talk to the parents about the need to have a routine in their house to practice the daily living skills”*. They also provided coaching and feedback to parents and engaged them when

creating learning plans for their children. In helping children manage their behavior, teachers also use step-by-step, problem-focused teaching along with emotion regulation techniques and reinforcements. In the same manner, to implement individualized and adaptive approaches, teachers adjusted their lessons based on students' developmental level, capabilities, needs, moods, and behaviors. For instance, Gemma said: *"I check if they're okay, not sick, and ready to participate. If the child is not well on a day, I will not force them to do tasks I know would agitate them and lead to tantrums and unproductive activities. Letting them stay in a peace corner to relax and observe would help them know that they are respected and well-loved in the classroom"*. Some teachers also used modeling to encourage imitation. For instance, Mara said: *"I use the model approach where I start with simple tasks using simple instructions and I ask my students to do it daily or as frequent as possible."*

Table 19

Teaching styles

Category	Teaching Styles
Structured and routine-based teaching	Gemma: Used visual schedules and structured routines
	Michelle: Established routines for learning
	Charise: Created structured classroom environments for children to practice various activities
	Nadine: Used task analysis for structured teaching and consistency
	Aster: Used structured individualized support, consistency, and structured teaching techniques
	Cherry: Used explicit teaching and repetition
	Ann: Users highly individualized, systematic, and consistent interventions
	Pamela: Used structured and predictable routines
Individualized and adaptive teaching	Gemma: Adapted teaching based on students' moods and behaviors
	Michelle: Used modeling to encourage imitation
	Mara: Used modeling as a core teaching approach
	Nadine: Adjusted teaching based on students' abilities
	Aster: Customized interventions based on students' preferences, difficulties, and strengths

	Pamela: Created calm environments with music and sensory-friendly strategies
Behavior management and reinforcement strategies	Gemma: Used "peace corners" for emotional regulation
	Nadine: Used positive reinforcement
Life skills and practical training	Gemma: Taught daily skills through daily activities and routines
	Michelle: Focused on activities that will help build their independence
	Leah: Taught life skills using visual cues
	Charise: Focused on independence-based life skills
	Mara: Emphasized skill-building for functional independence
	Nadine: Uses PECS to help in communication
	Aster: Focused on building practical abilities, self-care skills, and functional communication skills
	Cherry: Emphasized practical, hands-on learning
	Ashley: Focused on developing functional life skills
	Pamela: Focused on self-help and communication skills
Parent collaboration and home-based learning	Gemma: Advocated for parent-led learning at home
	Michelle: Coached parents to create home routines to practice daily living activities
	Leah, Charise, Mara, Nadine, Aster, Ashley: Advocated for parent-led learning at home
	Cherry: Actively collaborated with parents through consistent follow-ups
	Pamela: Proposed regular parent teacher conference

Pain points.

The pain points that teachers faced were mostly around managing challenging student behaviors such as aggression, emotional regulation, handling tantrums and meltdowns, along with unpredictable behaviors. For instance, Michelle said, *“Sometimes, we get hurt by children with severe autism. They need therapy, but parents cannot afford therapy for their child”*. Mara also faced the same challenges, she said: *“In my experience, I work with three boys, ages 5-6, who all dislike noise, sound, or music. Before entering the classroom, they check if the TV is on. I turn it off so they’ll come in. One of them bites, pushes, and spits. He’ll hit you, then laugh and run, expecting you to chase him.”* Gemma also expressed the same challenge when she said: *“I always anticipate misbehavior in every class.” The first thing I do is get to know the student,*

their strengths, weaknesses, likes, and dislikes”. Teachers also struggled to improve students’ sitting tolerance and to keep regular attendance at school to ensure consistent learning. Mara said, *“I don’t chase him. When he returns, I firmly tell him to sit down. He’s not into writing, so I introduce big Lego blocks. At first, he’ll throw and scatter them. My goal is to build his sitting tolerance. I maintain a firm voice to prevent him from thinking I’m easy to manipulate.”*

Educators also raised concerns about insufficient training and institutional support for special-needs teachers, and limited partnerships with both private and public institutions that could have offered more affordable therapies to parents. Leah said: *“The challenges that we face include limited resources, inadequate training, and a lack of support for special education teachers. We would always need to plan, establish continuous communication, provide feedback, and seek support with special needs educational sectors”*. Some teachers handled big classes that comprised more than 20 students and struggled to keep up with their workload. For instance, Cherry said: *“Handling several learners with a class size of 22 is challenging. There is a need to add more SPED teachers”*. Teachers also face insufficient classroom materials that prevent them from meeting learners’ diverse learning needs.

Table 20

Pain points

Category	Pain points
Managing student behaviors and sensory sensitivities	Gemma: Managing unpredictable behaviors and emotional regulation
	Michelle: Handling aggressive behaviors from severe autistics
	Charise: Struggled with managing challenging behaviors
	Mara: Managing sitting tolerance of students
	Nadine: Struggled with non-verbal students and behavior regulation
	Aster: Handling attendance and learning consistency among students
	Ashley: Struggled with student engagement and focus retention

	Pamela: Managing tantrums and meltdowns
Limited teaching resources, large class size and workload	Leah: Insufficient classroom materials for diverse learning needs
	Cherry: Handled 22 students in a single class
Parental engagement and home reinforcement challenges	Michelle: Parents have limited access to affordable therapy services
Lack of institutional and community support	Michelle: Needed more partnerships for therapy funding
	Leah: Insufficient training and institutional support for special education teachers

Needs and goals.

Teachers' needs and goals encompass support to perform better in their jobs and to find more avenues to assist parents in supporting their child's learning at home. Educators sought greater access to teaching resources and materials to meet better the varied learning needs of students who require a personalized learning approach. Tools that would enable the use of a picture-based communication system were also mentioned, as this is fundamental in teaching non-verbal students to communicate. They also sought more institutional partnerships and community support to assist public school teachers, hire more special-needs educators, and offer affordable therapy options to parents. Strengthening parent-teacher collaboration was another area for improvement, with teachers highlighting the need for more structured programs and tools to help parents implement interventions at home to ensure continuity of learning. For instance, Ashley said: *"Involving parents actively in the therapeutic process not only helps create more consistency and generalization of skills but also strengthens the parent-child bond"*.

Table 21*Needs and goals*

Category	Teacher Needs
Behavior management and student engagement	Gemma: Needed strategies and support to manage unpredictable student behaviors
	Charise: Needed behavior management support
Access to teaching resources and materials	Leah: Needed more access to teaching resources
	Nadine: Needed PECS-based tools and individualized learning resources
Parental involvement and collaboration	Mara: Needed more structured parental intervention programs
	Aster: Wanted parent training programs to ensure learning continuity
	Ashley: Wanted to strengthen parent-teacher collaboration
	Pamela: Wanted coaching tools for parents to improve home-based learning
Institutional, community support, and continuous professional development	Michelle: Sought affordable therapy options and partnerships
	Leah: Sought local government support for teachers
	Cherry: Advocated hiring more special education teachers
	Leah: Needed continuous training in autism interventions

Perspective on digital education tools.

Teachers were asked about their perspectives on the use of digital tools for education as one means to alleviate their pain points and meet their needs and goals. Their perspectives ranged from health-related concerns to learners who were brought in due to prolonged screen exposure and a tendency to be dependent on them. They also raised device affordability and the capacity to use mobile applications not only by teachers but also by parents. For instance, Michelle said: *“Some are willing, but not all parents are knowledgeable or educated using mobile applications. They also don’t have time to teach their child because some need to work to earn money”*. Despite these perceived challenges, some teachers still recognized the value of applications in building life skills and in assisting parents in implementing interventions. Leah said: *“I believe that it is a great and innovative strategy to teach learners with severe autism”*.

Teachers recommended adding interactive elements, such as challenges and games, and providing incentives or rewards. Ashley said, *“Children, especially younger ones, have limited attention spans. Life skills learning through an app may require engaging content that holds their attention, making it difficult to sustain interest over time. Apps would need to be designed to offer interactive elements, games, and rewards to keep children focused”*. Educators also emphasized the need for personalization by individualizing content based on learners’ skills, needs, and learning styles, as well as the type of engagement parents need to support their child’s learning. Other teachers mentioned that apps can also be used in conjunction with traditional learning methods, where verbal and actual practice can be supplemented by digital methods, or used mainly as a supplementary tool for teaching. Cherry said: *“Mobile applications may be a visual aid for both parents and learners; however, practical application is still essential”*.

Table 22

Perspective on digital education tools

Category	Perspectives
Health concerns	Gemma: Believed digital tools should be used in moderation to avoid dependency
	Gemma: Concerned about learners’ prolonged screen exposure
	Pamela: Worried that children will be dependent on the apps
Limited capacity and device affordability	Michelle: Found it hard to use apps for teaching. Concerned about parents’ ability to afford and use apps effectively.
	Charise: Believed that apps’ effectiveness depends on the willingness and support of parents to use with the child
	Cherry: Believed that success was depended on the availability of gadgets and the consistency of the parent in teaching
	Leah: Concerned about access to devices at home
Need for personalization	Nadine: Needed individualized content, parental engagement, and supporting consistency in implementation to be effective
	Mara: Supported but emphasized the need to consider the diverse needs of the child and their skill levels.
	Ashley: Believed that apps can encourage engagement, if they are designed to align with the unique needs and learning styles of children

Good for skill building	Leah: Supported mobile apps for skill-building and parent interventions
	Charise: Believed parents of students with severe autism will benefit, most especially if their child is non-verbal
	Nadine: Believed that apps when used thoughtfully and in conjunction with other teaching strategies, can provide engaging, customized, and flexible learning experiences.
Supplementary tool only	Cherry: Saw digital tools as supplemental, not a primary means for teaching
Hybrid approach	Pamela: Believed in a combination of traditional (verbal practice) and digital methods would be effective
Need for interactive elements	Ashley: Concerned that apps wouldn't be able to sustain children's attention unless it comes with interactive elements, games and rewards
	Aster: Believed that incorporating gamified components can greatly inspire kids and can encourage them to continue honing their everyday living abilities by completing challenges, leveling up, or earning incentives.

Findings from workstream 3: Iterative design and development

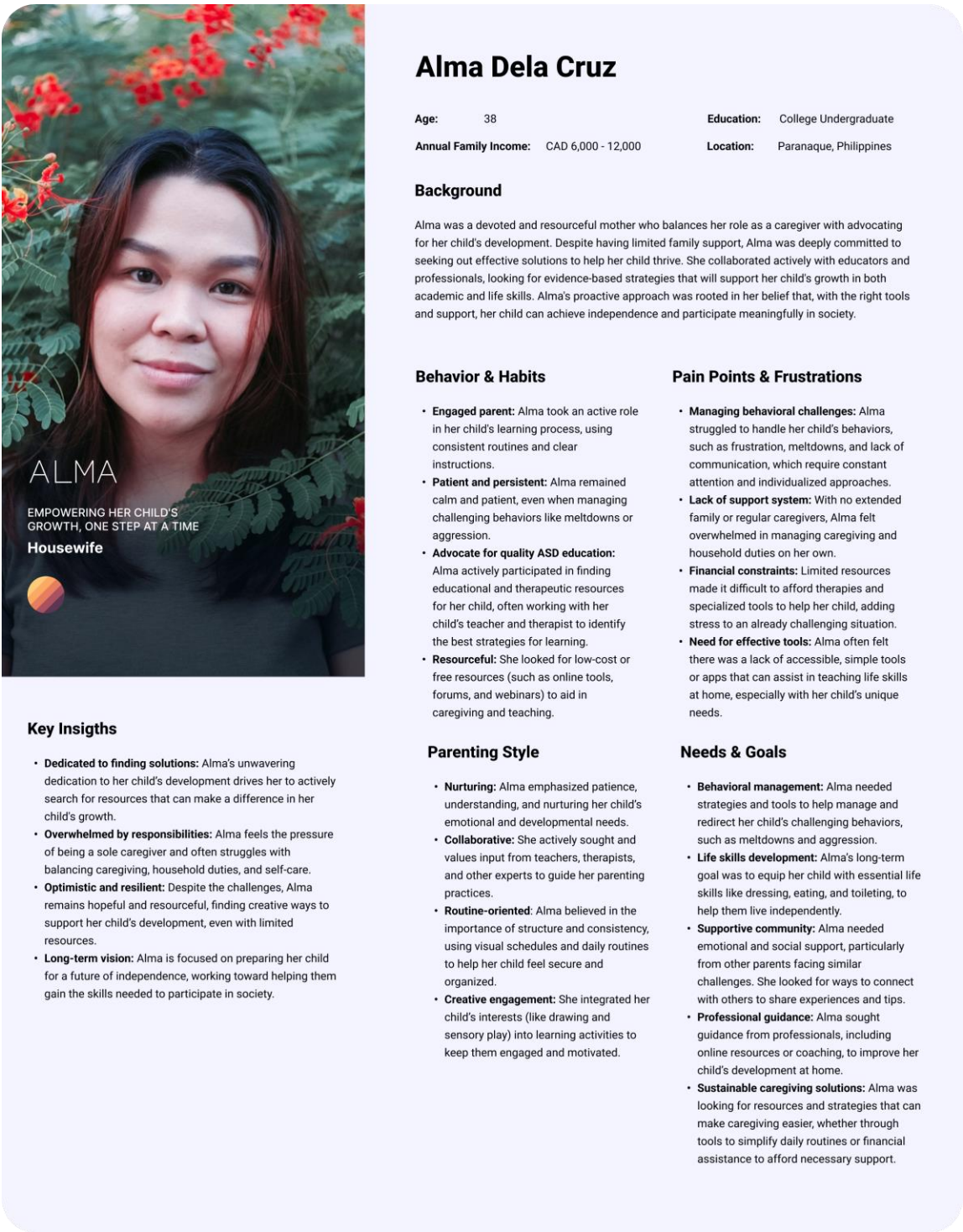
Based on profiles of parents and teachers from the qualitative survey and parent interviews, the user personas for a parent of a child with autism and a special-needs teacher were updated.

Updated user persona of parents and teachers.

The updated personas reflected common backgrounds, pain points, and frustrations, as well as the needs and goals of the actual parents and teachers who participated in the study. These personas were used to inform and iterate the design of the digital health solution for life skills development of individuals with severe autism, with a focus on their support network, specifically parents and teachers.

Figure 27

Updated parent user persona



At 38, Alma Dela Cruz lived in Parañaque, Philippines, where she devoted her life to raising and caring for her child with special needs. Although she had not completed college, Amy's lack of formal education never deterred her from becoming a deeply committed, informed, and proactive parent. As a housewife managing a household on a modest family income of CAD 6,000 to 12,000 per year, Amy faced financial and emotional pressures every day, but her resolve remained unwavering.

Amy's parenting was grounded in love, structure, and an unshakeable belief in her child's potential. She relied on routines and clear communication to create a sense of stability, using visual schedules and sensory-based activities to keep her child engaged. Even when confronted with frequent meltdowns, behavioral challenges, or communication difficulties, Amy approached each situation with patience and persistence. She drew strength from her vision of a more independent future for her child, one in which they could care for themselves and engage meaningfully with the world.

With little family support and no consistent help at home, Amy carried the dual responsibilities of full-time caregiving and household management alone. This left her stretched thin, emotionally and physically, and often without time for her own needs. Despite the isolation, she actively sought out effective solutions. She read articles, joined online parent forums, attended free webinars, and regularly consulted with teachers and therapists. Amy valued professional insight and believed in collaborative care. She did everything in her power to make informed decisions, even if that meant sacrificing her own comfort or rest.

One of Amy's greatest frustrations was the lack of accessible, easy-to-use tools that matched her child's unique learning needs. She often wished for affordable mobile applications

or behavioral management resources to support her child's life skill development at home. Therapies were expensive, and specialized services were often out of reach; financial constraints limited her options. Still, she remained hopeful, constantly looking for creative, low-cost ways to support her child's growth.

More than anything, Amy dreamed of seeing her child thrive. Whether it was learning to dress independently, manage emotions, or safely navigate the community, each small milestone was a victory she worked tirelessly toward. She also longed for a supportive community, other parents who understood her situation and could offer empathy, ideas, or simply a space to talk.

Amy Reyes may not have had every resource at her fingertips, but what she did have was heart, grit, and an unrelenting drive to ensure her child had the best possible chance at a fulfilling life.

Figure 28

Updated teacher user persona



Marivic Ramos

Age: 44

Years Teaching: 9

Education: University Graduate; Master's Degree Units

Location: Muntinlupa, Philippines

Background

Marivic had nine years of experience teaching children with moderate to severe autism in both private and public schools. She specialized in fostering independence through structured routines and step-by-step instruction. Marivic was passionate about holistic student development, emphasizing collaboration between educators and parents.

Behavior & Habits

Teaching Style:

- Created structured and predictable classroom routines to help students feel secure and engaged.
- Used modeling and repetitive practice to teach essential life skills, ensuring students understand and internalize tasks.
- Balanced positive and negative reinforcement to address behaviors and teach compromise.

Classroom Strategies:

- Focused on practical daily living skills like dressing, toileting, and eating.
- Groups students based on their needs or readiness to personalize learning approaches.
- Incorporated visual schedules, task breakdowns, and interactive resources to maintain focus.

Collaboration:

- Regularly communicated with parents to align learning strategies between home and school.
- Provided parents with low-tech resources, such as printed schedules or instructional videos, to accommodate varying levels of tech proficiency.

Professional Habits:

- Advocated for affordable tools and therapy options to make interventions more accessible.
- Constantly explored innovative teaching methods and resources to improve student engagement and learning outcomes.

Pain Points & Frustrations

Resource Limitations:

- Limited availability of teaching aids, sensory tools, and digital resources tailored to autism education.
- Lack of affordable therapy options for families, creating gaps in learning continuity.

Parent Collaboration Challenges:

- Some parents struggled to find time or lack the technical knowledge to support home-based learning.
- Ensuring consistency in routines and interventions between home and school was a recurring challenge.

Behavioral and Environmental Management:

- Managing diverse behaviors, including resistance to change, sensory sensitivities, and unpredictable reactions.
- Struggled with creating inclusive activities that cater to varying developmental levels within a single class.

Key Insights

- Consistency is key:** Structured routines and repetition were fundamental in teaching children with autism.
- Collaboration is critical:** Effective learning depended on strong parent-teacher partnerships to ensure skill reinforcement.
- Balancing digital and hands-on learning:** While digital tools were promising, they must be complemented with practical, screen-free activities to avoid overstimulation.
- Accessibility and training:** Teachers needed affordable resources, ongoing training, and better collaboration tools to support students and parents effectively.
- Holistic support:** Empowering families through accessible therapy, coaching, and peer support networks can significantly enhance learning outcomes.

Main Motivations

- Marivic was deeply motivated by her desire to see her students develop independence and thrive in daily life.
- She found joy in empowering children with moderate to severe autism to overcome challenges and reach their potential.
- She was equally passionate about supporting parents and creating a collaborative environment where students can succeed both at school and at home.

Needs & Goals

Teaching Resources:

- Access to affordable or free materials, including both digital tools and hands-on activities.
- Training programs for parents to equip them with practical skills for supporting interventions at home.

Professional Development:

- Advanced training on behavior management strategies, especially for severe autism cases.
- Peer networks for sharing teaching strategies and learning from experienced colleagues.

Student-Centered Goals:

- Fostered independence in students by equipping them with essential life skills.
- Maintained student engagement through a mix of digital and hands-on methods tailored to individual learning styles.

Parent Collaboration:

- Built stronger partnerships with parents to ensure consistent reinforcement of skills at home.
- Provided flexible, low-barrier resources for parents to support their children effectively.

Marivic Ramos, a 44-year-old special-needs education teacher based in Muntinlupa, Philippines, brought nearly a decade of experience to her work with children diagnosed with moderate-to-severe autism. A university graduate with a master's degree in special education, Michelle had taught in both private and public schools, where she built a reputation for her calm presence, structured teaching style, and deep empathy for her students and their families.

Marivic's teaching philosophy centered on building independence through structured routines and step-by-step instruction. She created predictable classroom environments that helped students feel secure, integrating visual schedules, repetitive modeling, and hands-on activities to guide them through essential life skills such as dressing, toileting, and eating. She grouped her students based on their developmental readiness, ensuring that interventions were personalized and goals remained attainable.

Her classroom was both a place of learning and a source of consistency. Marivic blended positive reinforcement with firm but compassionate boundary-setting to teach compromise and manage behavior. Despite daily challenges such as sensory sensitivities, resistance to change, and varying developmental levels among her students, she remained grounded in the belief that every child, with the right support, could grow in confidence and capability.

Collaboration with families had been a cornerstone of her practice. Marivic regularly communicated with parents, offering low-tech solutions such as printed schedules and instructional videos to bridge the gap between school and home. She understood that many families lacked the time, resources, or digital fluency to support interventions outside the classroom fully. To address this, she advocated for accessible, affordable tools and consistently pushed for parent training programs that empowered caregivers in their roles.

However, the journey had not been without frustrations. Marivic faced limited access to teaching aids, sensory materials, and autism-specific resources. Therapy services remained out of reach for many of the families she supported, often disrupting continuity of learning. Inconsistencies between school-based instruction and home routines posed ongoing hurdles, making it more difficult for her students to retain skills.

Despite these challenges, Marivic remained committed to professional growth. She continuously sought new teaching methods, engaged in peer networks, and aspired to advanced training in behavior management, particularly for severe cases of autism. Her goal had always been more than instruction; it was about building bridges: between home and school, between students and independence, and between parents and the tools they needed to be effective partners in learning.

Marivic was driven by a heartfelt vision to see every child under her care thrive in daily life. Her work had not been merely instructional; it had been transformational. With patience and purpose, she guided her learners and their families toward greater confidence, capability, and connection.

RQ 3: What capabilities, features, and processes are essential for developing a digital health solution that effectively supports learners with moderate to severe ASD, parents, and educators

To determine the capabilities and features for learners, parents, and teachers, three workstreams were executed, adopting an incremental, iterative approach. The first workstream leveraged a literature review to conduct a preliminary analysis of capabilities and functional requirements, and to develop initial use cases that informed a preliminary user interface design.

The second workstream focused on updating the capabilities and functional requirements based on the results of primary data gathering. The third workstream synthesized both secondary and primary data to iteratively design and develop a digital health solution for autism life skills development in collaboration with parents, teachers, students, and industry partners.

Findings from Workstream 1: literature review research and design thinking

An initial set of design capabilities and features was identified through an extensive review of existing literature and related literature, complemented by design-thinking-driven activities. These served as the starting point for determining the capabilities and requirements for a digital health solution for the life skills development of learners with moderate to severe autism.

Design themes derived from literature review.

Based on the synthesis of scholarly research and design thinking insights, 13 capabilities were identified to address known challenges faced by learners, parents, and teachers. These capabilities guided the consequent ideation of features for a digital health solution for autism life skills development (See Appendix 9). The capabilities defined were further broken down into specific features to operationalize them in a digital health solution for autism life skills development. A total of 8 features were initially identified in the literature to address accessibility, customization, and ease of use for users with ASD and their support networks (See Appendix 10). These features were further expanded as the primary data gathering progressed.

Findings from Workstream 2: qualitative surveys and interviews

The initial design requirements from the literature review evolved as data gathering progressed. Qualitative surveys and interviews were conducted with parents and teachers, and design themes emerged as the analysis of primary data progressed. Design themes were derived from the challenges, pain points, and needs shared by parents and teachers during the primary data gathering. In addition, the requirements emerged from design feedback sessions conducted with a parent, a teacher, and industry partners.

Life skills development and daily living support

Design themes under this category focused on building foundational life skills through structured, visual-based routines and personalized support. The requirements reflected learners' needs for assistance with daily living tasks, attention and cognitive challenges, academic flexibility, and nutritional needs. Parents emphasized the need for guidance in creating structure at home and preparing their children for future independence. Teachers highlighted the value of individualized plans and visual planners in supporting diverse learning needs. Key features included visual task sequences, customizable routines, step-by-step tutorials, and progress-tracking tools.

Table 23

Design themes for life skills development and daily living support

ID	Design theme	Description	Emerg ed from
----	--------------	-------------	---------------

DT #1	Visual task modeling for daily living skills	1.1 Provide structured, visual-based task sequences such as digital schedules, step-by-step instructions, and video-based modelling to teach life skills. 1.2 Use video-based modelling or instructions where the model is the child himself/herself, a peer, their parent or teacher. 1.3 Include home-based reinforcements customized based on learner's hobbies, likes and preferences to support independence to help in encouraging the repeated use of a life skill. 1.4 Provide the facility to create step-by-step animated or video tutorials for the skills the child needs to learn which are individualized and/or personalized based on learners' profile and needs	Literature review Children (through their parents, acting as proxies) • Ann • Reg and Roy • Anthony • Alfie • Ken • Greg • Chris Design feedback from parent • Edward
DT #6	Attention and focus support through gamified tasks	6.1 Embed short, visually guided tasks with progress indicators. 6.2 Break down tasks into manageable steps. Integrate training to improve focus through play. Use structured, time-bound tasks like a "focus builder" section with timed drawing challenges or problem-solving games. 6.3 Integrate role playing games by tapping and dragging to complete tasks (e.g., choosing ingredients or following steps for personal hygiene)	Literature review Children (through their parents, acting as proxies) • Ann • Anthony • Alfie • Ken • Greg • Chris
DT #7	Flexible, interest-based academic learning tools	7.1 Allow flexible pacing and interest-based modules. 7.2 Integrate visual instruction, reward-based activities, and enrichment themes (e.g., Lego, puzzles). 7.3 Send reminders for scheduled tasks or daily life skill activities. Use motivational prompts, such as: "Practice tying shoelaces today! Remember, small steps lead to big achievements."	Literature review Children (through their parents, acting as proxies) • Ken • Greg • Chris
DT #11	Nutrition education	11.1 Provide meal prep simulations or visual food charts.	Literature review

	through visual and reinforced tools	11.2 Use reinforcement strategies tied to favorite foods to build interest in healthy choices.	Children (through their parents, acting as proxies) • Reg and Roy • Greg • Chris
DT #12	Customizable visual routines for home transitions	12.1 Provide customizable visual step-by-step routines (e.g., bedtime, getting ready for school, mealtime) with the option to add timers and alarms. 12.2 Enable caregivers to update and adapt routines to reflect the family's evolving schedules and cultural practices. 12.3 Allow routines to include transition supports (e.g., countdown visuals, calming prompts, music cues) to ease difficult changes at home.	Literature review Children (through their parents, acting as proxies) • Ann • Reg and Roy • Anthony • Alfie • Ken • Greg • Chris
DT #16	Home-based life skills coaching and virtual guidance	16.1 Enable parents to create routines, reminders, and interactive life skills trainings tailored to their child's needs and interests 16.2 Provide virtual teacher avatars resembling familiar, friendly faces to help provide instructions, feedback, and encouragement.	Literature review Parents • Rose • Rex • Amy • Donna • Edward • Jane • Lyane Design feedback from an educator • Mara
DT #17	Life skills and vocational readiness toolkit	17.1 Help and guide parents create learning materials that will help simulate life skills, job-readiness training, and future planning.	Literature review Parents • Edward • Lyane

DT # 33	Individualized learning plans with real-time tracking	33.1 Enable teachers to create, customize, and monitor individual learning plans with measurable goals, gamified activities, and real-time progress tracking. 33.2 Learning plans can be shared access with parents with reminders for periodic review to ensure learning consistency in school and home environments. 33.3 Enable teachers to personalize interventions based on learner profiles (age, ability, mood, preference) 33.4 Enable teachers to update or change learning materials based on the students' progress	Literature review Teacher
DT # 41	Collaborative visual daily planner	41.1 Provide a shared visual planner where teachers, parents, and students can collaboratively add and view activities. 41.2 Distinguish activities by environment (school vs. home) while presenting them in a unified child-friendly visual timeline. 41.3 Offer role-based controls (teachers add school tasks, parents add home tasks, students can check off or interact with tasks). 41.4 Include reminders/notifications to reinforce consistency and help the child anticipate what comes next in both settings.	Literature review Teacher • Gemma • Leah • Charise • Mara • Nadine • Pamela • Cherry

Communication and social skills

Design themes under this category focused on strengthening communication and social interaction for learners, while also supporting effective collaboration between parents and teachers. Learners need tools to express themselves and build relationships, especially those with limited or inconsistent verbal skills. Parents emphasized the importance of helping their children communicate needs at home, while teachers highlighted the challenges of addressing diverse communication styles in the classroom. Key features include multimodal communication systems like PECS and AAC, AI-driven prompts to support expressive language, peer-matching

tools for social engagement, and built-in messaging to support ongoing parent-teacher communication.

Table 24

Design themes for communication and social skills

ID	Design Theme	Description	Emerged From
DT #3	Multimodal communication and expressive language support	3.1 Provide access to multimodal communication supports (e.g., PECS, AAC integration). Include interactive exercises to practice selecting the right pictures to communicate. 3.2 Support learners who have inconsistent or fluctuating communication skills with intelligent tools that anticipate needs through an AI that learns commonly used phrases, routines, or emotional states, and suggest communication options proactively. 3.3 Make communication skill-building part of everyday tasks rather than isolated therapy sessions by integrating communication prompts at each step of their activities such as prompting them to say “done” or ask for more.	Literature review Children (through their parents, acting as proxies) • Anthony • Ken • Greg • Chris
DT #10	Peer interaction through storytelling and turn-taking	10.1 Enable simple social storytelling and turn-taking features. The child can interact with characters to practice turn taking or collaborative play 10.2 Match students with peer buddies for play and learning, or school projects 10.3 Incorporate familiar characters and storytelling for group-based activities	Literature review Children (through their parents, acting as proxies) • Ken
DT# 28	Picture-based parent-child communication tools	28.1 Enable parents to communicate with their child through pictures or symbols, which are customizable to include frequently used phrases and personal preferences. 28.2 A facility to teach parents how to implement multi-modal communication strategies that use gestures, facial expressions, visual supports, vocalizations, and physical actions in tandem with verbal language.	Literature review Parents • Edward • Jane • Lyane
DT # 32	Personalized communication tools and profile	32.1 Similar to parents, implement PECS with voice output features to support non-verbal learners.	Literature review Teachers

	for classroom use	32.2 Develop a profile of the learner's communication style, preferred methods (e.g., pointing, scripting, echolalia), and triggers/barriers that are accessible to educators, aides, and caregivers via app or secure portal. 32.3 Curate video clips, symbol boards, language milestones, and strategy notes for each learner.	• Nadine • Leah
DT # 36	Parent-teacher communication and coaching platform	36.1 Chat or messaging feature for parents to connect with the teacher for feedback, clarifications, or encouragement. 36.2 Provide a mechanism to provide feedback to learning goals, interventions and related activities done at school and at home 36.3 Provide a facility for teachers to provide structured home intervention guides, daily routine templates that parents can use with children. 36.4 Provide a facility for teachers to create learning materials or daily bite-sized coaching sessions (i.e. 10-15 minutes) with video examples and articles with practical techniques that will help parents implement interventions and continue their child's learning at home. 36.5 Organize virtual or in-person parent groups for sharing insights on implementing daily living skills at home. Assign a mentor or buddy parent to guide new or struggling parents in adopting the interventions. 36.6 Host educational workshops and community training programs, which not only inform families of their rights and available services but also help them develop the skills necessary to support their children.	Literature review Teachers • Nadine • Mara • Charise • Leah • Michelle • Gemma • Aster • Pamela • Cherry • Ashley Design feedback from an educator • Mara

Behavioral and emotional regulation

Design themes under this category addressed the regulation of emotions and behaviors in learners, with consideration of the emotional demands placed on caregivers and educators.

Across respondents, there was a shared emphasis on the need for tools that help children express emotions, manage anxiety, and understand behavioral expectations through visual cues and

stories. Additionally, parental burnout emerged as a concern, underscoring the need for built-in emotional check-ins and caregiver wellness features.

Table 25

Design themes for behavioral and emotional regulation

ID	Design theme	Description	Emerged from
DT #2	Emotional regulation and behavior cueing for children	2.1 Provide children emotional regulation tools such as digital emotion boards to help express how they feel based on icons or pictures; ready to access calming sounds; and access to breathing videos that they can follow to help reduce their anxiety. 2.2 Provide access to social stories to help demonstrate appropriate behaviors and how to handle frustrations 2.4 Provide visual supports that demonstrate clear expectations and rules; and contingency maps to help clarify the consequences of behavior.	Literature review Children (through their parents, acting as proxies) • Ann • Reg and Roy • Atticus • Alfie • Ken • Greg • Chris
DT #14	Parental tools for managing behavior at home	14.1 Provide learning materials and guides that will help parents manage behavioral challenges; and include step-by-step instructions and culturally relevant examples 14.2 A quick access “Calm Down” button with soothing visuals, sounds, and music that parents can easily provide to their child to de-escalate stressful moments. 14.3 Allow parents or teachers to efficiently log behavior events following an antecedent, behavior, consequence format; while ensuring that only relevant information is captured so it wouldn’t be cumbersome to use.	Literature review Parents • Rose • Rex • Amy • Donna • Edward • Jane • Lyane Design feedback from parent • Edward
DT #15	Caregiver wellness and	15.1 Develop self-care prompts and emotional check-ins within apps	Literature review

	emotional support tools	15.2 Offer access to virtual counseling or mindfulness tools	Parents • Rose • Rex • Amy • Donna • Edward • Jane • Lyane
DT # 31	Behavior management and monitoring tools for teachers	31.1 Implement individualized behavior management plans leveraging multidimensional assessments that consider sensory profiles, emotional health, and the presence of co-occurring conditions such as anxiety or depression 31.2 Implement positive reinforcement to reinforce good behavior 31.3 Use visual cues and supports to provide structure, clarity, and predictability, which can help reduce anxiety 31.4 Provide guides for teachers how to effectively implement a structured learning environment for children to reduce anxiety, provide predictability, and minimize distractions 31.5 A facility to log progress, behaviors, and challenges, and provides insights based on entries, such as identifying patterns in frustration triggers. Enable seamless sharing of behavior reports between teachers and parents for consistency 31.6 To address irregular attendance and engage students consistently, a gamified attendance tracking feature, where students earn rewards for regular participation and completing tasks can be implemented.	Literature review Teacher • Pamela • Mara • Charise • Leah • Michelle • Gemma

Physical, motor, and sensory support

Design themes in this category addressed learners' sensory processing and motor development needs by providing customizable, engaging, and developmentally appropriate supports. Sensory sensitivities such as sensitivity to noise, light, or texture can interfere with participation in daily activities. To address this, features that allow children to personalize

sensory inputs and access calming digital environments would be helpful. In addition, the development of motor skills can be supported through gamified activities and movement-based suggestions tied to each child's interests. These features aimed to create a more comfortable and responsive learning environment while promoting gradual desensitization and physical engagement.

Table 26

Design themes for physical, motor, and sensory support

ID	Design Theme	Description	Emerged From
DT #4	Personalized sensory regulation tools	4.1 Provide customizable sensory-friendly settings (e.g., mute buttons, textured visuals, brightness adjustment, color changes and filters). 4.2 Provide a digital sensory space where children can access soothing visuals, soft music, guided breathing, or animated fidgets. 4.3 Gradually expose children to triggers such as classroom noise, crowds, or light patterns, with adjustable intensity levels to gradually desensitize and reduce anxiety associated with real-world sensory exposure. Use gamification to reward progress in tolerating different inputs.	Literature review Children (through their parents, acting as proxies) • Reg and Rom • Ken • Chris
DT #5	Gamified motor skills and movement integration	5.1 Provide the capability to gamify gross and fine motor tasks (e.g., tapping, swiping, matching activities). 5.2 Include physical movement suggestions using children's preferred activities like biking or dancing.	Literature review Children (through their parents, acting as proxies) • Ann • Anthony • Ken • Chris

Parental support, training, and community

Design themes in this category addressed the broad spectrum of support parents needed to engage effectively in their child’s development. Financial concerns, limited access to training, and feelings of isolation were frequently reported, pointing to the need for affordable solutions, culturally responsive learning materials, and peer support systems. The implementation of micro-modules, multilingual content, and practical instructional videos to build their skills and confidence could help in addressing these challenges. Tools for goal tracking, progress monitoring, and content curation were also recommended for maintaining structure and safety in digital use. Collaboration with teachers and access to an intervention library further support continuity between home and school. Together, these features aimed to empower caregivers through accessible, personalized, and community-informed digital support.

Table 27

Design themes for parental support, training, and community

ID	Design Theme	Description	Emerged From
DT # 13	Financial aid navigation and subsidized support	13.1 Provide freemium, low-cost, subsidized, or tiered-pricing services 13.2 Offer free resource Kents and guides to help parents develop the skills necessary to support their children. 13.3 Explore partnerships for financial aid 13.4 A capability to search and apply for autism services, school programs, funding, and subsidies. 13.5 Intelligent assistant that guides caregivers through service navigation, budgeting, home therapy, and mental health support.	Literature review Parents • Rose • Amy • Donna • Edward • Jane • Lyane
DT # 18	Micro-training modules for parent empowerment	18.1 Embed learning micro-modules, with localized language options. 18.2 Offer short training videos on common strategies used by therapists and educators.	Literature review Parents • Rose

		18.3 Reward parents for consistency in using the app with digital badges or small rewards, such as access to additional resources or certificates of completion for training modules. Recognize their efforts to reinforce their importance in the learning process.	• Rex • Amy • Donna • Edward • Jane • Lyane
DT # 19	Family and peer support integration	19.1 Integrate in-app family task sharing 19.2 Local peer support groups for parents to share tips, ask questions, and connect with caregivers in similar situations	Literature review Parents • Rose • Rex • Donna • Edward • Lyane
DT # 20	Culturally inclusive autism awareness and advocacy	20.1 Feature positive narratives, parent testimonials, and culturally diverse stories of resilience. 20.2 These uplifting accounts, delivered through short videos, blog posts, or audio snippets, can normalize the experiences of raising a child with moderate to severe autism and help shift public discourse toward empathy, strength, and shared understanding	Literature review Parents • Rose • Jane • Lyane
DT # 21	Multilingual and low-literacy accessible content	21.1 Provide content in multiple local languages and add visual icons/symbols for low-literacy users 21.2 Allow voice guidance as an option	Literature review
DT # 22	Local service and policy support directory	22.1 Provide a list of available support organizations in their area that parents can reach out to.	Parents • Amy • Donna • Edward • Jane • Lyane
DT# 25	Curated digital content with parental controls	25.1 Content curation tools to select YouTube videos, songs, and games that the child can only access. 25.1 A locking feature that would require a password to go beyond the approved content.	Parents • Rose • Rex • Amy • Donna

			• Edward • Jane • Lyane
DT# 26	Goal tracking and progress reporting tools	26.1 Customizable learning goals based on the child's profile 26.2 Automated reports that show progress charts based on learning goals 26.3 Include parent grading/self-assessment features; and include integrity checks to discourage inflated self-reporting. 26.5 Provide insights based on entries, such as identifying patterns in frustration triggers. 26.6 Provide charts, filters, and visual dashboards	Literature review Parents • Rose • Rex • Amy • Donna • Edward • Jane • Lyane Design feedback from parent • Edward
DT# 27	Parent to teacher and parent to parent communication tools	27.1 Messaging and sharing functionality for parents and teachers to share updates about child activities, progress, challenges and milestones reached 27.2 Global parent chat with profile verification for trust and safety so that parents can also directly communicate with each other	Literature review Parents • Edward Design feedback from parent • Edward
DT# 29	Customizable intervention resource library	29.1 A repository of digital interventions created by teachers and therapists targeted to build common life skills for children with autism. 29.2 Allow parents to personalize and update interventions by recording and upload custom videos of their child following the same pattern of interventions published in the library	Literature review Parents • Rose • Rex • Amy • Donna • Edward • Jane • Lyane

			Design feedback from an educator • Mara
DT# 30	Interactive parent-child learning activity hub	30.1 A repository of parent-child bonding activities that promote learning through play (e.g., sensory play, motor skills, communication exercises). 30.2 Includes step-by-step video guides.	Literature review Parents • Rose • Rex • Amy • Edward • Jane • Lyane
DT # 35	Teacher and parent digital training community	35.1 Provide in-app tutorials, usage guides, and quick-start training modules tailored for both teachers and parents 35.6 Provide a digital community where teachers, therapists and various health and education professionals can collaborate and share their knowledge and experience	Literature review Teachers • Gemma • Michelle • Leah • Charise • Mara • Nadine • Aster • Pamela • Cherry • Ashley Design feedback from an educator • Mara

Teacher support and collaboration

Several areas for digital support, particularly tools that streamline individualized planning and reduce workload, were identified. Key recommendations included editable intervention templates, auto-generated progress trackers, and intelligent suggestions for individualized plans. Collaborative features, such as shared access with aides and exportable reports, were seen as

valuable for both classroom coordination and communicating with administrators. A secure and supportive digital environment that upholds data privacy, fosters peer support, and recognizes their efforts was also identified, along with the integration of personalization tools aligned with students' profiles, further supports inclusive and effective teaching practices.

Table 28

Design themes for teacher support and collaboration

ID	Design Theme	Description	Emerged From
DT # 38	Intervention templates and AI-Based planning tools	38.1 Create ready-to-use templates for commonly used interventions and positive reinforcements to help reduce teacher workload. 38.2 Leverage machine learning to help in drafting individual learning plans, intervention recommendations 38.3 Provide auto-generating progress trackers to monitor child performance and progress	Teachers • Gemma • Michelle • Leah • Charise • Mara • Nadine • Aster • Pamela • Cherry Design feedback from an educator • Mara
DT # 39	Teacher peer support and digital recognition	39.1 Provide a digital community that has peer sharing spaces 39. 2 Provide digital recognition for progress and milestones achieved	Literature review Teachers • Leah • Pamela •
DT # 40	Admin collaboration and multi-user access	40.1 Enable exportable reports that can be shared with school administrators 40.2 Allow multi-user access for teacher-aide collaboration.	Literature review Teachers • Leah • •

DT # 42	Secure data handling and privacy compliance	42. 1 Encrypt personally identifiable and sensitive information. 42.4 Add face blurring/anonymization for student videos/photos	Literature review Teachers • Design feedback from an educator • Mara
DT #44	Personalized lesson creation using child profiles	44.1 At setup, the app collects information about the child's developmental stage, abilities, interests, sensory preferences, and specific goals through a user-friendly questionnaire or an interview format. 44.2 Offer pre-made templates from teachers that parents can edit to fit their child's needs. Enable teachers and parents to upload photos, videos, or recordings to personalize lessons with familiar objects or environments. 44.3 Allow parents to choose themes, colors, sound levels, and visual styles that align with the child's sensory profile to avoid overstimulation.	Teachers • Gemma • Leah • Charise • Mara • Nadine • Aster • Pamela • Ashley Design feedback from parent • Edward Design feedback from an educator • Mara

Motivation and engagement

Motivation and engagement emerged as central themes across both home and school contexts. Parents and teachers emphasized the importance of using learners' individual interests, such as music, drawing, or games, as natural entry points for learning and engagement. Features such as drawing pads, personalized game elements, and interactive activities were recommended to sustain interest. Gamification strategies, including achievement badges, mini-games, and level progression, were seen as effective in promoting continued participation. Additionally, tailored

reward systems that mirror classroom practices were viewed as essential for reinforcing positive behavior consistently across settings.

Table 29

Design themes for motivation and engagement

ID	Design Theme	Description	Emerged From
DT #8	Interest-driven learning and creative expression	8.1 Leverage child interests (e.g., music, drawing, video games) as entry points for learning. 8.2 Add drawing pads to encourage creative interests. 8.3 Personalize game elements based on individual preferences. 8.4 Provide a means to learners to see themselves in videos or pictures, to increase motivation, reinforcing routine and engagement.	Literature review Children (through their parents, acting as proxies) • Ann • Reg and Roy • Anthony • Alfie • Ken • Greg • Chris Design feedback from an educator • Mara
DT #45	Gamified learning with rewards and challenges	45.1 Achievement badges, level progression, mini-games, and virtual rewards can be implemented to motivate skill mastery, along with customizable content and collaborative challenges to foster engagement.	Children (through their parents, acting as proxies) • Ann • Reg and Roy • Anthony • Alfie • Ken • Greg • Chris
DT #43	Consistent reward systems across home and school	43.1 Collaborate with parents to create reward systems that align with what is used in the classroom, ensuring consistency in behavior management.	Literature review Teachers • Cherry

		43.2 Reward charts, token systems, or positive reinforcement, can reinforce desired behaviors at home, mirroring the structure of the classroom. 43.3 Add non-material reward options for low-resource contexts	- Ashley Design feedback from an educator - Mara
--	--	--	--

Technology access and usability

Access and usability challenges emerged as significant concerns across both parent and teacher accounts, particularly due to limited internet connectivity, device availability, and digital literacy. Parents emphasized the need for offline access, flexible training schedules, and simplified user interfaces. At the same time, teachers highlighted the importance of minimizing reliance on high-spec devices and ensuring resources are accessible in low-bandwidth environments. Additionally, hesitancy about screen time led to inferred needs for hybrid learning options that encourage real-world engagement, with app-based support primarily used by adults. These themes underscore the importance of designing a solution that is both technically inclusive and sensitive to the realities of users' home and school contexts.

Table 30

Design themes for technology access and usability

ID	Design Theme	Description	Emerged From
DT #9	Offline and low-bandwidth accessibility tools	9.1 Add guidance for families without devices to ensure accessibility 9.2 Include offline access, caregiver tutorials, and printable resources for families with limited resources. 9.3 Ensure low-bandwidth mode for mobile use.	Literature review Design feedback from an educator Mara

DT # 23	On-demand learning aligned with parent schedules	23.1 Provide on-demand training and learning materials that parents can access anytime 23.2 Provide a capability to create custom schedule for parent-child activities that revolve around the parent's schedule reminders for flexible routines 23.2 Offline capabilities to support areas with poor network and internet access	Literature review Parents • Rose • Rex • Amy • Donna • Edward Design feedback from an educator • Mara
DT # 24	User-friendly interface with guided tutorials	24.1 Design simple UI, clear navigation and intuitive icons. 24.2 Include a "how to use" tutorial upon first use. 24.3 Provide contextual guidance (tooltips, walkthroughs) to avoid overwhelming navigation. 24.6 Simplify complex user flows or break them into smaller guided steps to reduce cognitive load for parents.	Literature review Parents • Rose • Rex • Amy • Donna • Edward • Lyane
DT # 34	Low-spec device compatibility and print alternatives	34.1 Ensure offline functionality 34.2 Minimize reliance on high-spec devices 34.3 Offer printable versions or low-bandwidth modes 34.4 Offer families a list of online resources and applications that are free or low-cost and easy to use.	Literature review Teachers • Michelle Design feedback from an educator • Mara
DT # 37	Screen time monitoring and hybrid learning features	37.1 Built-in alerts to limit app usage, suggesting breaks after a set duration. Offers tailored reminders for teachers and parents to transition students to physical or screen-free activities. 37.2 Include hybrid activities that require real-world engagement. Teachers and parents can document completion using the app without the student needing screen interaction.	Teachers • Pamela • Aster • Gemma Design feedback from an educator • Mara

Integration of primary and literature review

The design themes derived from the primary data collected in Workstream 2, through interviews and surveys with parents, teachers, and learners, refined the initial capabilities and features identified from the literature review in Workstream 1, and also identified new requirements based on experiences and expressed needs of learners through their parents and teachers, along with the needs and challenges of parents and teachers themselves.

For instance, the literature review emphasized the use of structured visual task sequences and video modeling as effective strategies for teaching life skills. These recommendations were strongly corroborated by parents and teachers, who highlighted the importance of visual supports and video demonstrations tailored to learners' daily routines. Emotional regulation and behavioral management features identified in the literature were likewise reinforced by primary findings, which emphasized the prevalence of anxiety and behavioral challenges among learners. Participants emphasized the need for accessible calming tools, clear behavioral expectations, and individualized reinforcement systems. Parental support emerged as a key theme through both data sources. Capabilities such as accessible instructional content, training modules, and communication tools, originally proposed based on a literature review, were confirmed by parents' accounts of the challenges they face in supporting their children at home and by the teacher's recommendations to involve the parents more in their children's learning. This convergence highlighted the importance of empowering caregivers with practical resources and ongoing guidance. Similarly, sensory sensitivities and individualized learning preferences, outlined in the literature review as important considerations, were validated by accounts from learners and teachers, underscoring the need for customizable sensory settings and personalized content to enhance engagement. Lastly, gamification and motivation strategies proposed in the

literature found strong support in the primary data, with respondents identifying rewards, progress tracking, and engaging interfaces as valuable components for maintaining learner motivation.

Workstream 3: Iterative design and development

The third workstream focused on the iterative design and development of a digital health solution for the life skills development of learners with medium-to-severe ASD, called “Odyssey”. The activities in this workstream were focused on developing a medium-fidelity prototype in Figma and a high-fidelity prototype Android application built from the ground up, based on the results of workstreams 1 and 2. In this third workstream, the researcher collaborated with MDTI students from the University of Ottawa and an industry partner, a locally based start-up, ACL.

Alpha Version.

The alpha version was co-created from May to August 2024 and focused on designing screens for creating digital interventions and on viewing completed interventions by learners and parents. Other screens were also designed to support the execution of these interventions from the perspectives of the teacher, parent, and child.

Design Prototype

In the alpha version, the researcher first created a low-fidelity prototype in Figma based on initial analysis and ideation from the completed literature review.

Figure 29

Initial design for task analysis and video-modelling intervention

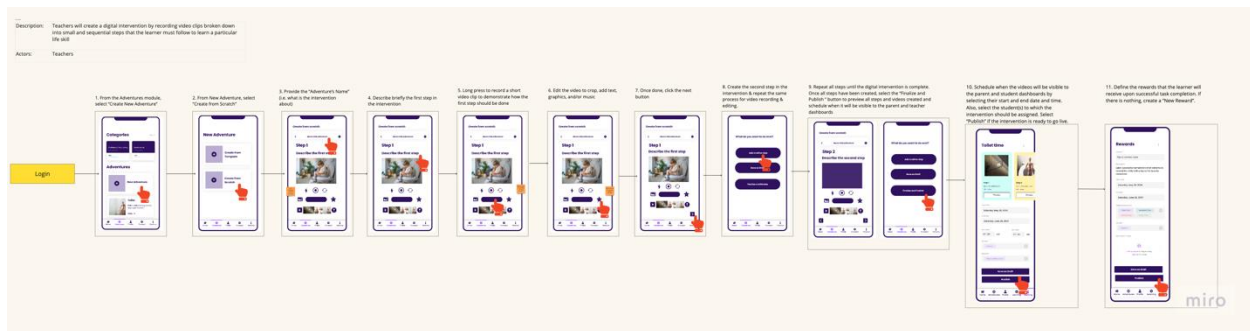
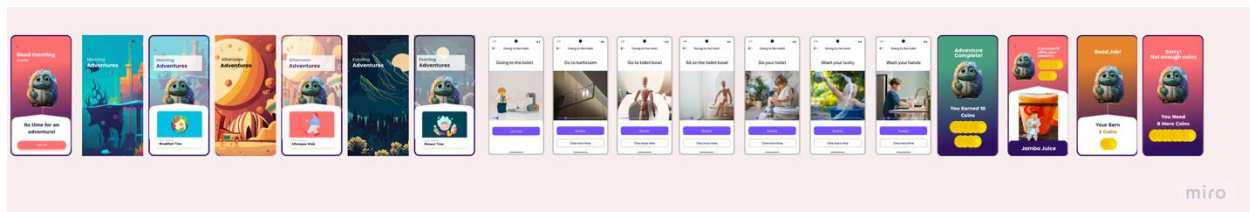


Figure 30

Initial design of how the child will access the created intervention



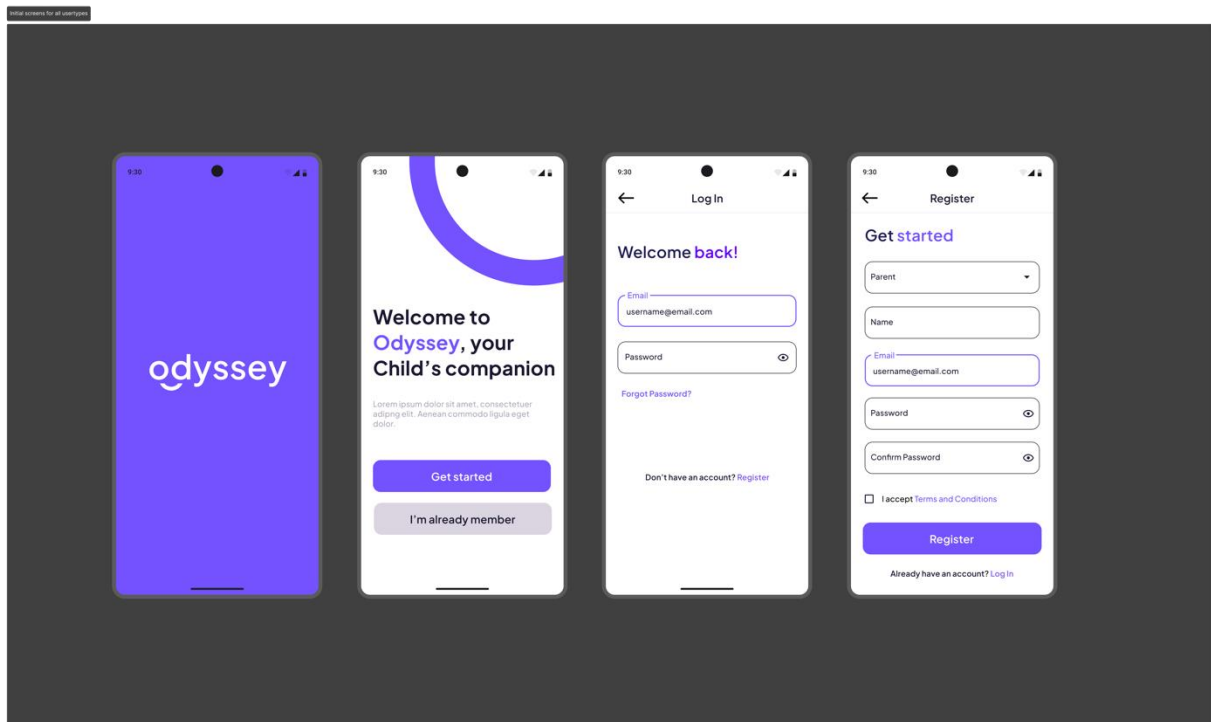
The screens in Figure 53 showed initial sketches for the task analysis and video modeling creation tool to be used by a teacher or parent. Screens in Figure 54 show initial sketches on how the child would access the completed digital intervention once the teacher has completed and published it, ready for the child to use.

This low-fidelity prototype was transformed into a medium-fidelity prototype through a collaborative effort with MDTI students from the University of Ottawa from May to August 2024. The initial designs were then handed over to the MDTI student, Raj Baldania, and converted into a medium-fidelity prototype, aligned with UI/UX standards and best practices. More detailed documentation of the design is available in the report completed by Raj Baldania in Appendix 2.

Figure 55 showed the login and registration pages, which asked users to provide an email address and password and to indicate whether they are a parent or an educator.

Figure 31

Login and registration



Upon logging in, the user, in this case a teacher, will be taken to the dashboard and landing page, where a summary of available digital interventions, called “adventures,” and positive reinforcements, called “rewards,” can be seen (i.e., Figure 56). Upon clicking the “View All” button in the Adventures summary section, an “Add new adventure” button appears, which, when clicked, directs the user to create a custom digital intervention (i.e., adventure). The adventure can be created through video modelling by enabling the recording of video clips and attaching them to the steps needed for the learner to complete a particular intervention. The user would also be asked to create a “reward” that the learner earns upon completing the adventure successfully. A simplified individual learning plan that ties adventures and rewards to a child’s

learning goals was also provided, along with the ability to track those goals throughout the academic year.

Figure 32

Teacher screens

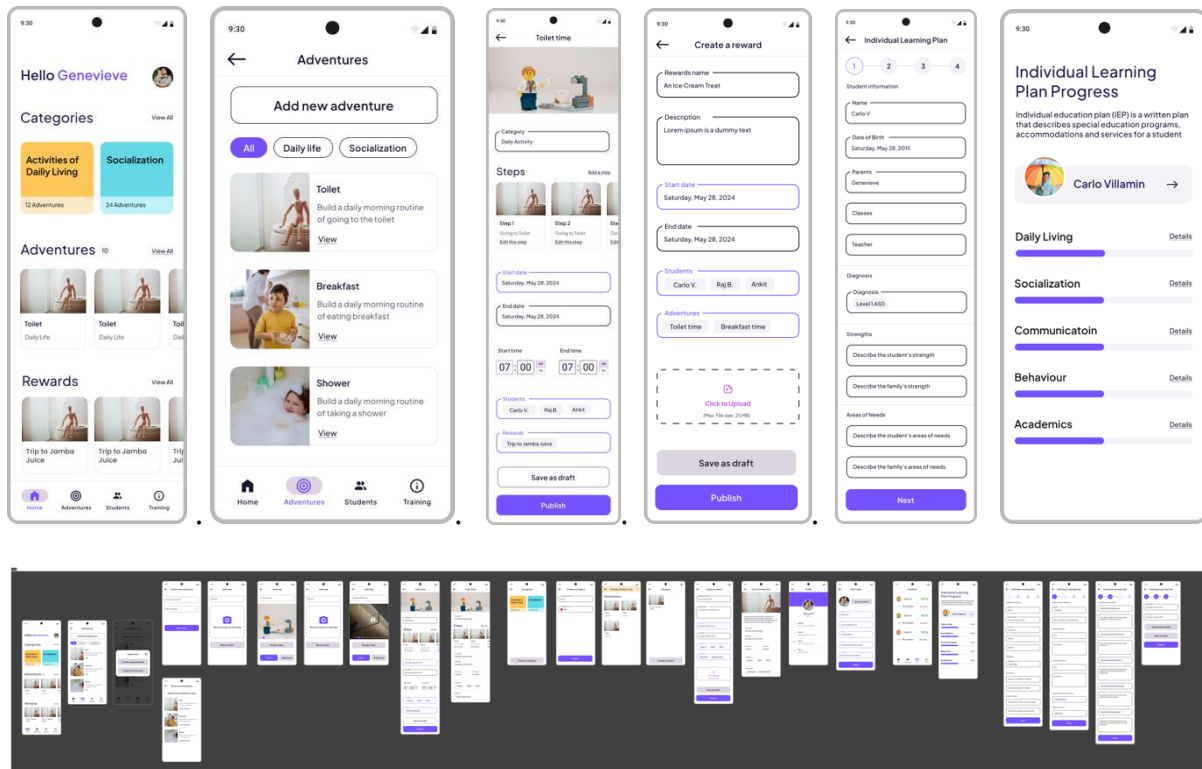


Figure 57 showed the parent screens, which comprised a dashboard and a landing page; a place where parents can watch micro-learning videos to teach them in supporting the learning of their child; a customizable schedule for their child to help in building healthy routines; and detailed reports to help them track their children's learning progress.

Figure 33
Parent screens

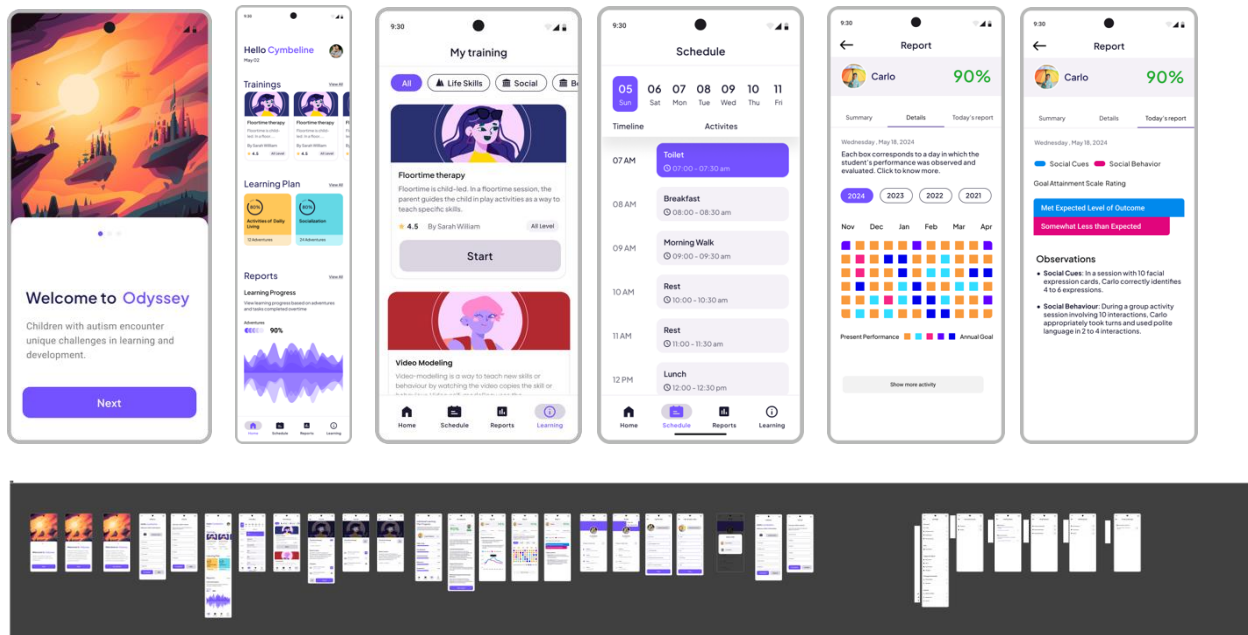
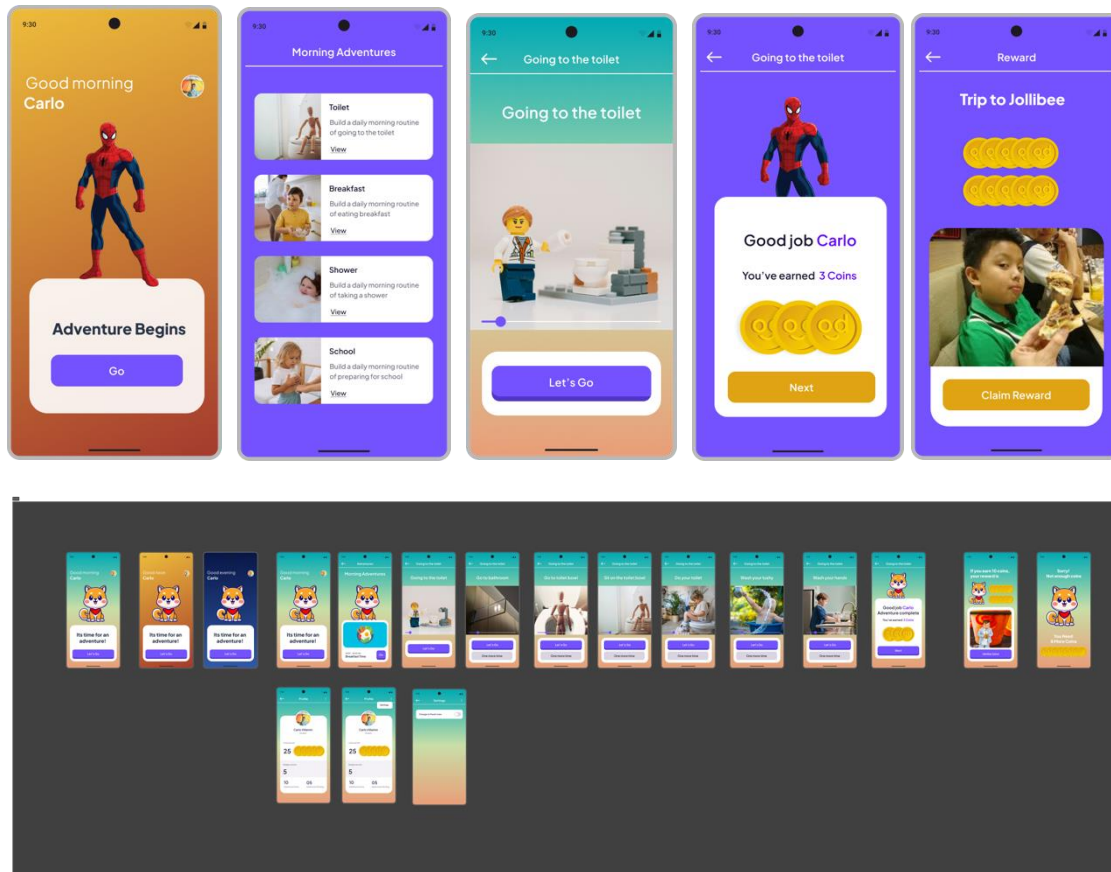


Figure 58 showed the learners' view of the adventures, which would be the interventions and positive reinforcements that the teacher created. Children screens were redesigned to be simpler and more straightforward, to reduce cognitive load and cater to the information processing needs of individuals with ASD, due to their weak central coherence (Sodian et al., 2015; Miller, 2022), and heightened ability to process and perceive sensory information, particularly in the visual domain (Baron-Cohen et al., 2009), also known as enhanced perceptual functioning. The screens could be personalized to align with learners' backgrounds, interests, and hobbies, supporting a learner-centered education approach (Msonde, 2023; McCombs and Vakili, 2005; Watson & Watson, 2011; Alexander and Murphy, 1998).

Figure 34

Learner screens



Android Prototype

The alpha version focused on developing registration, login, and video recording capabilities. This was done in collaboration with the MDTI student Ankit Arora. During this stage, the Login and Registration pages were completed, and a placeholder landing page was set up. More detailed documentation of the front-end and back-end development activities can be found in the report completed by Ankit Arora in Appendix 2, who collaborated with the research team to build the first Android prototype from May to August 2024.

Beta version.

The Beta version was co-created from January to March 2025 and focused on developing the UI/UX design for the missing screens for the teacher and child personas, along with re-designing key screens and updating the product branding and color schemes, in collaboration with another MDTI student. This version also focused on re-architecting and re-implementing the mobile application, moving from a native Android application to a hybrid Android application, in partnership with the Ottawa-based start-up ACL.

Design Prototype

The medium-fidelity prototype in Figma from version Alpha was updated through a collaborative effort with the MDTI student Malavika Mahesh from January to April 2025. Using input from primary data collection, the design from version Alpha was updated to include information from parents and teachers about their experiences teaching and caring for children with ASD. More detailed documentation on Malavika's design is available in Appendix 4.

The updated Figma prototype included new screens for teachers to create learning materials for parents (i.e., parent implemented interventions); new screens for a community library of digital interventions shared with consent, that are publicly available and can be utilized by others; a parent-teacher collaboration hub for group and individual messaging; and a form that teachers can use to evaluate the progress of a learner through scheduled parent check-ins.

Figure 35

Login, Registration, Splash Screen, Profile Creation

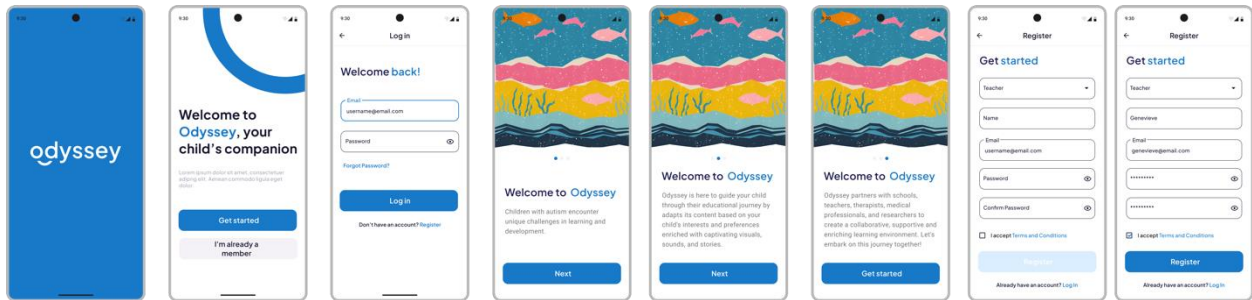


Figure 59 showed the updated registration, login, and onboarding pages. The color schemes were also updated to consider sensory sensitivities common among individuals with ASD. A cooler color scheme in shades of blue replaced the bright purple color scheme from version Alpha.

Figure 36

Teacher Landing Page, Dashboard, Classes, Students, Parents View

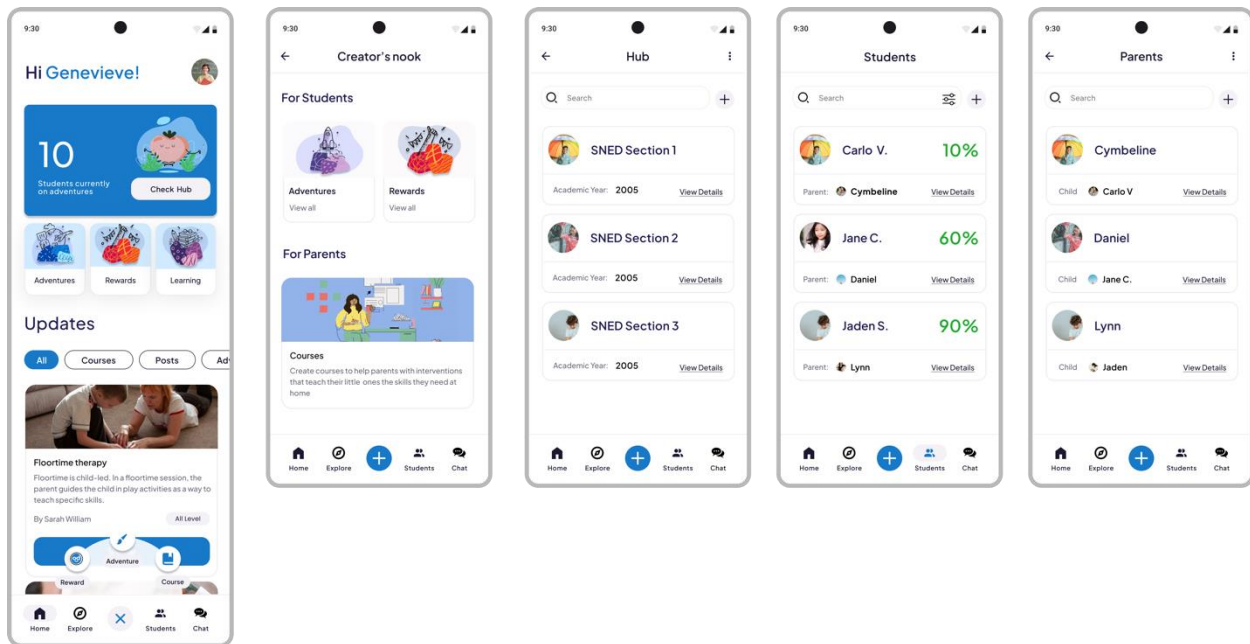


Figure 60 showed the updated teacher landing page, which included a link to access adventures, rewards, and learning modules that educators can provide to parents to help them continue their child's learning at home. A new page called the “creator’s nook” also provided teachers with a consolidated view of the learning creation tools that they can use to create these learning and instructional materials. Another page, called the “hub,” provided a list of all classes and students an educator is responsible for. Each student was also linked to a parent profile, so the teacher can easily communicate with parents regarding their children's learning progress and provide relevant updates or announcements.

Figure 37

Individual learning plan (Voyage path)

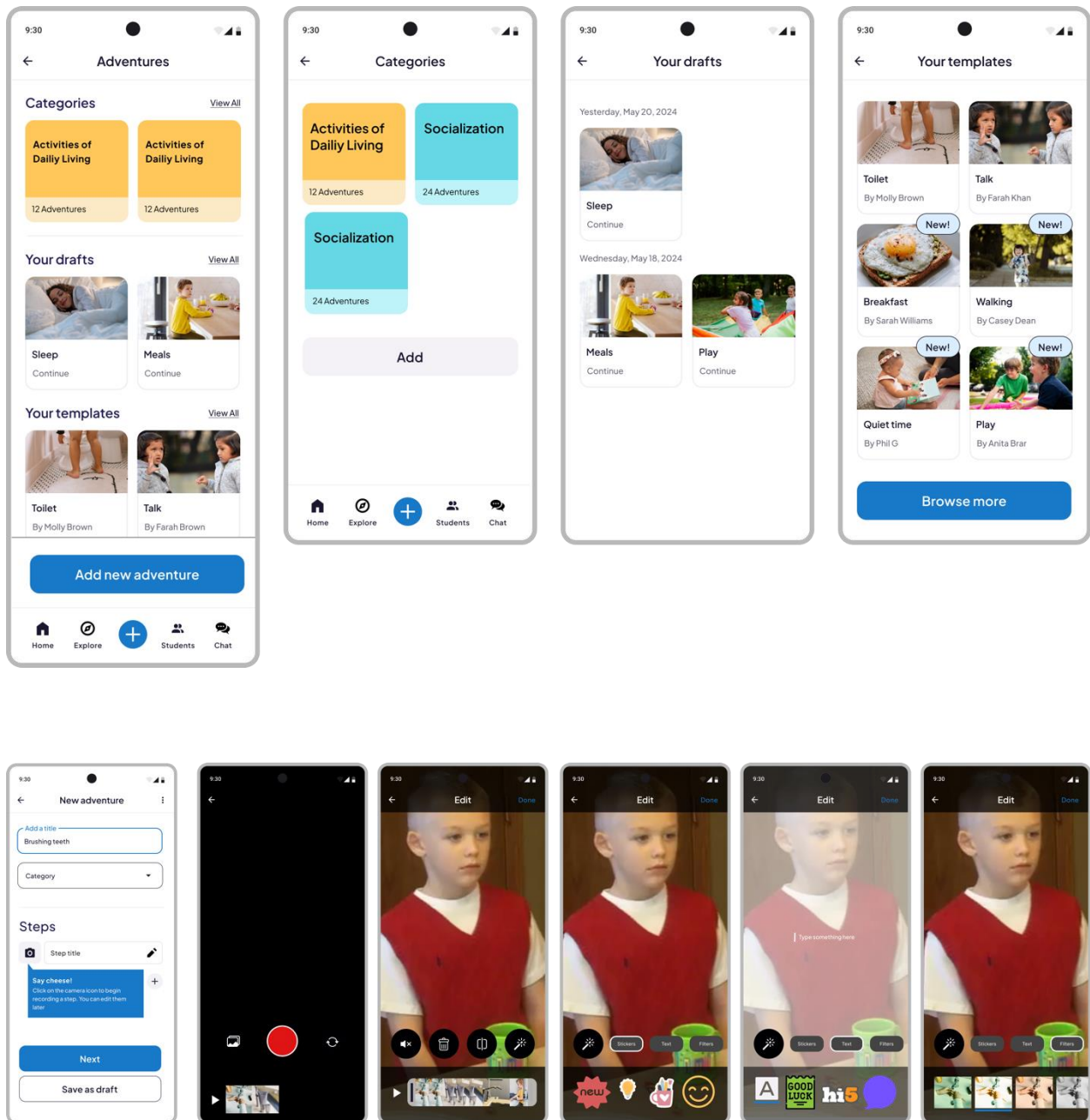
The figure displays five mobile app screens for creating an individual learning plan (Voyage path) for a student named Jaden Miguel Santos. The screens are as follows:

- Screen 1: Students** - Shows the student's profile (Level 3 ASD, Age: 5 years, Parent: Lynn) and a "Create Voyage Path" button. Below the button is a message: "Jaden has no stats to show. Add an adventure to start!" and an "Add adventure" button.
- Screen 2: Edit Voyage Path (Step 1)** - Shows the "Explorer's Mission" section with a text box for the mission: "Enable Jaden to perform self-care routines and manage transitions with minimal parental supervision." Below this is the "Treasure Islands" section with a text box for goals: "Jaden can prepare his own breakfast with visual support." and "Jaden can follow a visual schedule to complete his morning hygiene routine (brushing teeth, washing face)." and "Jaden can manage emotional regulation through calming exercises during transitions." A "Next" button is at the bottom.
- Screen 3: Edit Voyage Path (Step 2)** - Shows the "Adventures" section with a text box for interventions: "Add interventions to support the child in their explorer's mission." Below this is the "Crew members" section with a text box for crew members: "You (default) Lynn" and a "Rewards" section with a text box for rewards: "Add rewards to support the child in their explorer's mission." Below this is a "Next" button.
- Screen 4: Edit Voyage Path (Step 3)** - Shows the "Explorer's logs" section with a text box for logs: "Scheduled check-in points every two months for the SNED teacher and Jaden's parents to discuss progress and adjust interventions as needed." Below this is a "Save as draft" button and a "Publish" button.
- Screen 5: Voyage Path** - Shows the completed "Voyage Path" for Jaden Miguel Santos. It includes sections for "Explorer's logs", "Treasure Islands" (with three islands: Island 1, Island 2, and Island 3), "Adventures", "Crew members", and "Rewards". An "Edit" button is at the bottom.

Figure 61 showed an updated individual learning plan form with a more user-friendly interface, in which the requested information was broken into several smaller pages, making it easier to complete. The learning plans were also renamed to “voyage path” and would enable educators to link the specific adventure and rewards they want to use for the student.

Figure 38

Creation of digital interventions (Adventures)



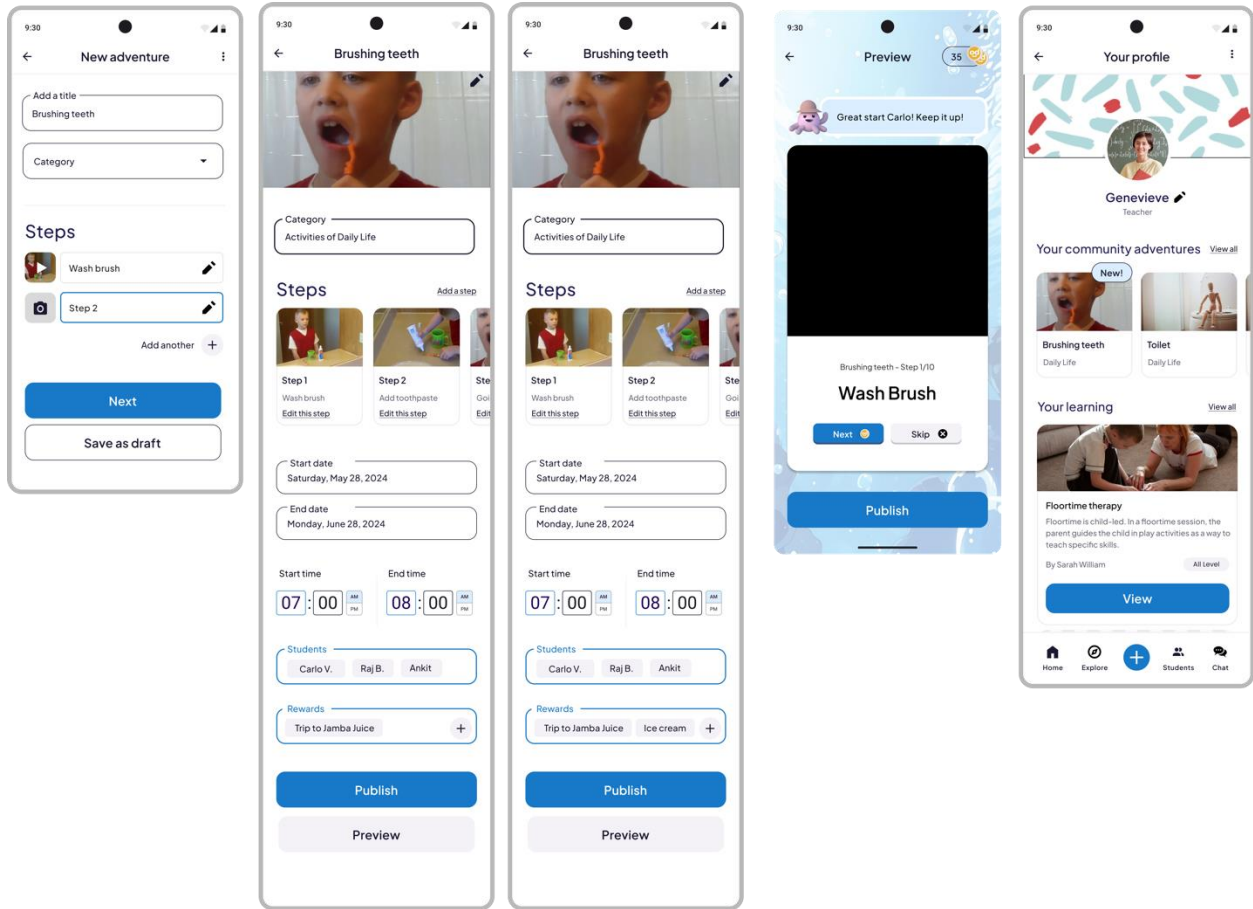


Figure 62 showed an updated form for creating adventures in which teachers would first be asked to break down a task into several smaller steps and then link a particular video clip or image to new or pre-created media to clearly demonstrate to the learner how to execute that step correctly. The videos or images can be customized, enabling users to use their phone cameras to capture short clips or photos and then combine them to create a specific intervention step. Each step can also be edited by cropping and merging, and by adding stickers, text, and filters. Upon completing all the intervention steps, a preview is provided, showing how the child would see the adventure on their device. This would allow the teacher to validate the adventure before publishing and sending it to the learner for execution.

Figure 39

Creation of positive reinforcements (Rewards)

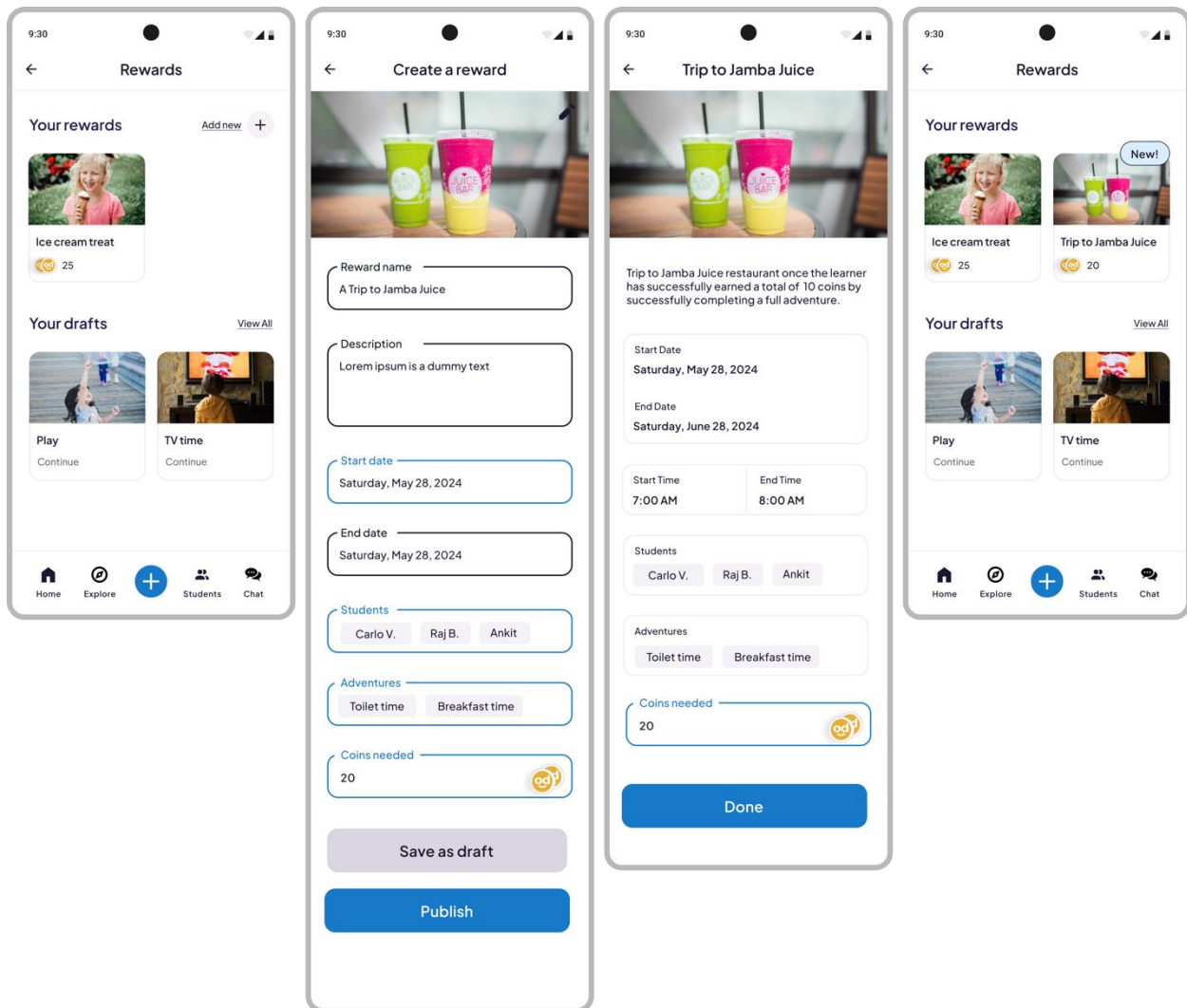


Figure 63 showed the updated rewards form that would allow the child to earn digital coins for completing each adventure step. The determination of successful step execution would still rely on the parent, caregiver, or teacher assisting the child in their learning. Once the child had accumulated the required coins to redeem the reward, the application would display a success message and indicate that it was time to enjoy the fruits of their learning. The rewards would also be customizable and depend on what's defined in their individual learning plan. Rewards could be simple, such as going out for a walk at their favorite park, or could be a trip to

their favorite restaurant. It could also provide access to a tablet, phone, or computer to play their favorite game or stream their favorite videos.

Figure 40

Creation of learning materials for parent-implemented interventions (Learning)

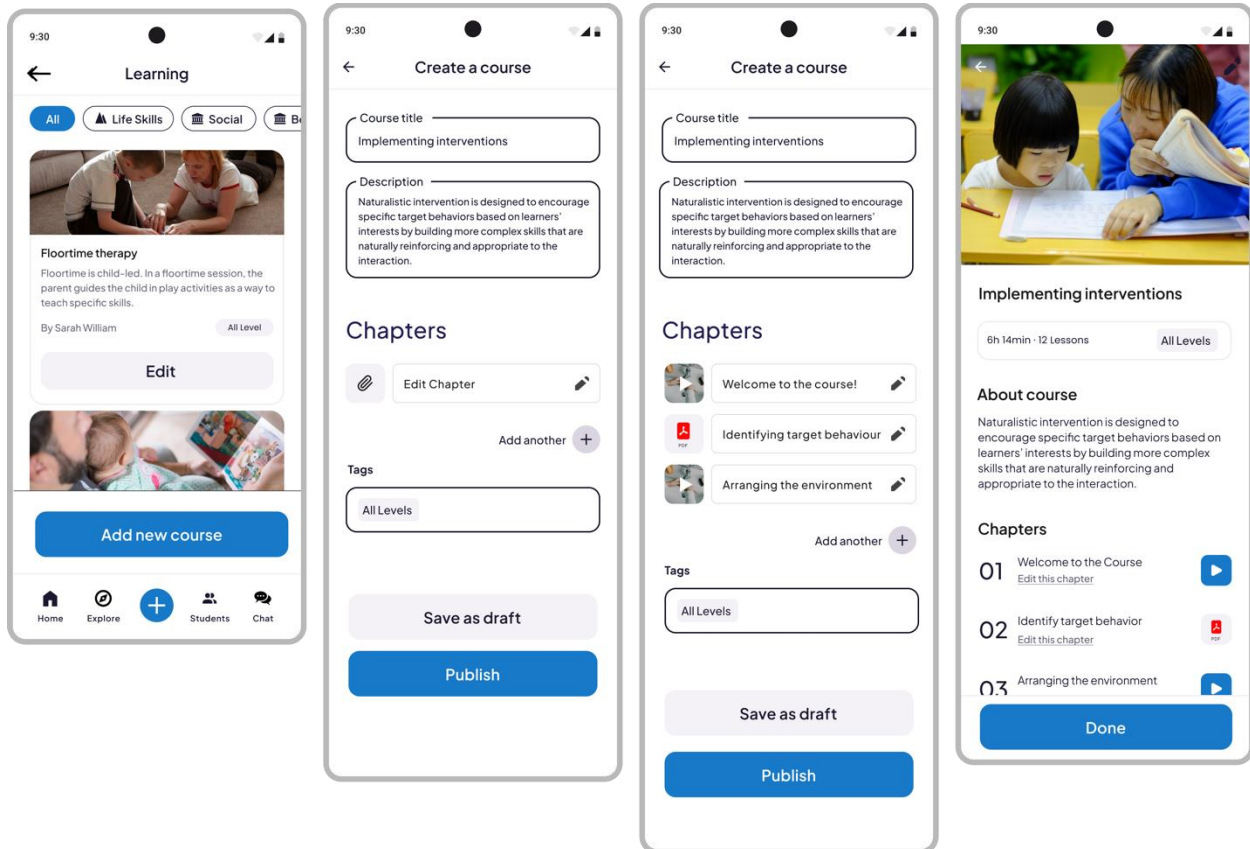


Figure 64 showed updated screens for teachers to create bite-sized instructions that the parents could use to help their child continue learning at home. Following the same layout for adventure creation, the teachers would also be asked to create main chapters or sections for parents' learning and to add related media, such as videos, photos, and presentations. Or upload

related documents such as PDF or Word files. This capability was informed by parent-implemented-intervention practices and by the need for both parents and teachers to work hand in hand to provide effective learning for a child with moderate to severe ASD, as informed by both the literature and primary data.

Figure 41

Sharing of content with other teachers and parents (Community)

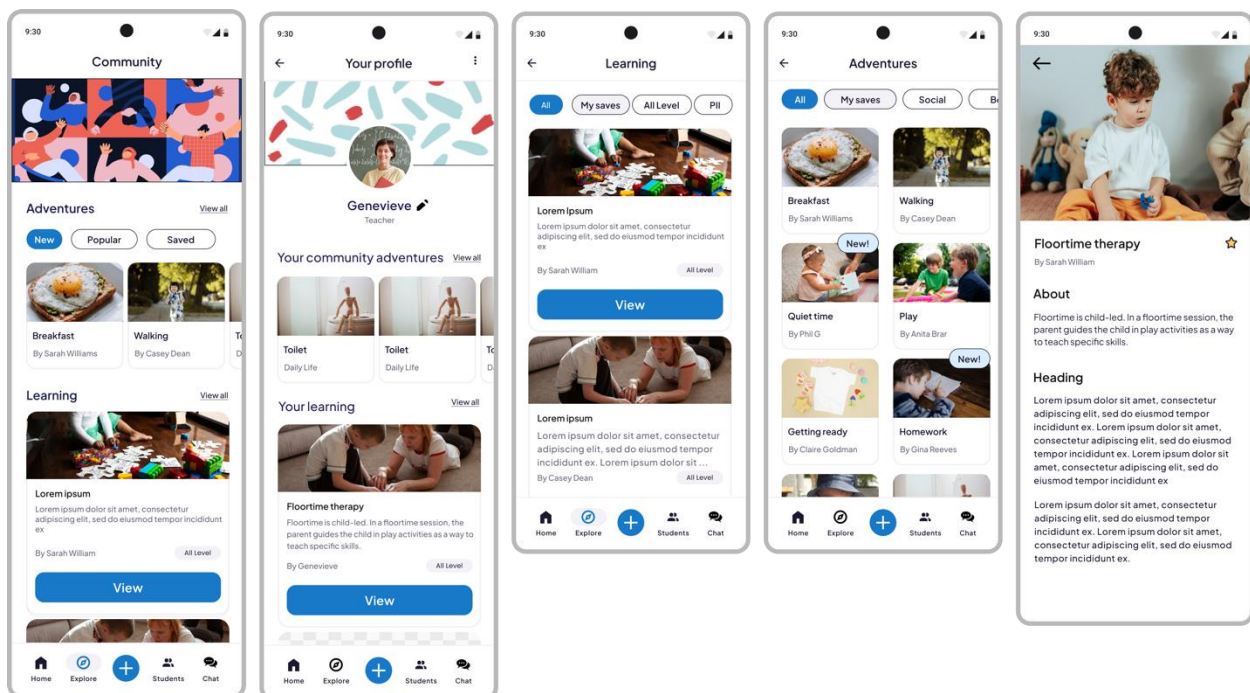
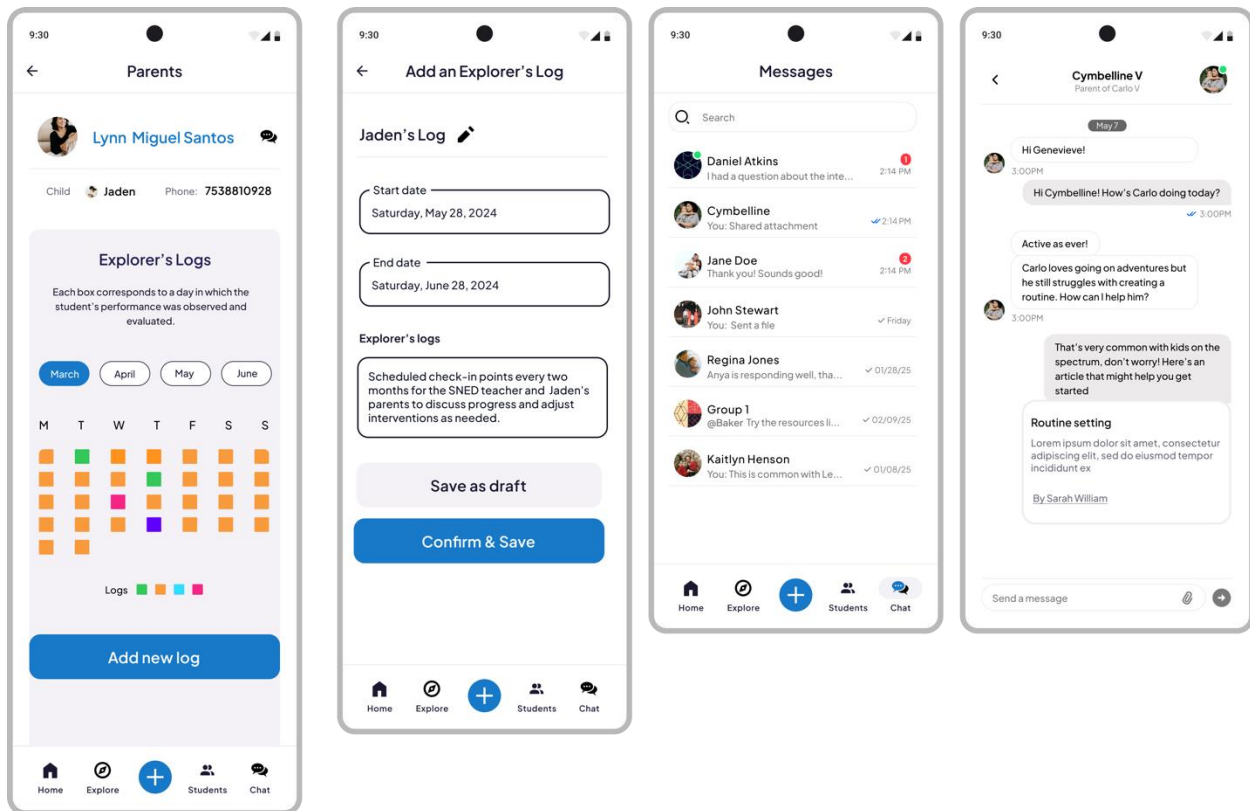


Figure 65 showed new screens called “community,” which would enable teachers and other users who create digital interventions and instructional materials to share their content with a broader community, so that parents, caregivers, and their support systems can also use and benefit from it. Inspired by crowdsourcing and the creator economy, this capability would enable the development of a digital community of parents, educators, health care practitioners, and ASD advocates to make ASD-specific learning, therapy, and guidance more accessible and affordable.

Figure 42

Parent collaboration and communication



Finally, Figure 66 showed new pages for parent-teacher communication via an individual and group chat feature that both parents and teachers can initiate, providing a secure, shared platform for discussing anything related to the child's learning journey. The chat feature would include industry standards for privacy and security and, at the same time, would enable users to review the history of past conversations, which would help inform the progressive refinement and improvement of the child's learning plans, goals, and activities.

Design feedback session

Design feedback sessions on version Beta were first conducted with industry partners on March 27, 2025, and with teacher Mara on March 29, 2025. The design session with ACL aimed to gather initial feedback on the user interface and user experience, and to assess whether the design and overall process flow can be understood regardless of whether a user has a background with children with ASD. This enabled the design team to gather initial review and feedback before conducting the actual design review with teacher Mara, which identified areas for improvement that were later incorporated into Figma before the design session with the teacher.

A few days after the feedback session with industry partners, a design feedback session was organized with teacher Mara. Originally planned as a think-aloud protocol, the approach changed during the session when teacher Mara experienced internet issues, and the Figma prototype failed to load on her screen. Instead of having her navigate the design prototype on her own, the researchers provided a demo of the app and its main capabilities.

The purpose of the design feedback session was to identify her perceptions, concerns, and suggestions regarding the design prototype by providing verbal feedback as pages in the application were being navigated. Feedback was received on nine major themes, which were presented below.

Table 31

Design feedback summary of an educator for teacher-focused screens

Category	Theme	Description	Transcript
Rewards and motivation	1. Rewards in low-resource areas	The use of virtual coins as positive reinforcement was questioned due to	“The problem is the parents are not able... The parents have no

		socioeconomic challenges in public schools. Non-material rewards such as praise or symbolic items were viewed as more culturally and economically appropriate.	means.” “In the Philippines, we only give them stamps, stars... or a simple ‘Good job’.”
	2. Motivational value of self-representation	Students with autism are motivated by seeing themselves in videos or pictures, reinforcing routine and engagement.	“Once they see their face on video... they’re happy. They’re proud.” “Especially children who are routinary... they cannot work if the routine is broken.”
	3. Motivational value of self-representation	Seeing themselves in videos or photos was reported as highly motivating for students with autism, especially those who thrive on routine and familiarity.	
Intervention / lesson creation	4. Necessity of intervention customization	Interventions must be adaptable to the developmental level and physical abilities of each child. Mara appreciated that the app allowed hyper-personalization of tasks and media.	“If the child has motor skill challenges, maybe the first step will not be even picking up the toothbrush. It might be first like hand exercises.” “What about if a child with cerebral palsy... it cannot even hold a pencil yet?” “You can personalize... even use actual recordings of the child.”
	5. Parent empowerment and delegation	The teacher proposed that responsibility for content creation could shift to parents, especially for home-based interventions. This would alleviate teacher workload and enhance parental involvement.	“If you will allow this app to be shared to the parent... for sure the parents can do it for their own child.” “The part of the teacher is to remind the parent... then the parent will be the one to do this.” “If the parents are techie, they can create their own content.”

Challenges and limitations	6. Teacher workload and practicality concerns	Teachers, especially in overloaded classrooms, may not have the time or energy to create individualized content for each student, potentially limiting app adoption.	“If the teacher will do every single life skill... the teacher will not sleep anymore.” It’s really an additional burden to the teacher... especially, we are overloaded with students.” “It’s another workload.”
	7. Variability in teacher digital literacy	Teachers’ technological proficiency, especially among older educators, was raised as a potential challenge. While younger teachers may adapt more easily, others may require additional training.	“Not all of us are techies... especially if we are nearing our senior citizen age.” “It’s a challenge to me... maybe the other younger teachers will be challenged also... but younger ones are techy.” “Younger teachers will be more comfortable.”
Infrastructure, security and implementation	8. Infrastructure and connectivity barriers	Concerns about poor internet access, limited device availability, and slow download speeds affecting usage of the app.	“It’s very slow downloading... it’s just turning around, but it’s not downloading.” “That’s also the problem... the internet.” “What if the family does not have a gadget?”
	9. Concerns over student privacy	Ethical considerations are raised regarding the use of real photos or videos of students, advocating for privacy-protective features such as face blurring.	“We cannot show their face... they are vulnerable.” “If you don’t want to show the child’s face, you can cover it.”
	10. Institutional and bureaucratic pathways for implementation	For the app to be adopted in public schools, participants emphasized the need to follow formal approval processes through the educational hierarchy in the Philippines.	“You finish your prototype. Then make a letter to our division supervisor in SPED... And then you will create a seminar.” “You must go through proper channels... start with the division superintendent, then principal, then teacher.”

			“Make a letter to our division supervisor first. That’s the only way it will reach the teachers.”
	11. Concerns about gadget use	Noted risks of gadget overuse among children with autism, such as tantrums, selective mutism, and therapist recommendations to limit screen time. Suggested controlled use and time-bound app access.	“Most of our parents... do not allow their child to use gadgets... once they give them gadgets, the child tends to be selective mutism.” “Most of our parents... do not allow their child to use gadgets...” “Therapists always say lessen gadgets.”

During the design feedback session with teacher Mara, insights were shared on the practical realities and professional needs of special education teachers working in low-resource public schools in the Philippines. While the prototype incorporated several promising features, such as customizable tasks, multimedia instructions, and reward systems, there are notable areas where alignment with teacher workflows, capacities, and institutional conditions can be further strengthened.

First, a major gap pertained to teacher workload and practicality. The expectation that teachers generate individualized content for each life skill for each learner was identified as a key barrier to adoption. In classrooms with high learner-to-teacher ratios and extensive administrative tasks, the additional responsibility of creating customized content may be overwhelming. This emphasized the need for scalable solutions, such as content libraries, templates, and AI-assisted content generators, to reduce manual effort.

Second, infrastructure limitations and connectivity barriers present critical usability issues. The prototype’s reliance on cloud-based access or high-bandwidth media could pose challenges for classrooms and homes with unstable internet and limited device access. This

indicated a need to ensure that the tool can operate offline, support low-spec devices, and allow print-based alternatives, features that were especially crucial in public school contexts.

Third, the feedback identified a digital literacy divide among teachers, especially among older educators, that could hinder effective use of the app. While some teachers may quickly adapt to the digital interface, others may require structured onboarding and continuous training. This highlighted a gap in the prototype's support ecosystem, which could be mitigated by integrating in-app tutorials, peer support features, and community-based technical assistance.

Additionally, although the prototype features personalized interventions using student-specific media, concerns were raised regarding student privacy and the ethical use of identifiable photos or videos. Teacher Mara emphasized the need for privacy-protective features, such as face blurring, masking, or avatar-based alternatives, to balance motivation and safety. This highlighted the importance of embedding robust privacy controls and guidance for ethical media use within the application.

The feedback also revealed an institutional gap: formal pathways for app implementation in public schools are absent from the current design narrative. Teacher Mara emphasized that any educational technology needed to go through bureaucratic approval processes involving division superintendents, principals, and other stakeholders. This suggested the need for accompanying materials such as endorsement templates, compliance documentation, and letters of intent that schools can use to introduce the app through official channels.

Lastly, a notable insight was the potential for parental delegation and empowerment. Teacher Mara advocated shifting some content-creation responsibilities to parents, particularly for home-based interventions. This strategy could not only reduce teacher workload but also foster deeper parent involvement and continuity of learning. However, in this version of the

prototype, no features were yet designed to enable parent-implemented interventions, collaborative content creation, or role-specific access controls tailored to caregiver participation.

Android prototype

The Android prototype from the alpha version was re-architected, and the technology stack shifted from using native Android to a hybrid application using Apache Cordova for front-end development, Node.js for backend development, and MySQL for the database. See Appendix 6 for the solution architecture of project Odyssey. The development of the Beta version was done in collaboration with the start-up ACL from August 2024 to March 2025.

The following factors cause the shift from a native Android application to a hybrid mobile application:

- Cordova enables rapid development using web technologies (HTML, CSS, JavaScript) rather than platform-specific languages like XML (Android).
- Node.js, as the backend, provides asynchronous execution through non-blocking I/O operations and an event-driven architecture, making it scalable and efficient.
- The hybrid application is also more cost-efficient, as it would require developing once for both Android and iOS, reducing development effort compared to maintaining separate native apps.

Figure 67 below shows the registration and login pages as of March 2025 in the updated high-fidelity prototype using a hybrid approach. The test device used was a Samsung Galaxy A14.

Figure 43

Registration and Login

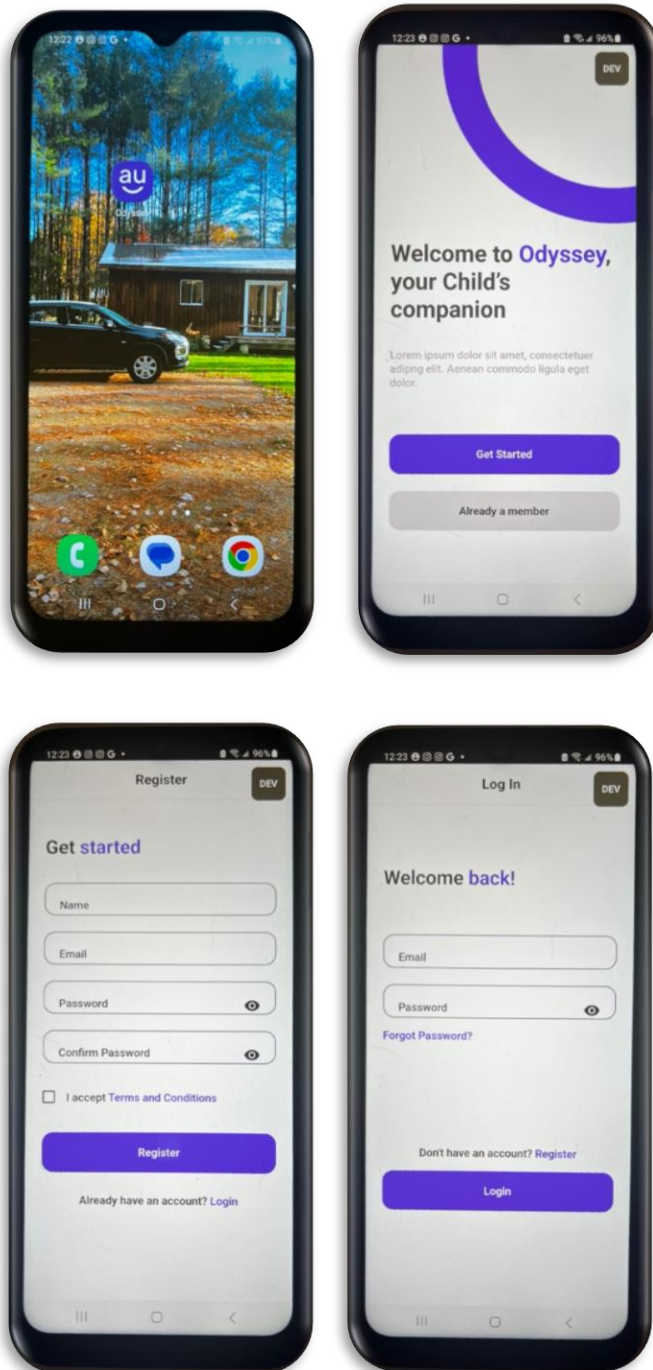
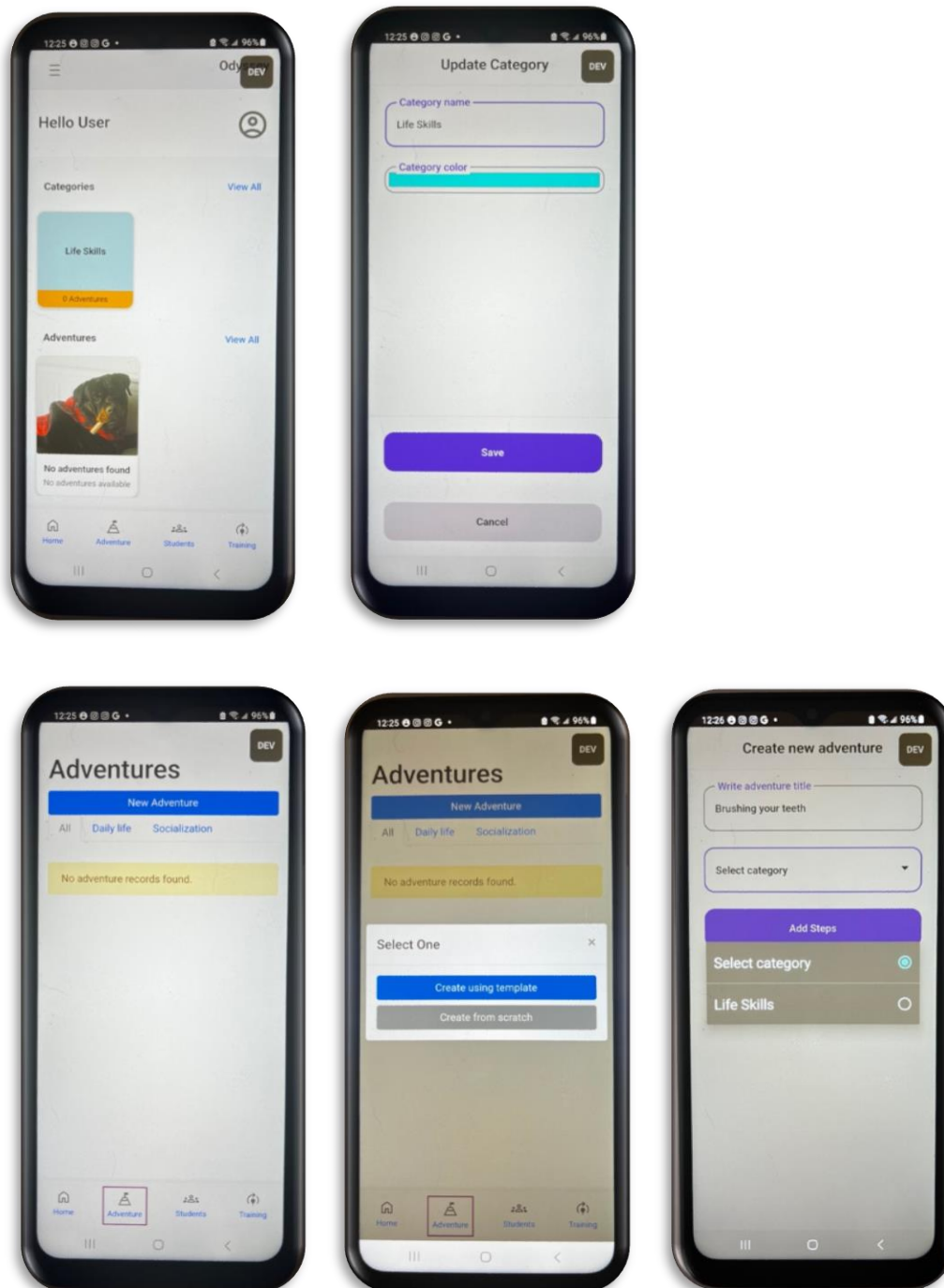


Figure 68 showed the screens to create an adventure, which was the digital intervention using task analysis and video modelling. In this version, the developers focused on building

back-end functionality, such as creating forms and steps, recording videos, and attaching the recording to each step and to the form. The UI was not yet fully aligned with the actual designs from version Beta, and what was shown below were placeholders tied to the UI elements once they were completed.

Figure 44

Creating adventures (i.e., digital interventions)



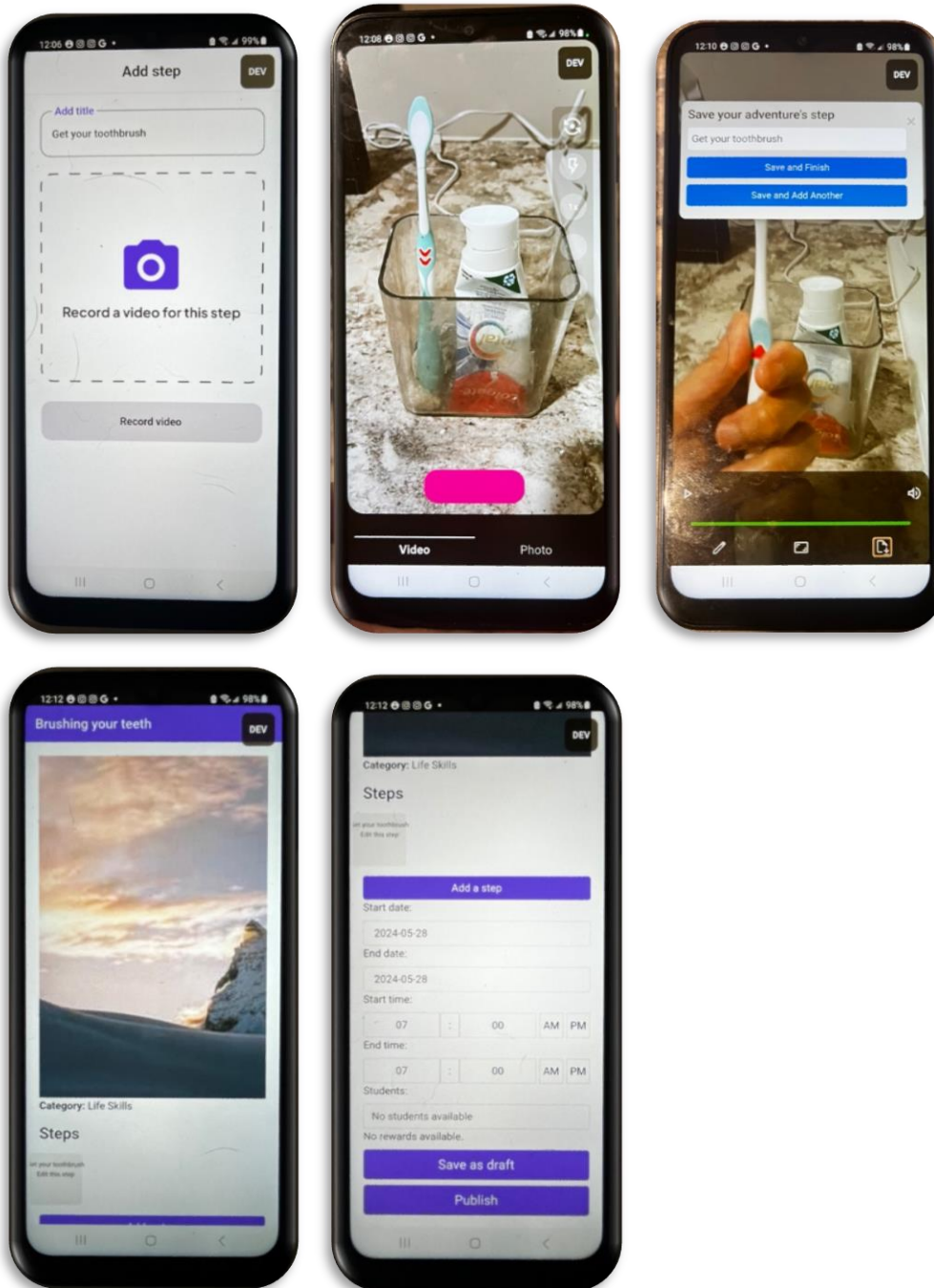
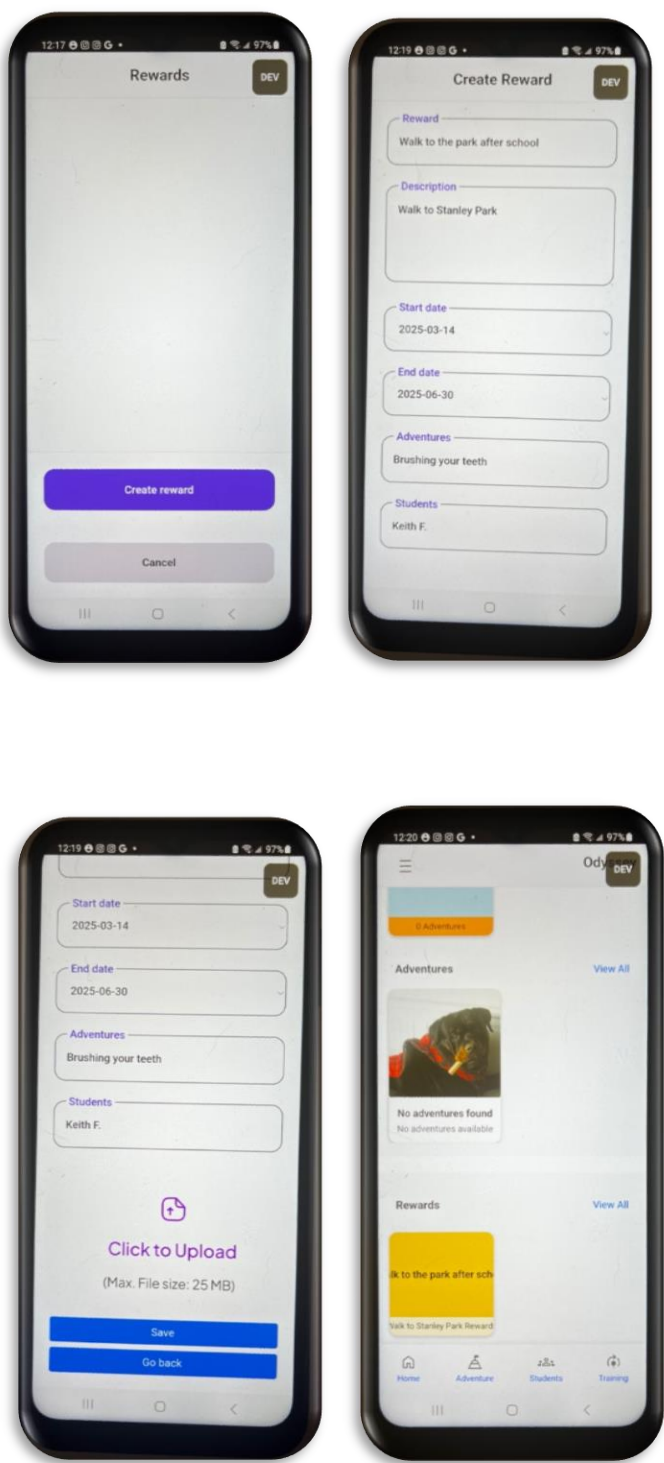


Figure 69 showed the screens used to create a reward. Similar to the adventure screens, they were not yet aligned with the Figma designs in the Beta version. The backend developers focused on creating the rewards form and linking it to an adventure.

Figure 45
Creating Rewards



Charlie version.

The Charlie version of the design focused on refining the Android prototype from the Beta version in collaboration with ACL, and on redesigning the parent persona screens in collaboration with the fourth MDTI student, Samiha Din. Charlie version was co-created from May to September 2025 (see Appendix 5).

Figure 46

Parent landing page, mood captain, and parent hub

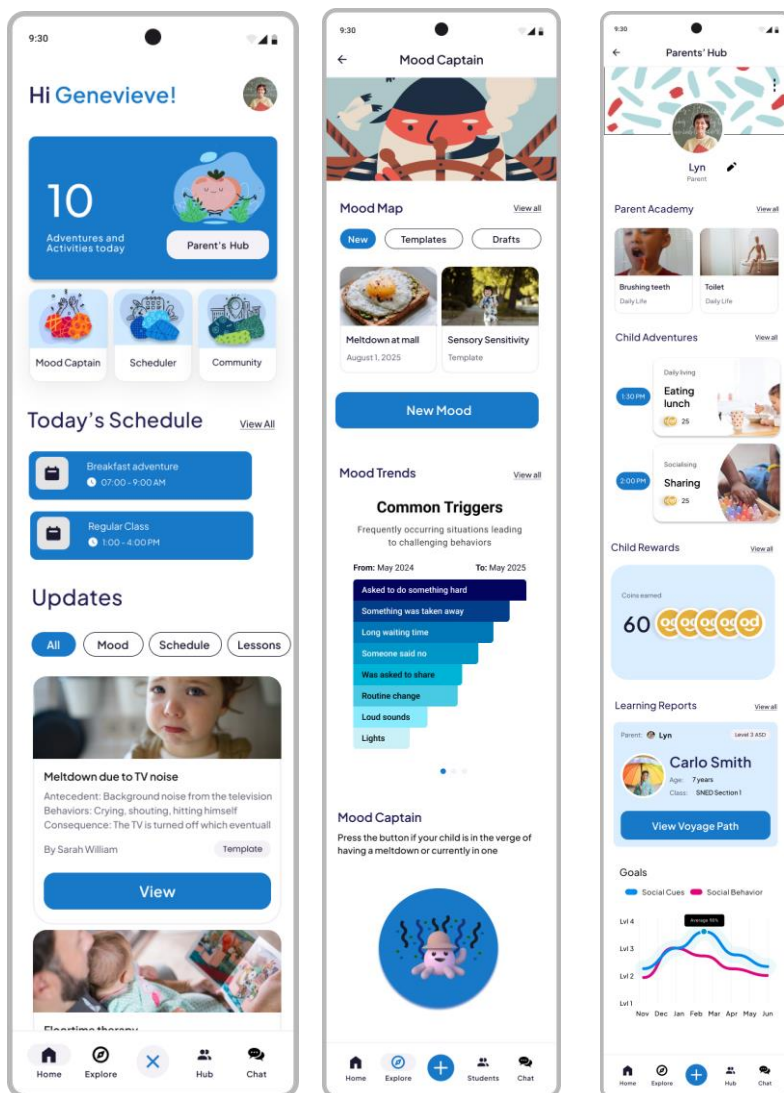


Figure 47

Behavior logging

9:30

Mood Map

1

2

3

Add a title

Getting Ready

Date

Saturday, May 28, 2024

Time

07:00 AM

What was going on

What was going on just before the behavior started?

Asked to do something hard

Something was taken away

What happened

Describe exactly what the child did. Focus on their actions.

Type or select from list

Next

Home

Explore

Hub

Chat

9:30

Mood Map

1

2

3

Add a title

Getting Ready

What happened after

What happened after the behavior? How did you handle it?

Type or select from list

Where it happened

Describe the location, situation or any related back story to the behavior

Type or pin through map

Notes

Use this to add notes for yourself or to discuss with the teacher

Type or record a voice note

Next

Home

Explore

Hub

Chat

9:30

Mood Map

1

2

3

Add a title

Getting Ready

Attach media

Upload a photo, video or voice note related to this behavior

Log

Log & Add as Template

Save as draft

Home

Explore

Students

Chat

What was going on?

Asked to do something hard

Loud noise

Something was taken away

Routine change

Long waiting time

Someone said No

Was asked to share

Long waiting time

Was asked to share

Long waiting time

More >

Next

What happened

Repeated the same phrase or action many times

Screamed or yelled

Ran away or tried to escape

Hit, kicked or pushed

Threw something

Cried or had a meltdown

Used hurtful words

Refused to move or follow instructions

More >

Next

How did you handle it

Gave a consequence or reminder

Gave the child a break or time alone

Removed the child from the situation

Comforted or soothed the child

Ignored the behavior

More >

Next

318

Figure 48

Behavior insights and recommendations with xAI

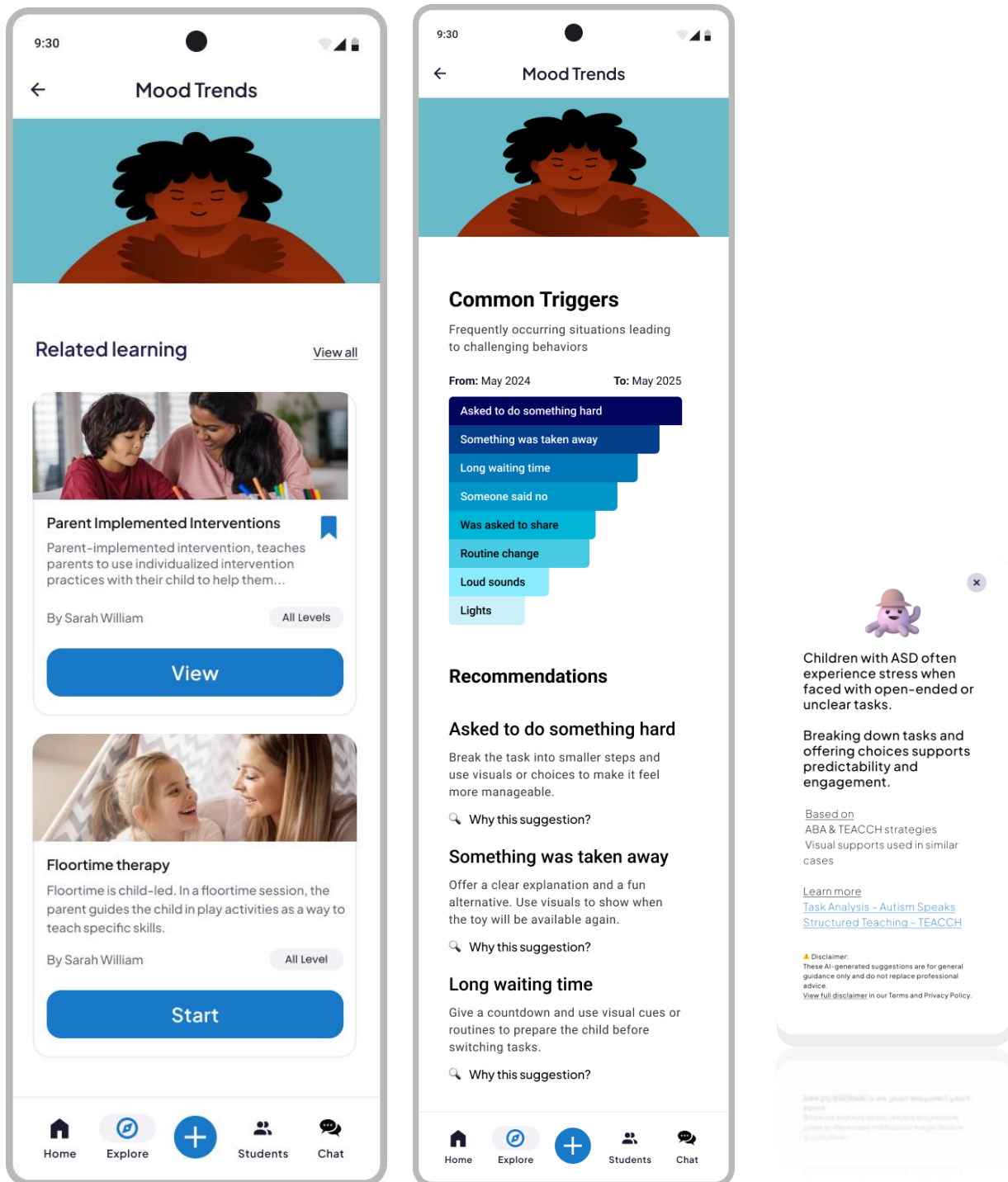
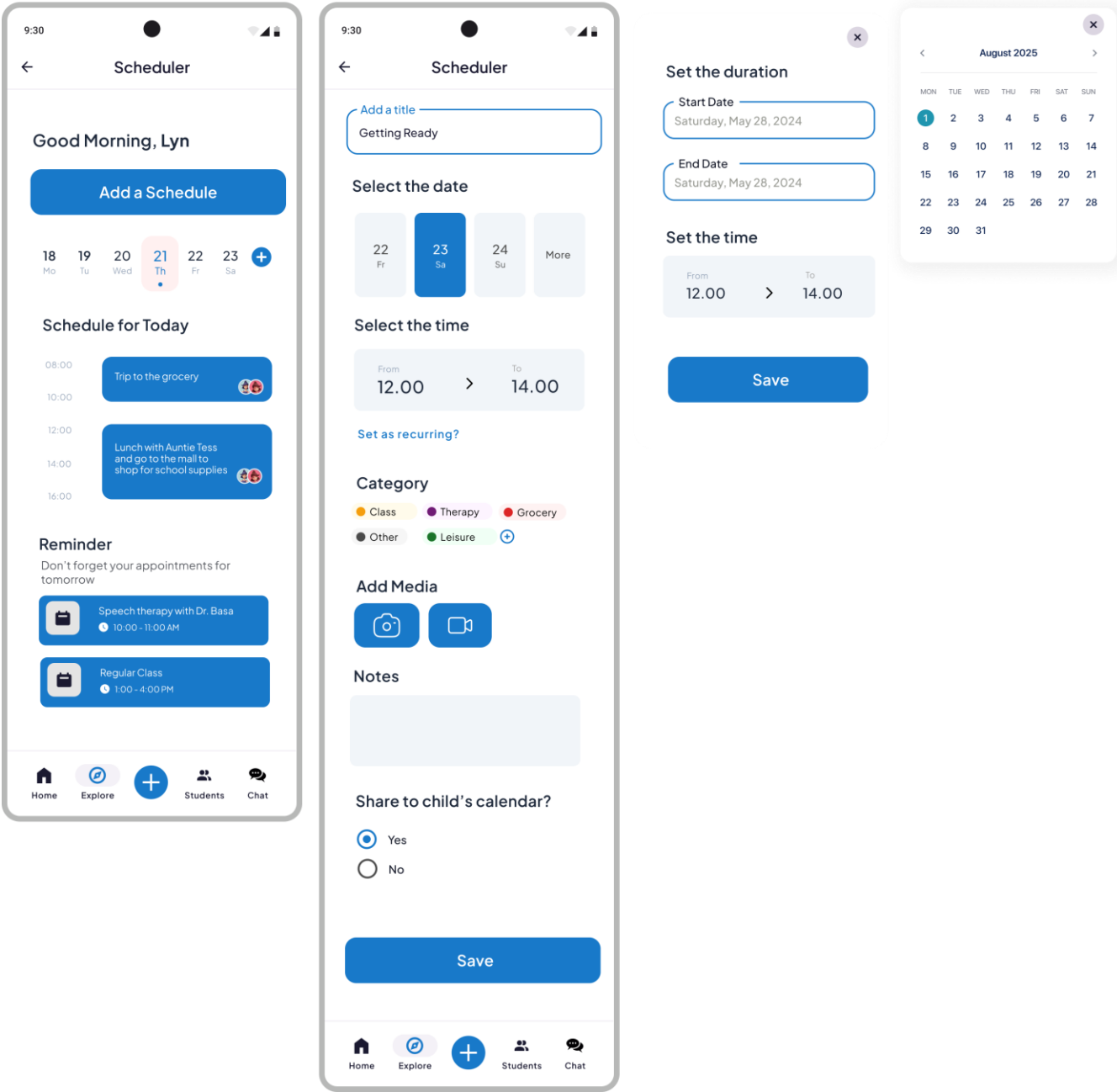


Figure 49

Parent-driven scheduling and calendars



Design feedback session

A feedback session on the Figma design for Version Charlie was conducted with industry partners via a demo by MDTI student Samiha Din on August 8, 2025, and with a parent, Edward, on September 7, 2025. Similar to the feedback session conducted on version Charlie, initial feedback was gathered from industry partners on the overall user interface and user experience, enabling designers to gather suggestions and recommendations and identify areas for improvement ahead of the parent-focused design feedback session. A few weeks after the design feedback session with ACL, a session was scheduled with the parent, Edward, on September 7, 2025. In this feedback session, the researcher provided a demo of the parent-focused design prototype, focusing on the creation of parent and child profiles, individual learning plans, adventures, rewards, schedules, and behavior management. The child's view of adventures and rewards was also shown to the parent. The table below summarizes the feedback received from Edward, organized around 14 themes.

Table 32

Design feedback summary of a parent for caregiver-focused screens

Category	Theme	Description	Transcript
Target users of the application	Clarity of app purpose and target users	Parent sought clarity on whether there is only one or multiple applications, and who the intended users were.	“So, this is for parents. So, how many apps are there? Two?”
	Adaptability to child’s knowledge level	Raised concern whether design supports children at different stages - early intervention, advanced, or in-between.	“Is the app meant for children learning from scratch... or those who hasn’t even started his early intervention?”

	Age and developmental continuity	Raised concerns about applicability for older children (16–18 years) and the need for evolving interests and vocational focus.	“What if he’s 16 or 18 years old who didn’t received early intervention, because they don’t have therapists or lack assistance in remote areas. Will he still think like a child or will think more maturely”
Instructional and learning design	Step-by-step learning and use of real-life materials	Emphasized the need for practical, concrete steps with the use of real tools (i.e., toothbrush, toothpaste, cup) and the importance of gradual imitation.	“When I teach brushing teeth, I will give my child a toothbrush, a cup, and toothpaste... Step by step, right?”
	Teaching using both visual and verbal instructions	Highlighted the importance of combining visuals with verbal instruction for better understanding.	“Because I’ll give everything to him so he’ll understand... He’ll understand the teaching better if both are given to him - visual and verbal teaching.”
	Peer modeling with consideration for gender	Suggested customization of learning models by gender or relatable peers, as children may respond better to relatable role models.	“Will it change depending on the gender? Maybe if he is a male model, and you have a female child... I just thought maybe it will be better if they have the same gender.”
	Customization with personal videos	Proposed replacing generic videos with recordings of the child, classmates, or peers to enhance engagement.	“For example, his classmate. Or you have a parent or you use that app. This is your classmate. You can copy him.”
	Daily routine alignment	Questioned whether all children follow the same routines; stressed the need for customizable schedules.	“Regardless of the level, will the routines all be the same... waking up in the morning, brushing your teeth, taking a nap, having breakfast... are they all the same?”
Motivation and assessment	Rewards and relationship to parent-led child assessments	Questioned reliance on rewards alone, and suggested grading/self-assessment for accuracy and progress tracking.	“Because the reward, it will be given regardless on how the child did it... but if you ask the parent are you satisfied... what grade will

			you give your child for this activity?”
	Parental responsibility and integrity	Stressed parents’ accountability in guiding and grading, highlighting integrity in reporting progress.	“Even if a parent is forced to do it, as a parent you have to do it properly because you will benefit in the future... the child will retain the skills if the parent grades regularly like every month or every week.”
User experience and engagement	Usability and simplicity	Appreciated simpler layouts for children’s ease of use.	“It’s simple so it’s easier for the child to understand.”
	Mascot and child recognition	Commented on Ody (Octopus mascot), linking it to imaginary friends and stressing recognizability and simplicity for children.	“He is like having an imaginary friend... or AI friend... He looks like the cartoon Pocoyo. If the child will look at his face regularly, he will listen to him or follow him. It’s an advantage, but I don’t know about other kids”
Social and community	Community and communication	Endorsed global parent-to-parent chat, with ability to check profiles and connect with trusted individuals.	“That chat should be global... everyone who uses the app can talk to the parent... you can check the profile of the person you know, and connect from there.”
Tracking and data management	Data logging and practical recording	Suggested reducing unnecessary details in behavior logging; highlighted importance of date, time, and place for practical tracking.	“Just reduce some details... the date, time, place, those are the most important.”

The design feedback confirmed that some design features aligned with parents' needs. For instance, the feedback received from the parent regarding the need for step-by-step learning and use of real-life materials is supported by the task analysis features of Adventures (i.e., digital interventions), along with the execution of Adventures in a real-life setting through the help of parents and teachers in guiding and prompting the child through video-modelling. The feedback

regarding the need for adapting the app to the learner's capabilities and skills so that it can support toddlers up to teenagers and young adults were also supported by the personalization and customization of the Voyage Path (i.e., individual learning plan) which informed which Adventures and Rewards (i.e., positive reinforcement) could be given to a child depending on their learning goals. Leveraging peer modeling, with consideration of the model's gender, to create more effective video modeling interventions through Adventures was also supported by the app's content creation and customization capabilities, which enabled parents and teachers to create custom videos using simplified video recording features aligned with industry designs in social media applications.

Prototyping outcomes through collaboration with ACL

The screens below showed the updated iteration of the Android mobile application, partially aligned with the updated user interface design from version Beta. Some capabilities were implemented, and placeholder screens and icons were added, which will be replaced in the next version.

Figure 50

Registration and Login

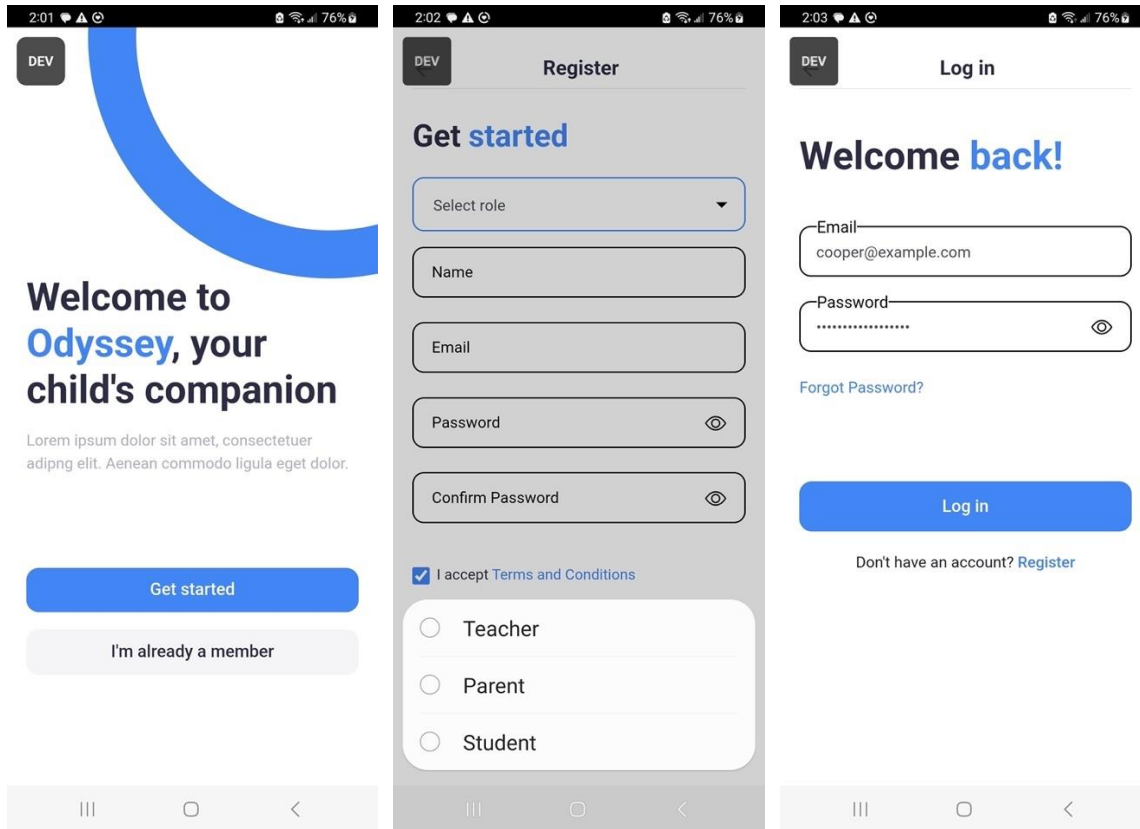


Figure 51
Landing page

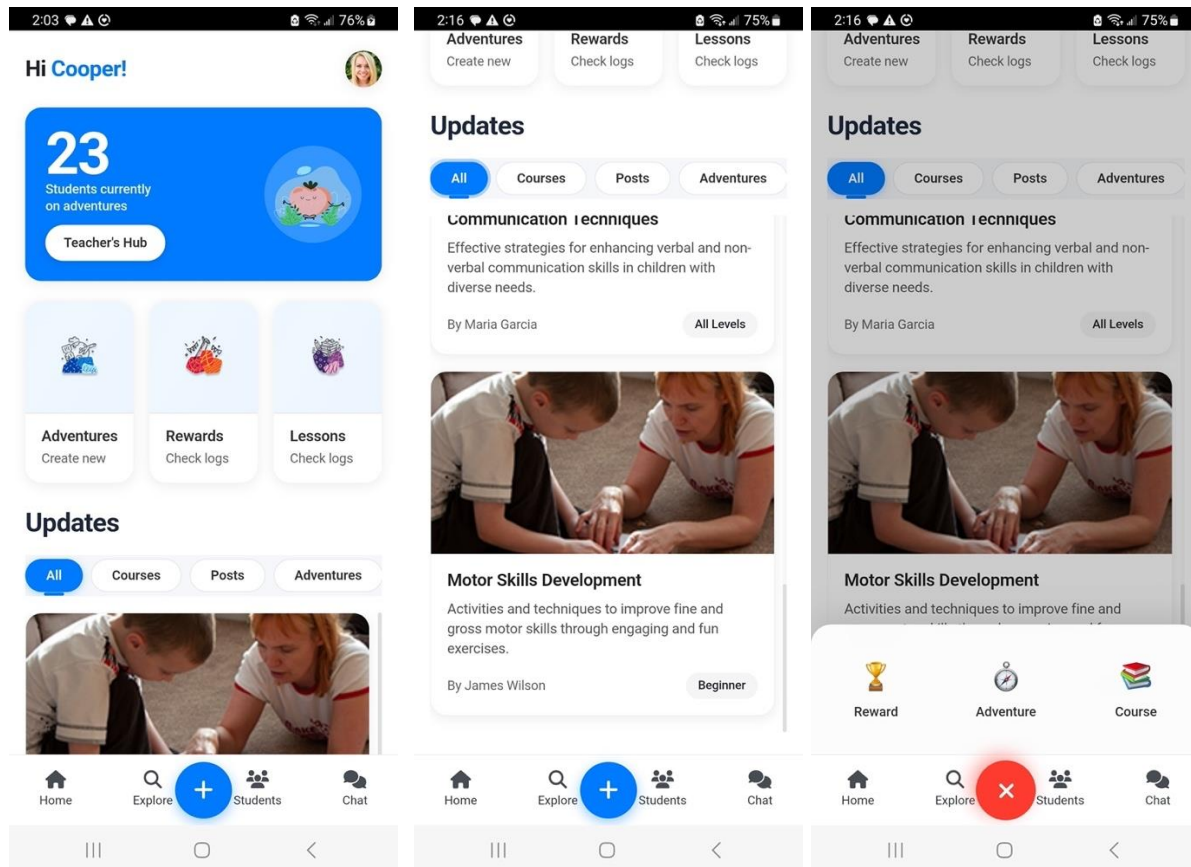
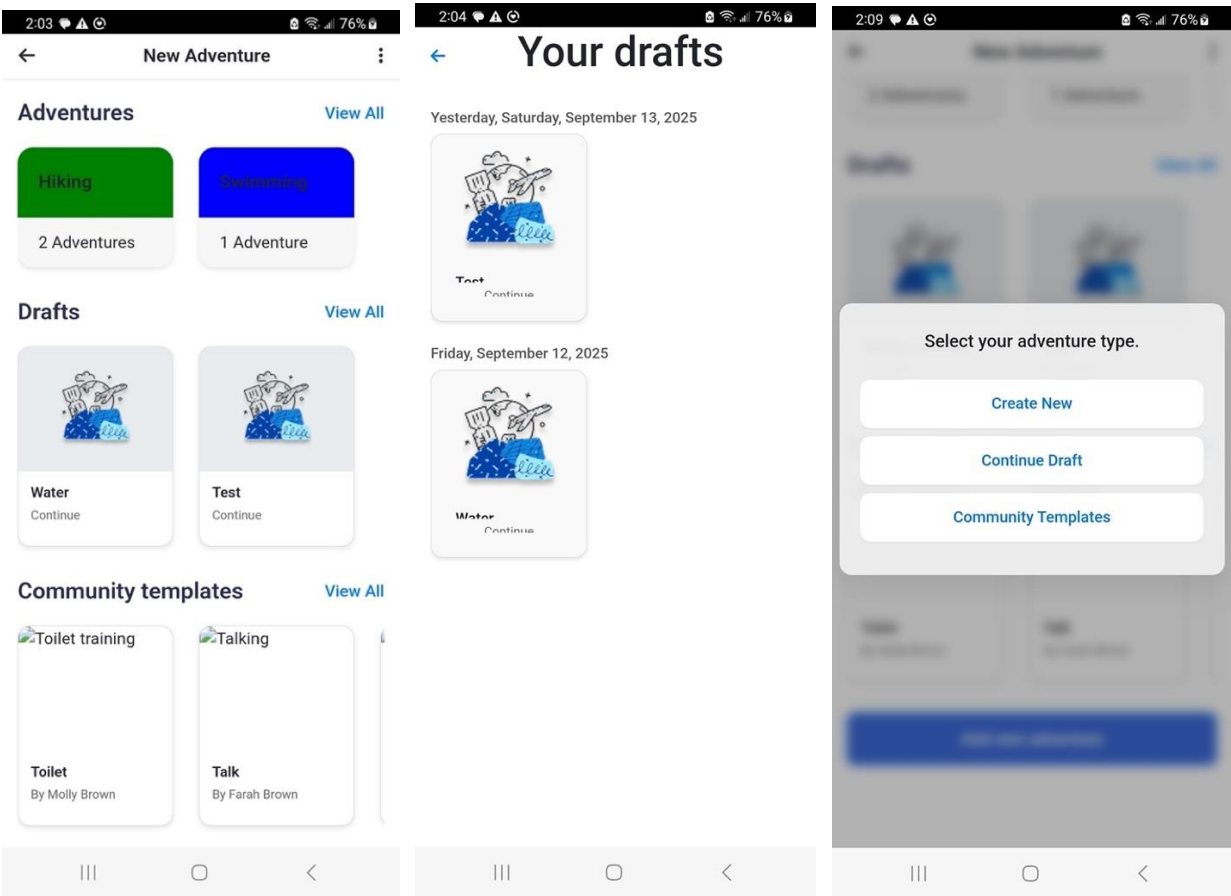
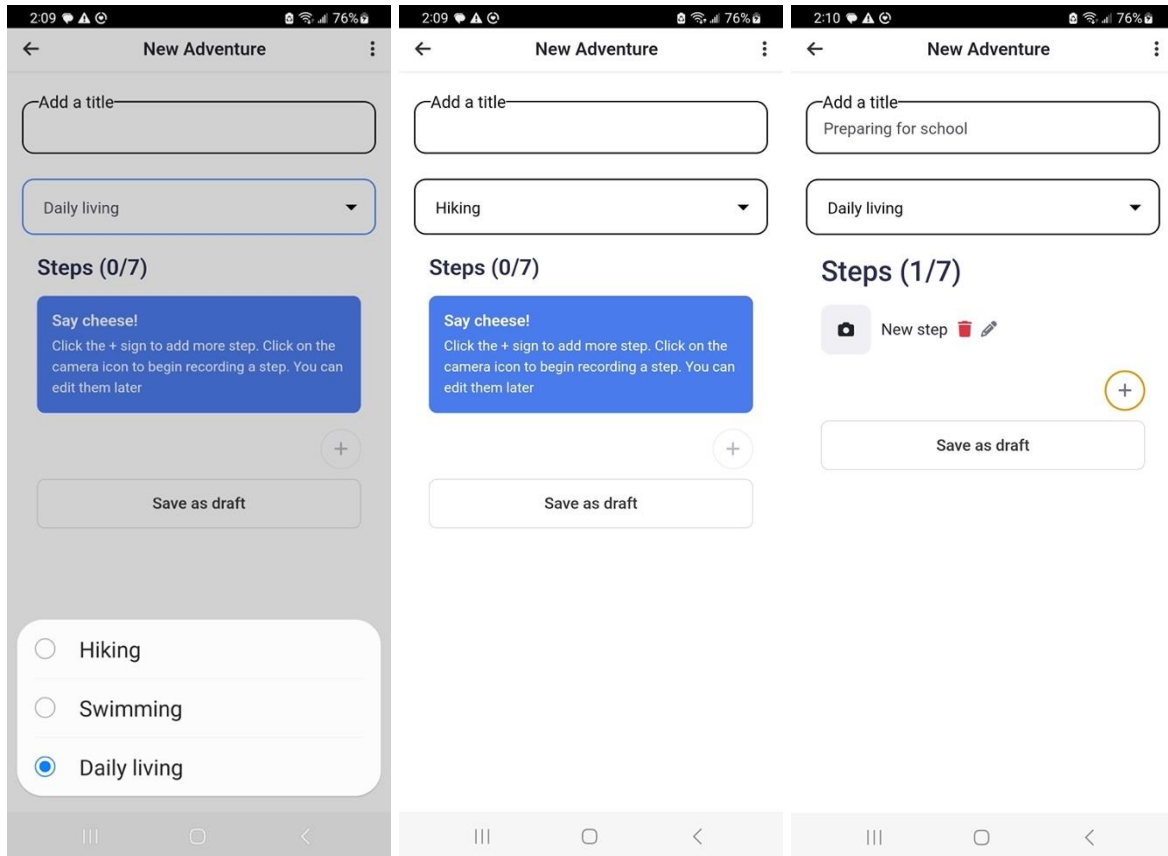
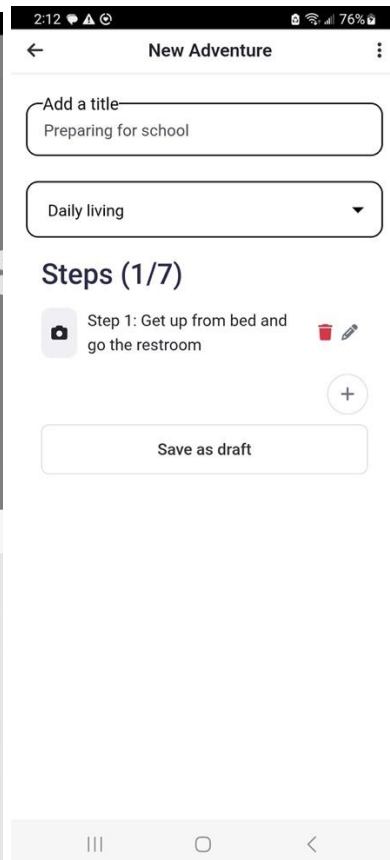
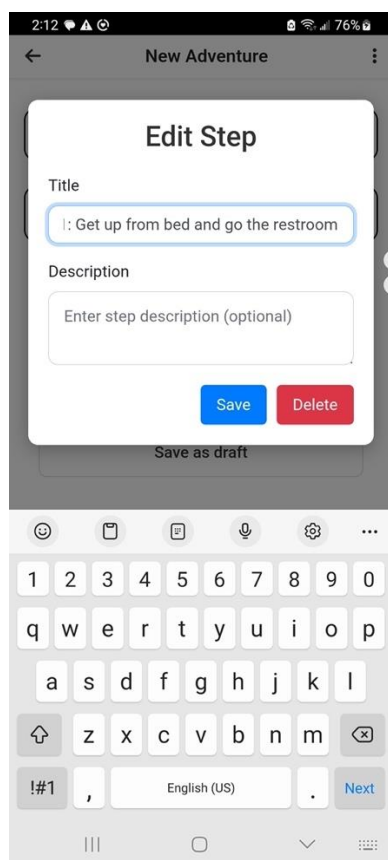


Figure 52

Creation of adventures









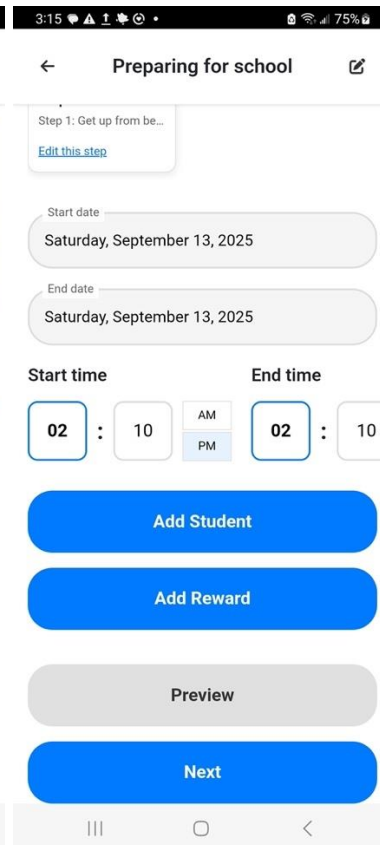
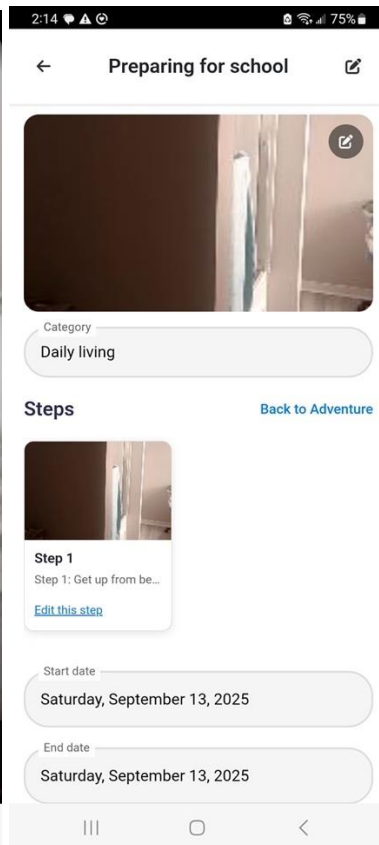
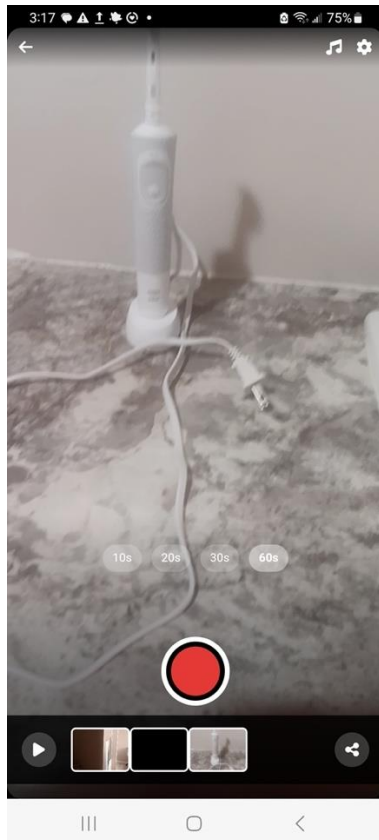


Figure 53

Teachers' hub landing page

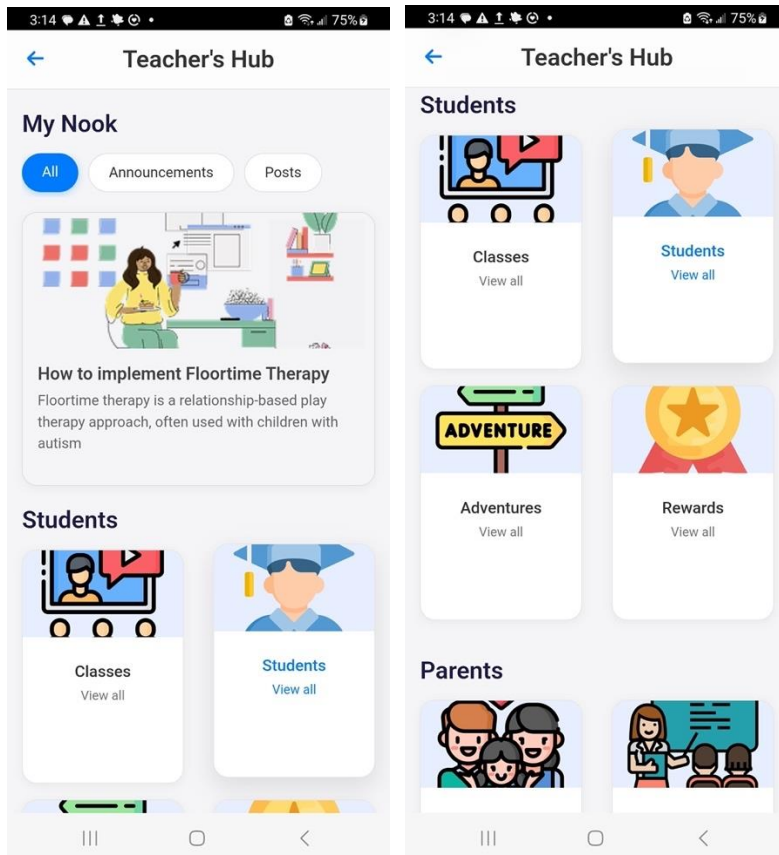
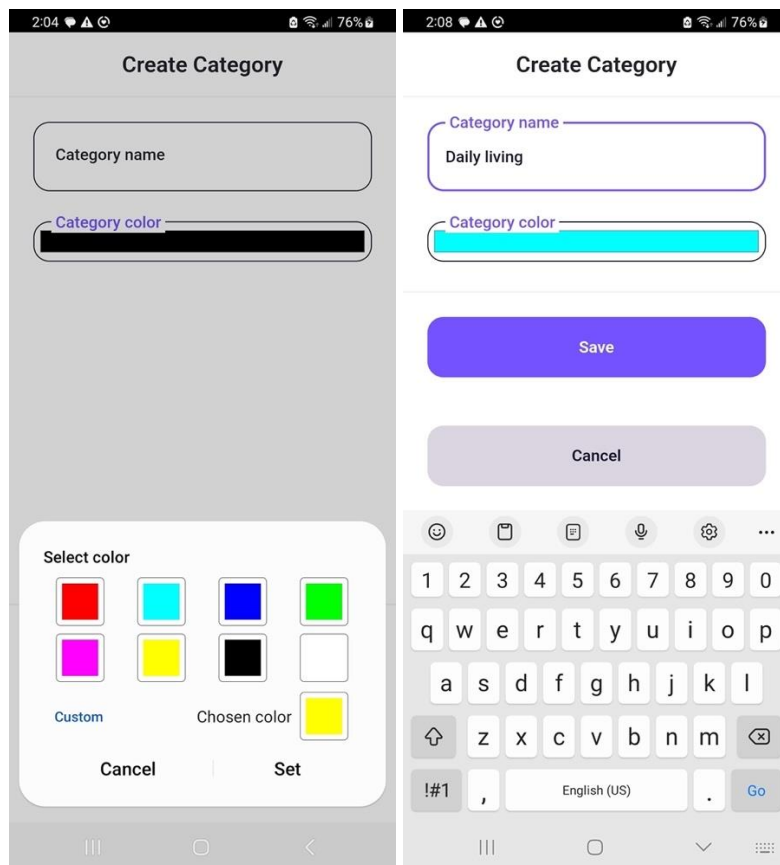


Figure 54

Create category



Process to design a digital health solution in low-resource areas

The process for designing and building a digital health solution to support life skills development for children with ASD in low-resource areas was structured into five stages, drawing on principles of human-centered design, participatory methods, and iterative development. This multi-phased approach was informed by both theoretical and industry methodologies, thematic analysis, and agile development. Each stage was shaped by the availability and capacity of stakeholders, particularly in marginalized educational settings, and

adjusted to reflect real-world constraints while maintaining a focus on user needs and evidence-based practices.

Identifying and understanding user needs, designing ideation, and building the technical foundations.

The first stage of the study, which spanned from January to September 2024, focused on identifying and understanding user needs through a literature review, securing ethics approval, and soliciting participants. The researcher started with a literature review to determine features of digital health solution for life skills development of learners with ASD; learn about cognitive and learning theories related to autism; and know about the challenges and pain points of children with ASD, their parents, and educators in the context of low-resource areas and marginalized families. The literature review informed the design thinking activities that followed, including the creation of empathy maps and user personas for children, parents, and teachers. This initial understanding of the users enabled the researcher to envision requirements in terms of capabilities and features that could address the end users' pain points and challenges. These initial requirements were translated into a low-fidelity user interface design that was later used as part of the solicitation materials sent to parents, schools, and education officers to inform them of the study's intent and goals.

The literature review also informed the methodology and approach that the study adopted, by serving as an input to fill in the University of Ottawa's Research Ethics Board (REB) ethics review forms and complete related artifacts necessary to secure the ethics board approval such as the solicitation letter, informed consent form, and preliminary primary data gathering instruments. During this stage of the study, which started in January 2024, the study

intended to use the diversity-for-design (D4D) framework of Benton et al. (2014), comprising three phases. The first stage focused on conducting a literature review to identify the strengths, preferences, and difficulties of children with ASD, as well as preparing and structuring design sessions. The second stage involved conducting design sessions through individual workshops, and the third stage encompassed the creation of prototypes using an iterative design and development process. The researcher had discussed this approach in her solicitation letters to the assistant secretary of the Philippine Department of Education, the chief education supervisor of the Division Office of Paranaque City under the Department of Education, and the school principal of Paranaque Elementary School Central (PESC). The process of reviewing, processing, and approving the request took almost six months, from solicitation in March 2024 to formal approval to execute the study in September 2024.

During this stage, the study also leveraged academic and industry partnerships to begin design ideation and build the application's technical foundation. In April 2024, the researcher started collaborating with two Master's students in Digital Transformation and Innovation at the University of Ottawa – Raj Baldania and Ankit Arora- and continued collaborating with the local startup Agile Creative Labs Inc., through its co-founder, Alexander Sanchez, to build the mobile app prototype incrementally. The first iterative design and development activities ran in parallel with the solicitation activities, from April to August 2024. In the first version, the medium-fidelity prototype of the design was built. The medium-fidelity prototype focused on the design of the core modules, including the implementation of Video Modelling and Task Analysis (i.e., Adventures), Rewards, and both teachers' and children's views of completed interventions. Individual education plans, profiles, reports, parent training, registration, login, and onboarding pages were also designed. In parallel, backend development commenced on foundational

capabilities that are not directly informed by the design, such as registration, log-in, and the database. On the final leg of this stage, frontend and backend development were conducted to include the designed login and registration pages, along with a placeholder landing page for teachers.

Ideating user requirements

The second stage of the study, which ran from September to December 2024, focused on collecting primary data. On September 8, 2024, the principal of PESC approved and endorsed the research scope, approach, and intended participants, and the first interview session with teachers was conducted on September 19, 2024. Initially intended as individual interviews, the teachers requested a group interview due to limited time. When the interview began, the project leader, who represented all the educators participating in the study, stated that the heavy workload and the school's limited resources would make it impossible for them to participate fully. There was a miscommunication between the principal and the teachers about what was expected of them in this study, as they thought their participation was a one-off exercise involving only interviews. As a result, the project leader, representing the teachers, stated that they would not be able to participate in multiple workshop sessions, assist their students with design activities, provide feedback on the iterative design process, or create digital interventions for students. The project leader said that after the initial interview, they can only answer survey forms and wouldn't go beyond that. Due to this constraint, the study decided to pivot and adapt its approach to participants' availability and preferences. As sound as the approach looks on paper, the constraints of low-resource areas made it difficult to implement.

The study pivoted to change its approach and also its research scope. To align with participants' preferences and still meet the study's objectives, the researcher used the qualitative survey approach of Braun and Clarke (2013) and conducted semi-structured interviews with participants who agreed to be interviewed after completing the survey.

The primary data gathering continued with an information form and a survey form, administered in person to some parents who preferred to complete it on paper and online via Survey Monkey to those who preferred to do it digitally. Meanwhile, all teachers have completed their qualitative survey forms online via Survey Monkey. During this stage, only two parents agreed to be interviewed, and only one teacher agreed to do a follow-up interview. All survey responses and interviews were coded using the Braun and Clarke (2006) approach to identify themes that addressed the study's research questions. Based on the results of the primary data collection, the researcher identified 45 design themes emerging from the participants. These design themes were eventually translated into additional capabilities and features that informed the application's design and development, which followed an iterative approach.

Design, prototyping and iterative development cycle 1

Running in parallel during the second stage, which spanned from September 2024 to April 2025, were the iterative development and design activities. Android development continued with a focus on mobile-based video editing embedded through a step-by-step form. In this stage, the technology stack shifted from native Android to a hybrid application to make the user interface and front-end processes more manageable to implement, thereby speeding up development and making the app available cross-platform.

In January 2025, a new MDTI student was engaged – Malavika Mahesh to refine the user interface and user experience design, prototype additional features for teachers and children based on the results of the primary data gathering, and help in running a think-aloud protocol to have an initial evaluation of the user interface and user experience. Malavika has updated the app's branding, made the design system more cohesive, and redesigned the teacher and child landing pages, the individual educational plan, the parent and children's profiles, and the rewards and adventures implementation.

After the design enhancements and additional features were completed mid-March 2025, a think-aloud protocol was conducted with a teacher who agreed to provide feedback on the design (i.e., Teacher Mara) on March 28, 2025. However, the poor internet connection in the Philippines prevented the Figma prototype from loading in her browser, and she wasn't able to open it on her own device. In effect, the researchers changed their approach and instead provided her with a demo of the application, during which she shared her thoughts about the design as screens were shown.

Design and iterative development cycle 2

The second stage of the iterative design and development was conducted from April to September 2025 in collaboration with another MDTI student, Samiha Din, who researched and conceptualized additional features for parent users, with a focus on behavior management and picture-based scheduling. The researcher then used Samiha's research and initial sketches to create additional Figma prototypes. The updated Figma prototypes for parent-focused screens were demoed to a parent named Edward, and feedback on perceived value, user experience, and user interface was collected.

ACL's development activities continued, with a focus on aligning the creation of adventure with the updated user interface design and flow, while also advancing the backend process and front-end screens for the digital intervention. Due to resource constraints and limited availability, the end-to-end process was not fully completed as of this writing and would need to continue outside the dissertation. However, it is worth noting that the completion of the Android mobile prototype was not within the scope of the study. The development activities were done as part of the exploration activities to validate basic technical assumptions that would help determine the application architecture and design of the overall digital health solution.

Fourth stage - future

The study concluded its design activities after the second iteration. Future development activities would focus on the final design for the minimum viable product, and the definition of technical requirements to align with the standards of digital health solution applications, with emphasis on protecting personal health information (PHI) and alignment with industry standards, particularly the Health Insurance Portability and Accountability Act (HIPAA) and General Data Protection Regulation (GDPR). The user testing, validation, and refinement activities, which are the final stage of the process, would be conducted after the study as part of the researcher's post-doctoral activities.

The table below summarizes the process the researcher used to design a digital health solution application for autism life skills development in a low-resource setting. The process took four stages, with more rigorous evaluation and refinement to be conducted as part of the next steps after the dissertation.

Table 33

Process to co-create a digital health solution application in low-resource areas

Design Stage	Approach and key activities	Deliverables
1. Identifying and understanding user needs, and starting the technical foundations <i>(January 2024 – August 2024)</i>	• Systematic literature review • Literature review on autism and cognitive/learning theories • Design thinking methods (Empathy mapping, personas) • Ethics preparation and approvals (REB forms, consent, solicitation letters) • Solicitation and stakeholder alignment • Design ideation and building of the technical foundation (MDTI master's student collaboration through Raj Baldania, Ankit Arora, and industry partnership with ACL through Alexander Sanchez.)	• Summary of literature-informed capabilities and features • User personas (child, parent, teacher) • Empathy maps • Ethics approval and documentation (REB forms, consent forms, solicitation letters) • Preliminary low-fidelity UI design for solicitation • Documented stakeholder constraints and study scope realignment • Initial medium fidelity prototype in Figma for teachers, parents and students • High-level technical documentation
2. Ideating user requirements <i>(September 2024 –Dec 2024)</i>	• Thematic analysis of secondary and primary qualitative data (Braun & Clarke, 2006) • Survey (in-person and digital via SurveyMonkey) • Semi-structured interviews • Pivoted research method to accommodate low-resource constraints	• Capabilities and features from literature review • Design themes (45 themes) from primary data • Translated features and capabilities from both data sources • Participant demographic profiles and survey responses • Updated user personas for child, parent and teacher • Refined app scope and user-informed insights
3. Iterative development cycle 1 <i>(Parallel activity with Stage 1& 2, April 2024– April 2025)</i>	• Iterative development with ACL • Pivoted the technical approach from native Android to hybrid technology stack • Technical implementation (front-end/back-end)	• Working mobile prototype (cross-platform hybrid app) ○ Proof of concept for digital media processing ○ Implemented modules: registration and login, teacher landing page,

and Iterative design cycle 1 (from January 2025 – April 2025)	• Iterative design with MDTI master’s student (Malavika Mahesh) • UI/UX enhancements and design system development • Think-aloud protocol with teacher (modified due to connectivity issues)	• student list, and creation of adventures • GitHub code repository • High-level technical documentation • Revised design system and branding • Redesigned landing pages and core modules (teacher/child) • Medium-fidelity prototype in Figma for: adventures, rewards, IEPs, registration, login, etc. • Documentation of teacher feedback and UI/UX observations
4. Iterative design and iterative development cycle 2 (May 2025–Sept 2025)	• Iterative development with ACL • MDTI student collaboration (Samiha Din) for parent-focused features	• Updated version of the Adventure module • Medium fidelity prototype for: behavior management, picture-based scheduling, parent’s hub, AI insights and recommendation • GitHub code repository • High-level technical documentation
5. Android prototype completion and evaluation (Future – Postdoctoral Phase)	• Completion of the Android mobile prototype • Think-aloud protocols • Usability testing • Validation against industry standards (HIPAA, GDPR) • Final iteration of UI/UX and backend • Post-study user testing and feedback loops	• User feedback reports • Feature improvement log • Final technical specifications • Compliance alignment documentation (HIPAA, GDPR) • Roadmap for public release and scale-up

Summary

This chapter presented a comprehensive examination of learner, parent, and teacher profiles, needs, and challenges to inform the design of a digital health solution for life skills development of learners with moderate to severe ASD. It synthesized findings across three

workstreams, beginning with literature review research and design thinking methods that produced empathy maps and user personas for learners, parents, and teachers, establishing a foundational understanding of stakeholder perspectives.

The second workstream detailed qualitative survey and interview data, highlighting demographics, capabilities, interests, needs, and pain points of learners, parents, and teachers. Individual profiles illustrated the diversity within these groups, while thematic insights uncovered key barriers and goals in life skills education, including perspectives on digital educational tools.

The third workstream focused on iterative design and development processes, describing updated user personas and integrating primary and literature review to develop actionable design themes and feature sets. The evolution of the digital health solution is traced through alpha, beta, and Charlie versions, showcasing how iterative prototyping and user feedback shaped functionality.

Finally, this chapter outlined a user-centered design process tailored for low-resource contexts, encompassing need identification, ideation, and technical development across multiple cycles. It concluded with considerations for future stages of solution refinement and deployment.

Chapter V: Analysis

This chapter presents an integrated qualitative analysis of the study's literature review findings, document analysis, qualitative surveys, interviews, and design feedback sessions. Guided by Creswell and Poth's (2018) qualitative research framework, the analysis employed thematic analysis (Braun & Clarke, 2006), within-case synthesis (Miles, Huberman, & Saldaña, 2014), and pattern matching (Yin, 2018) to connect participant experiences with established research on autism-focused digital interventions. Participatory design principles (Frauenberger, Fitzpatrick, & Iversen, 2015) further informed interpretation by centering stakeholder knowledge from parents, educators, and low-resource community contexts.

This case study focused on the participatory design of a digital health solution to support the development of life skills among learners with moderate-to-severe ASD in low-resource settings. Stakeholders included parents and educators from Metro Manila, the Philippines; graduate student collaborators from the University of Ottawa; and an Ottawa-based technology start-up partner (ACL). The analysis sought to identify learner capabilities, challenges, and support needs, as well as the caregiving and instructional realities shaping the design requirements of an accessible and sustainable digital intervention.

Learner strengths, challenges, and engagement needs

Findings from both primary data and existing literature revealed that learners with moderate to severe ASD in this case study experience intersecting cognitive, communication, sensory, emotional, and daily living challenges. These challenges were particularly evident in

attention regulation, task initiation and completion, expressive communication, social interaction, sensory sensitivities, and adaptive independence skills. Parents consistently described difficulties in establishing hygiene routines, managing transitions, supporting emotional regulation, and enabling children to communicate needs effectively at home and in school.

At the same time, learners demonstrated important strengths and interests that represent meaningful design opportunities. Many children showed strong engagement in creative expression, music, building activities, puzzles, and physical play. Parents reported interests such as drawing, coloring, Lego construction, crafting, singing, dancing, and digital play. These strengths align with prior research highlighting the visual and detail-oriented cognitive processing styles often associated with ASD (Baron-Cohen et al., 2009; Mottron et al., 2006). Rather than viewing learner support solely through deficits, these findings emphasize the importance of capability-driven and interest-aligned learning environments that foster motivation and engagement.

Design implications emerging from this learner profile highlight the need for systems that are visually structured, flexible, and personalized. Features such as learner profiles capturing interests and strengths, multimodal learning supports, and tailored reinforcement mechanisms can enhance participation in life skills development. Interest-based rewards, creative learning tools, and strengths-based play activities may support sustained motivation while promoting autonomy and competence in daily living.

In addition, learners with emerging cognitive and problem-solving capabilities benefited from activities involving pattern recognition, memorization, and structured instruction-following.

Supporting these strengths through scaffolded puzzles, step-by-step tasks, and visual guidance can foster skill development while accommodating working memory and executive functioning difficulties commonly reported in ASD.

Communication remained a central challenge across participants, particularly for minimally verbal and non-verbal learners. Parents described reliance on gestures, hand-leading, echolalia, and inconsistent expressive language. These findings highlight the importance of multimodal communication supports that combine visuals, symbols, gestures, and audio prompts to enhance expressiveness and reduce frustration.

Social interaction needs were also evident, with limited exposure to role play, turn-taking, and peer engagement activities. Digital storytelling tools, structured social narratives, and peer interaction scaffolds represent potential avenues for supporting social-emotional learning in safe, predictable environments.

Overall, learner findings indicate that digital interventions must balance structure with personalization, providing clear routines and task supports while embedding learner interests, sensory regulation strategies, and communication scaffolds into daily life contexts.

Table 34

Summary of learner patterns and design response

Learner domain	Key challenge / need identified	Design response	Relevant DTs
Daily living skills	Difficulty completing hygiene, toileting, dressing, meal preparation routines independently	Step-by-step visual task modeling and home-based life skills coaching	DT #1, DT #11, DT #16

Routine & transitions	Struggles with task initiation, transitions, and maintaining predictable schedules	Interactive visual calendars and customizable routine scaffolds	DT #12, DT #41
Attention & focus	Limited sitting tolerance, difficulty sustaining attention and completing multi-step tasks	Gamified attention-building activities and structured task sequencing	DT #6
Communication barriers	Minimally verbal learners rely on gestures, echolalia, inconsistent expression	Multimodal AAC/PECS-based expressive communication supports	DT #3, DT #28, DT #32
Social interaction	Difficulty with peer engagement, turn-taking, role play, nonverbal cue interpretation	Social storytelling and structured peer interaction scaffolds	DT #10, DT #19
Emotional regulation	Frustration, meltdowns, tantrums linked to communication and sensory overload	Emotion boards, calming tools, behavioral cueing supports	DT #2, DT #14
Sensory sensitivities	Hypersensitivity to noise/light and sensory-triggered distress	Personalized sensory regulation environments and calming media	DT #4
Motivation and engagement	Higher participation when tasks align with interests (music, Lego, digital play)	Strengths-based learning profiles and interest-driven reinforcement	DT #7, DT #8, DT #43, DT #45
Safety awareness	Limited danger awareness and risk of getting lost	Interactive safety stories and structured task guidance	DT #1
Long-term independence	Need for adulthood preparation and vocational readiness	Life skills progression and vocational simulation toolkits	DT #17, DT #29

Caregiver challenges and support needs

Parents in this study reported substantial and overlapping challenges that shaped their ability to support their children’s development. These challenges were particularly pronounced in managing behavioral dysregulation, sensory sensitivities, caregiving fatigue, financial constraints, limited access to services, and weak support systems.

Behavioral challenges, including tantrums, meltdowns, aggression, and distress responses to environmental stimuli, were among the most pervasive caregiver concerns. Parents emphasized the need for practical, consistent strategies to manage emotional escalation, reinforce learning routines, and support communication to reduce frustration-driven behaviors. These experiences reflect broader caregiving literature describing behavioral difficulties as closely tied to sensory overload, communication barriers, and emotional dysregulation among children with ASD (Delafield-Butt et al., 2019; Gorlin et al., 2016; Waizbard-Bartov et al., 2024).

Caregiving fatigue and work-life imbalance also emerged as recurring themes. Several parents described the emotional and physical toll of round-the-clock caregiving, often with minimal support. These demands frequently led to burnout, reduced well-being, and diminished capacity to sustain intervention delivery. Parents expressed a need for emotional support tools, accessible self-care resources, and opportunities for peer connection to mitigate isolation.

Financial hardship further constrained caregiving capacity. Families reported difficulty affording therapies, accessing government support, and sustaining long-term intervention services. In low-resource settings where formal ASD services remain limited, caregivers sought affordable, accessible, and practical tools that could supplement professional intervention and empower home-based learning.

In addition, caregivers described limited extended family involvement and community stigma, which contributed to isolation and reduced support networks. Parents expressed the need for spaces where they could connect with others, share experiences, and access culturally affirming narratives that normalize caregiving challenges and foster resilience.

Finally, caregivers emphasized the need for structured educational guidance. Many parents reported uncertainty in teaching life skills at home, maintaining consistent routines, and preparing children for long-term independence and adulthood. These findings highlight the importance of parent-friendly digital supports that provide step-by-step coaching, adaptable learning templates, and collaboration mechanisms with educators.

Table 35

Summary of parent patterns and design response

Parent challenge	Key challenge / need identified	Design response	Relevant DTs
Behavioral management burden	Parents struggled with aggression, tantrums, emotional escalation	Calm-down tools, stepwise behavioral guidance, behavior cueing	DT #2, DT #14, DT #33
Sensory overload support	Children distressed by noise, light, textures, picky eating	Sensory customization and sensory regulation activities	DT #4, DT #11
Caregiving fatigue and burnout	Chronic exhaustion, emotional strain, lack of respite	Caregiver wellness supports, mindfulness, self-care reminders	DT #15
Work-life balance constraints	Parents needed flexible access to interventions and learning materials	Offline access, micro-learning modules, flexible scheduling tools	DT #23, DT #18
Financial constraints	Therapy costs unaffordable, limited subsidies and guidance	Funding navigation assistant and tiered affordability features	DT #13
Social isolation and limited support networks	Parents lacked community support and felt stigma	Peer support groups, shared caregiving tools, resilience narratives	DT #19, DT #20
Parent–teacher communication gaps	Difficulty coordinating strategies across home and school	Coaching and messaging platform with shared intervention guides	DT #36, DT #41
Future readiness concerns	Parents wanted pathways toward independence and adult life skills	Life skills toolkit and vocational preparation modules	DT #17, DT #29

Teacher challenges and instructional needs

Teachers of learners with ASD reported complex instructional and systemic challenges that shaped their capacity to provide individualized and inclusive education. These challenges included managing behavioral disruptions, addressing communication barriers, sustaining learner engagement, coping with limited resources, and navigating insufficient institutional support.

Behavioral unpredictability and emotional dysregulation were described as significant classroom challenges, often compounded by sensory sensitivities and difficulty sustaining attention. Teachers emphasized the need for structured behavior supports, emotional regulation tools, and consistent reinforcement strategies across home and school environments.

Communication barriers were particularly pronounced among non-verbal learners, limiting students' ability to follow instructions, express needs, and participate socially. Teachers highlighted the importance of accessible multimodal communication tools, including picture-based systems and voice-supported expressive aids.

Resource constraints were a persistent issue across participants. Teachers reported insufficient instructional materials, uneven teaching workloads, and limited preparation time, particularly among early-career educators managing multiple classes. These systemic inequities reduced the feasibility of individualized approaches despite the recognized necessity of personalized instruction for learners with ASD.

Teachers also identified weak parent–teacher collaboration as a barrier to continuity of learning. Educators emphasized the need for structured communication systems, parent-coaching

supports, and shared intervention-planning tools to bridge school-based instruction with home reinforcement.

Finally, teachers reported inadequate institutional training and limited professional development opportunities in autism-specific practices. Participants expressed the need for peer support networks, accessible intervention libraries, and integrated resources to strengthen educators' confidence while reducing workload.

Table 36

Summary of teacher patterns and design response

Teacher challenge	Key challenge / need identified	Design response	Relevant DTs
Classroom behavioral disruptions	Emotional dysregulation and sensory triggers disrupted instruction	Emotion regulation tools and individualized behavior plans	DT #2, DT #31
Communication barriers	Non-verbal learners struggled with expressive/receptive language	AAC/PECS supports and voice-output communication aids	DT #3, DT #32
Attention and engagement difficulties	Sustaining learner engagement was time-intensive	Gamified focus supports and interest-driven learning tools	DT #6, DT #8, DT #45
Limited teaching resources	Insufficient materials, uneven workload distribution	Printable templates and intervention libraries	DT #1, DT #29, DT #34
High workload and time constraints	Teachers lacked capacity for individualized content creation	AI-supported lesson templates and scalable content generation	DT #38, DT #44
Weak home-school continuity	Strategies not consistently reinforced at home	Shared schedules and parent coaching infrastructure	DT #36, DT #41
Institutional training gaps	Limited autism-specific professional development	Peer educator communities and shared expertise platforms	DT #39, DT #40
Low-resource infrastructure	Unreliable connectivity and device limitations	Offline-first design and low-bandwidth accessibility modes	DT #9, DT #34

Cross-stakeholder pattern synthesis

Across learners, parents, and educators, the analysis revealed a consistent set of cross-cutting patterns that shaped the requirements for a digital life skills intervention in low-resource contexts. While each stakeholder group experienced challenges differently, the findings converged around shared domains of need, including cognitive scaffolding, communication support, emotional regulation, sensory accommodations, motivation, caregiver burden, and institutional constraints.

The table below summarizes the primary patterns observed in the qualitative data, the corresponding alignment with established literature, and the resulting design implications that informed the development of Odyssey.

Table 37

Summary of cross-design patterns

Capability	Core feature	Stakeholders	Design themes
Life skills scaffolding	Task analysis + visual modeling for daily routines	Learners, Parents, Teachers	DT #1, DT #11, DT #16, DT #17
Routine and planning supports	Visual schedules, reminders, shared calendars	Learners, Parents, Teachers	DT #12, DT #41
Communication tools	AAC, PECS, expressive multimodal supports	Learners, Teachers, Parents	DT #3, DT #28, DT #32
Emotional and behavioral regulation	Calm-down tools, emotion boards, behavior plans	Learners, Parents, Teachers	DT #2, DT #14, DT #31
Sensory regulation supports	Sensory customization, calming environments	Learners, Parents	DT #4, DT #11
Motivation and gamification	Rewards, achievements, interest-based engagement	Learners, Teachers	DT #43, DT #45, DT #7, DT #8
Collaboration tools	Coaching, communication, shared intervention planning	Parents, Teachers	DT #36, DT #35

Resource scalability tools	Intervention libraries, AI templates, printable content	Teachers, Parents	DT #29, DT #38, DT #34
Caregiver support systems	Wellness tools, peer support, resilience narratives	Parents, Teachers	DT #15, DT #19, DT #20
Accessibility in low-resource contexts	Offline mode, low-bandwidth usability	All stakeholders	DT #9, DT #34

Theoretical integration and how it informed the design

The findings of this study were interpreted through a multidisciplinary theoretical framework that guided the translation of stakeholder needs into design concepts. This section consolidates the primary theoretical contributions that informed Odyssey's design themes and prototype capabilities.

CLT provided a foundation for structuring life skills interventions into manageable, stepwise components. Given the attentional and executive-functioning difficulties reported by learners, CLT supports the design of digital task scaffolds that reduce cognitive overload and help children process one routine step at a time. This was particularly relevant for daily living routines such as hygiene, dressing, meal preparation, and transition management.

DCT and the CTML reinforced the importance of combining visual, auditory, and symbolic communication formats. This integration is especially critical for minimally verbal learners who require alternative pathways for comprehension and expression across learning contexts.

In addition, WST emphasized that communication is not only about language development, but also about using words, symbols, and interactional tools to support shared meaning in everyday routines. This lens strengthened the inclusion of caregiver-supported communication scaffolds and multimodal systems that help learners participate socially, even with limited expressive speech.

ToM contributed to understanding social-communication barriers and the difficulty learners experienced in interpreting emotions, intentions, and reciprocal interaction. This theoretical lens supported the inclusion of structured social narratives, role-play scaffolds, and expressive communication tools to help learners practice social engagement in safe, positive environments.

EPF highlighted the importance of visual and sensory processing strengths among many learners with ASD. EPF emphasized visual modeling, sensory customization, calming environments, and multimodal learning supports that leverage visual cognition while minimizing sensory overwhelm.

WCC and EDT further explained learner challenges in synthesizing information holistically, managing inhibition, planning routines, and sustaining attention. These theories supported the inclusion of structured routines, predictable schedules, and consistent reinforcement mechanisms to scaffold independence and reduce behavioral escalation.

DMT explained why many interaction challenges in autism arise not only within the learner, but through misalignment between autistic and non-autistic communication styles. This perspective reinforced the importance of designing tools that support shared understanding, co-regulation, and more responsive caregiver–child interaction rather than placing responsibility solely on the child.

LCE served as an overarching paradigm emphasizing personalization, autonomy, and motivation. Findings consistently demonstrated that learner engagement increased when interventions aligned with individual interests, strengths, and preferences. LCE therefore highlighted the need for adaptive learner profiles, flexible scheduling, and meaningful reward systems that are relevant to each child’s lived context.

Finally, Vygotsky’s (SCT grounded learning as a socially mediated process shaped through interaction, guidance, and shared activity across home and school contexts. This perspective aligned strongly with stakeholder calls for caregiver involvement, teacher support, and context-sensitive interventions to support child development over time.

This integrated theoretical foundation directly informed the study’s design themes and the development of Odyssey’s prototype features. Cognitive and multimedia theories guided the structuring of routines and multimodal supports, while autism-specific and relational theories emphasized sensory regulation, social understanding, and co-regulation within everyday caregiving environments.

Table 38

Summary of patterns, theoretical lens, and design implications

Pattern domain	Pattern in primary data	Literature alignment	Theoretical lens (only included theories)	Design implications
Cognitive and attention difficulties	Learners struggled with focus, task initiation, sitting tolerance, and multi-step routines.	Executive functioning and attention challenges are widely documented in ASD.	CLT + EDT: attentional and executive limits require reducing cognitive overload through stepwise scaffolding.	Visual schedules, scaffolded task sequencing, gamified attention supports.
Daily living and independence needs	Parents emphasized support for hygiene, toileting, dressing, meal preparation, and household routines.	Life skills interventions are critical predictors of long-term independence.	CLT + SCT: routines are learned through mediated scaffolding in everyday contexts, gradually transferred	Visual task modeling, home-based coaching modules, routine-building tools.

			toward autonomy.	
Communication barriers	Learners relied on gestures, echolalia, hand-leading, inconsistent expressive language.	Research supports multimodal communication needs and AAC/PECS effectiveness.	DCT + CTML + WST: communication requires multimodal symbolic tools that support shared meaning-making beyond speech.	Picture-based communication systems, expressive multimodal tools, caregiver-supported scaffolds.
Social interaction challenges	Limited peer engagement, difficulty interpreting nonverbal cues, minimal role play exposure.	Social isolation and turn-taking difficulties are common in moderate to severe ASD.	ToM + DMT: interaction breakdowns emerge relationally through misattunement, requiring reciprocity and co-regulation supports.	Social storytelling tools, structured turn-taking activities, peer interaction scaffolds.
Emotional dysregulation and behavioral episodes	Parents and teachers reported tantrums, aggression, meltdowns, frustration, destructive behaviors.	Sensory overload and emotional self-awareness deficits contribute to escalation.	EDT + DMT + SCT: dysregulation reflects executive limits and challenges in shared emotional attunement, requiring mediated calming supports.	Emotion boards, calming tools, behavior cueing supports, rapid de-escalation features.
Sensory sensitivities and food-related needs	Learners exhibited hypersensitivity to noise/light and selective eating patterns.	Sensory processing differences are central in ASD caregiving literature.	EPF + DMT: sensory overwhelm contributes to interactional misattunement, requiring adjustable environments and regulation supports.	Sensory customization settings, calming environments, sensory regulation interventions.

Strengths and interest-driven engagement	Learners showed strong interests in music, art, Lego, puzzles, sports, and digital apps.	Intrinsic motivation increases engagement through strengths-based learning.	LCE + SCT: engagement is strongest when mediated through meaningful interests and socially grounded learning.	Creative learning tools, interest-aligned learner profiles, strengths-based play modules.
Motivation through reinforcement	Higher engagement occurred when tasks aligned with favorites (games, media, food).	Reinforcement systems improve persistence and skill acquisition.	LCE + WST: motivation is sustained when reinforcement is personalized and socially meaningful within everyday routines.	Tailored reward systems, achievement progression, gamified routines.
Parent caregiving fatigue and burnout	Parents experienced chronic exhaustion, isolation, lack of rest, emotional strain.	Caregiving stress is amplified in low-resource contexts.	DMT + SCT + LCE: caregiver strain reflects relational misattunement and the sociocultural context of caregiving, requiring sustainable family-centered supports.	Caregiver wellness tools, mindfulness supports, peer support features.
Financial constraints and limited service access	Families lacked affordable therapy, funding guidance, accessible interventions.	Systemic inequities limit ASD health coverage in LMICs.	SCT + LCE: interventions must serve as accessible mediating tools that remain flexible within real resource constraints.	Tiered affordability models, funding navigation support, offline-first accessibility.
Weak parent–teacher collaboration	Teachers reported inconsistent home reinforcement and	Poor collaboration is a barrier to intervention continuity.	SCT + WST: collaboration depends on shared communicative tools that coordinate	Coaching platforms, shared schedules, micro-trainings, collaborative planning tools.

	communication gaps.		routines across contexts.	
Teacher workload and resource constraints	Teachers lacked materials, high class loads, limited preparation time.	Under-resourced systems hinder inclusive education implementation.	CLT + SCT: educators require mediating tools that reduce cognitive burden while supporting scaffolded instruction.	AI-supported templates, intervention libraries, printable content options.
Long-term transition and future readiness	Parents expressed need for pathways toward adulthood, vocational skills, independence.	Transition planning is critical for moderate to severe ASD outcomes.	SCT + EDT: autonomy develops through scaffolded participation and executive support across the life course.	Life skills progression systems, vocational simulation toolkits, future planning supports.
Low-resource context constraints	Families required offline, mobile-friendly, culturally grounded tools.	Accessibility and cultural responsiveness are essential in underserved settings.	SCT + DMT + LCE: interventions must remain culturally mediated, relationally supportive, and feasible under resource constraints.	Low-bandwidth modes, culturally inclusive narratives, adaptable interventions.

Capability and feature prioritization for the Odyssey digital health solution

Building on the design themes derived from the literature review and primary data, the study identified a set of prioritized capabilities and feature requirements for developing a prototype mobile application called *Odyssey*. Odyssey was envisioned as a life skills development and support platform designed to assist learners with moderate to severe autism, while simultaneously empowering parents and teachers within low-resource environments.

The minimum viable product (MVP) scope of Odyssey was determined through two primary considerations:

1. The potential impact of each design theme on learner independence and life skills development.
2. The reusability of core technical capabilities to support multiple intervention needs through configurable content creation.

To guide feature prioritization systematically, the study applied the MoSCoW framework, which categorizes features into:

- Must Have
- Should Have
- Could Have
- Won't Have (for now)

This approach enabled the research to balance stakeholder urgency, feasibility, and long-term scalability in determining which intervention supports should be prototyped first.

Core prioritized capabilities in the Odyssey MVP included:

- Visual task modeling for daily living routines
- Interactive schedules and routine scaffolding
- Multimodal communication supports for minimally verbal learners
- Emotional regulation and calming tools
- Personalized learner profiles incorporating interests and strengths

- Parent–teacher collaboration and coaching infrastructure
- Offline and low-bandwidth accessibility modes
- Template-based intervention libraries to reduce educator workload

The prioritized MVP feature set reflected the study’s emphasis on structured independence-building supports, caregiver empowerment, and practical feasibility in marginalized educational settings (see Appendix 11).

The following sections of this chapter further analyze how these capabilities emerged through the iterative participatory design process and how methodological adaptations, infrastructural constraints, and stakeholder feedback shaped Odyssey's development trajectory.

Analysis of the iterative design process

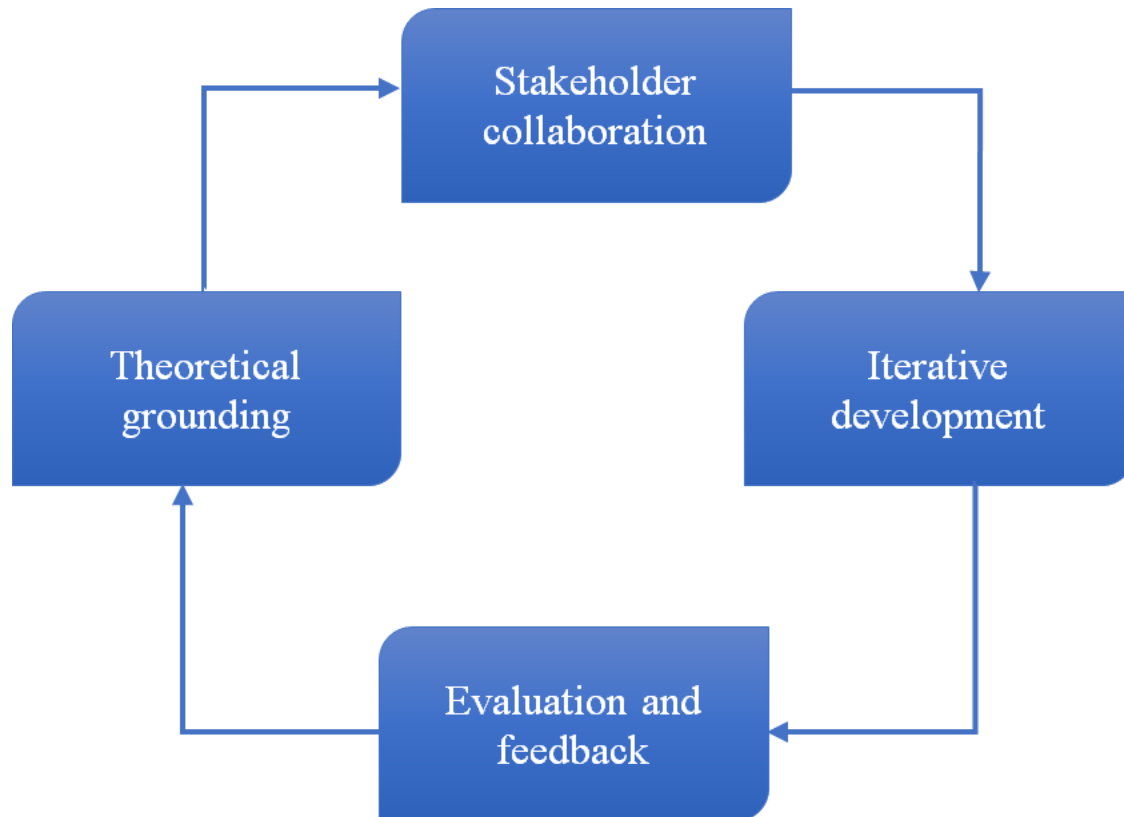
This section analyzes the design process used to develop Odyssey, a mobile application intended to support the development of life skills among children with moderate to severe autism in low-resource contexts. The analysis is grounded in Yin’s Logic Model (2018), which aligns program inputs, activities, and outcomes, and Frauenberger, Fitzpatrick, and Iversen’s (2015) Four Design Lenses framework, which examines participatory design through epistemology, values, stakeholders, and outcomes.

Rather than conceptualizing the design trajectory as linear, the development of Odyssey reflected an iterative and adaptive process shaped by real-world constraints, infrastructural limitations, and the lived realities of marginalized families and educators. Participatory design in this study, therefore, emerged not only through direct co-design activities but also through the

careful integration of stakeholder insights into evolving technical and design decisions. The figure below presents the process model for the co-design and development of Odyssey.

Figure 55

Process model for the co-design and development of the digital system for ASD



Identifying and understanding user needs: foundations for design ideation.

The design process began with an extensive literature review of assistive technologies for autism and of cognitive and learning theories related to ASD. It documented challenges experienced by learners, parents, and educators in low-resource environments. This phase produced a capability-feature matrix identifying 33 potential features and 24 intervention

pathways, which served as the initial foundation for conceptualizing solutions for moderate to severe autism (see Appendix 11).

These literature -informed insights were translated into early design artifacts, including empathy maps, user personas, and a low-fidelity prototype. These artifacts supported the communication of research intent and helped ensure accessibility in participant recruitment materials.

From a values-based perspective, transparency, respect, and contextual sensitivity guided engagement with stakeholders. Ethical diligence was demonstrated through extended coordination with the Philippine Department of Education and school administrators, as well as the inclusion of simplified visual prototypes to reduce participant burden and ensure clarity.

Stakeholders in this phase included institutional education authorities, school leaders, academic collaborators, and industry partners. However, early power imbalances were already evident, as classroom teachers were not always fully informed of the expected scope of involvement. This misalignment later steered feasibility and contributed to methodological adaptation.

Key outputs of this stage included:

- Literature review synthesis
- Capability-feature matrix
- Empathy maps and personas
- Ethics approvals
- Low-fidelity prototype

- Institutional endorsements

Envisioning user requirements through primary data collection

Primary data gathering occurred between September and December 2024. After approvals were granted, initial engagement with teachers revealed significant misunderstandings about expectations for participation. Teachers anticipated a single interview but expressed concern upon learning that iterative workshops and repeated feedback cycles were originally planned. Given high workloads and limited resources, sustained participation in workshops was not feasible.

This resulted in a critical methodological pivot: the participatory design approach shifted from synchronous workshop-based collaboration to an asynchronous model relying on qualitative surveys with optional follow-up interviews.

This adaptation had epistemological implications. Instead of co-constructing solutions in live collaborative sessions, participation became participant-controlled in timing, depth, and format. Despite these constraints, rich experiential knowledge was captured. Parents shared emotional exhaustion, frustration in teaching minimally verbal children, and the complexity of managing behavioral escalation. Teachers contributed insights into classroom realities, resource limitations, and instructional burden.

This stage reinforced values of care, flexibility, and co-responsibility. Participation was approached ethically as an added burden within already-strained caregiving and teaching environments. Power dynamics became increasingly visible: teachers and parents were

recognized as experts in lived experience, yet lacked institutional capacity and time to engage extensively.

Key outputs of this stage included:

- 16 qualitative surveys (9 teachers, 7 parents)
- Two parent interviews
- One teacher group interview (five teachers)
- Emergence of 45 design themes
- Updated personas and prototype refinements

Design and development cycle 1: Prototype refinement and teacher feedback

The first major design iteration occurred between September 2024 and April 2025. This cycle focused on refining user interface design, strengthening visual branding, and improving usability cohesion, informed by stakeholder input.

New features were added for educators, including:

- Class management tools
- Parent–teacher communication modules
- Individual learning plans
- Community and collaboration support

A design feedback session was conducted with one teacher participant in March 2025. Connectivity limitations prevented access to the prototype independently, requiring a live

walkthrough via screen share. Despite modest participation volume, the session yielded critical insights into usability barriers within low-resource classrooms.

Teacher Mara emphasized that expecting educators to create individualized content for every life skill was unrealistic, given the workload. This feedback highlighted the need for scalable supports such as:

- Templates
- Pre-built intervention libraries
- AI-assisted customization
- Shared content creation with parents

Infrastructure limitations were also raised, including unreliable internet, limited access to high-spec devices, and uneven digital literacy among educators. These concerns reinforced the importance of offline functionality, printable materials, and onboarding resources.

Ethical issues also emerged regarding student media use, prompting recommendations for privacy-protective features such as masking, avatars, or face blurring.

Epistemologically, this phase reflected a synthesis of multiple knowledge sources. Although not fully participatory in practice, the design remained participatory in intent, translating stakeholder insights into technical decisions through iterative reflection and principled compromise.

Key outputs of this stage included:

- Refined high-fidelity prototype in Figma

- Updated UI/UX branding
- Teacher feedback log
- Technical design documentation
- Updated code base in Git

Design and development cycle 2: parent-oriented expansion

The second design iteration took place between April and August 2025. During this cycle, additional features were conceptualized for parent users, including behavioral management supports and visual calendar modules.

ACL continued frontend and backend development, though progress was constrained by developer availability and the technical complexity of multimedia processing.

One parent participant, Edward, engaged in a design feedback session focused on feature relevance, usability, and perceived value. Feedback supported the importance of caregiver-centered tools, especially those enabling home-based coaching, communication scaffolds, and affordable accessibility.

Key outputs of this stage included:

- Updated parent-focused prototype refinements
- Parent feedback log
- Additional technical design documentation
- Continued code base development

Evaluation and refinement (future work)

The evaluation phase was planned as future postdoctoral work. This phase would involve completing the Android prototype and conducting usability testing, think-aloud sessions, and observational studies with learners, parents, and teachers.

This stage is intended to reintroduce stakeholders as active participants to validate assumptions, uncover emergent needs, and refine Odyssey within real-world classroom and home contexts.

The value of co-ownership would be central, positioning participants not as testers but as co-shapers of the intervention. Ethical priorities would include child safety, privacy, and accessibility accommodations across diverse communication and cognitive profiles.

Anticipated outputs include:

- Completed mobile prototype
- Usability and observation results
- Refinement recommendations
- Validated MVP for low-resource deployment

Chapter Summary

This chapter presented an integrated qualitative analysis of the capabilities, interests, challenges, and needs of learners with moderate to severe autism, alongside the intersecting realities faced by caregivers and educators in low-resource settings.

Findings highlighted that learners require structured yet personalized supports that scaffold daily living routines, communication, emotional regulation, sensory management, and social participation. Learner strengths and interests emerged as essential anchors for motivation, engagement, and capability-driven design.

Caregivers reported significant burdens related to behavioral management, sensory sensitivities, fatigue, financial constraints, limited service access, and social isolation. These challenges underscore the importance of digital interventions that empower parents through accessible coaching, emotional support, peer connection, and affordable home-based learning resources.

Teachers described complex classroom challenges, including behavioral unpredictability, communication barriers, limited instructional materials, high workloads, and insufficient institutional training. Strengthening parent–teacher collaboration and providing scalable intervention resources were identified as critical requirements for sustainable implementation.

Cross-stakeholder synthesis revealed consistent patterns across cognitive scaffolding needs, multimodal communication supports, emotional regulation tools, structured routines, caregiver empowerment, and low-resource accessibility constraints. These patterns informed the prioritized capabilities of Odyssey, a prototype digital health solution platform designed to support life skills development while addressing systemic limitations in underserved autism contexts.

Finally, the chapter analyzed the iterative participatory design process underpinning Odyssey’s development. Grounded in Yin’s Logic Model and the Four Design Lenses

framework, the design trajectory demonstrated methodological adaptation, ethical responsiveness, and stakeholder-informed refinement amid real-world constraints.

Together, the findings and design analysis provide a comprehensive foundation for guiding the development of a contextually relevant and sustainable digital intervention for moderate to severe autism life skills development.

Chapter VI: Conclusion

The study aimed to answer the central question: *What are the essential requirements for designing a digital health solution to support the life skills development of learners with moderate-to-severe ASD in low-resource settings?* More than a technological challenge, this study posed a social question of how to make digital health solution inclusive for marginalized individuals.

Over the course of the research, this guiding question was explored through a rich blend of theoretical inquiry, participatory design, design thinking, requirements engineering, and iterative and incremental practices in design and development. The findings were presented through detailed portraits of the lived experiences of learners with moderate-to-severe ASD, their parents, and their teachers, culminating in a feature matrix organized by design themes. An ideated user interface and user experience design, along with a mobile proof of concept, which validated and informed the solution design, were also co-created in collaboration with MDTI students and IT industry collaborators.

The core of this research involved three interconnected workstreams: literature review and synthesis, qualitative surveys and interviews, and incremental, iterative prototyping with design feedback. Together, these workstreams supported the formation of user personas, feature requirements, and design themes to help address the needs and challenges of learners with moderate to severe ASD and their support systems.

This chapter synthesized the findings, discussed the limitations encountered, outlined recommendations, and presented future directions.

Summary of Major Findings

Learners with moderate to severe ASD

Most learners were children aged 6 to 8, predominantly male, and typically the only child in their family. A majority did not have formal diagnoses, though exhibited behaviors and capabilities aligned with moderate to severe ASD. Learners demonstrated notable strengths in creative and musical expression. Emerging skills were observed in cognitive and problem-solving abilities, physical activity, and basic daily living skills such as toileting, dressing, and simple cooking. These capabilities and interests could be used to personalize lessons and reinforcement strategies, as well as daily routines, and to create natural opportunities for learning across morning, afternoon, and evening activities.

Needs and challenges were focused on communication and socialization; attention and working memory; emotional and behavioral regulation; independence in self-care; sensory sensitivities, food selectivity, and safety awareness. Learners often require structured environments, clear routines, and visual support to manage transitions and multi-step tasks.

Parent–educator collaboration was found essential for aligning home and school approaches, and multimodal tools such as AAC, PECS, video modeling, and gamified activities were identified as vital for supporting communication, skill development, and motivation. The digital health solution for ASD life skills development drew on multiple theoretical frameworks, including ToM, EDT, WCC, EPF, DCT, CLT, CMTL, and LCE, to effectively scaffold skills, leverage strengths, and address challenges in a low-resource context for learners with moderate-to-severe ASD. These insights formed the foundation for tailoring digital interventions to enhance independence, engagement, and social participation for learners with moderate to severe ASD.

Parents of learners with moderate to severe ASD

Most parents of children with ASD were between 31 and 40 years old, with some in their 40s and one senior caregiver aged 61 to 70. The majority were married, while a few were in common-law relationships or single. Education levels tend to be high, with most caregivers having completed college, though some have only finished high school or have incomplete higher education. These caregivers worked across various sectors, including private employment, self-employment, local government, and full-time homemaking. Household incomes averaged between CAD 6,000 and 12,000 annually (PHP 240,000–480,000), which fell below the national average in the Philippines, particularly in urban areas with high living costs. Most families were trying to thrive within their lower-income brackets.

Parents adopted a blend of nurturing, structured, and interest-driven caregiving approaches, and tailored their approaches to meet their child's individual needs. They emphasized consistent routines, proactive problem-solving, and engagement with their child's personal interests. Despite these adaptive methods, common challenges persisted, such as managing behavioral and sensory issues, balancing caregiving with work demands, coping with financial strain from therapy and education costs, limited access to specialized services, and minimal support from family or community networks. Parents' primary goals centered on fostering their child's independence and life skills, securing financial and government assistance, improving their own well-being through rest and support, enhancing educational and behavioral interventions with professional tools and guidance, and preparing their children for the future through employable skills, community integration, and lifelong learning opportunities.

To better support parents in managing their children's emotional regulation and sensory needs, digital emotion boards, calming visuals, customizable sensory settings, gamified exposure, and picture-based communication systems could be used to promote consistent behavioral strategies across home and school environments. Caregiver well-being could be supported through mindfulness activities, virtual counseling, emotional check-ins, flexible micro-training modules, and family task-sharing features designed to reduce burnout and foster shared caregiving responsibilities. Financial accessibility could be enhanced by tiered pricing, subsidized services, printable resources, intelligent guidance for navigating funding, and offline or low-bandwidth modes to ensure usability in low-resource settings. Educational components that could provide customizable visual routines, task modeling, intervention libraries, progress tracking, and gamified, interest-driven learning tools could accommodate diverse parenting styles while fostering independence and future readiness. In addition, parental empowerment and training could be achieved through home-based coaching tools, modular micro-training, and peer support communities. Furthermore, social inclusion and cultural responsiveness could be promoted through the integration of community and peer support, culturally diverse content, and advocacy features to reduce stigma and empower families within their cultural contexts.

These design features were grounded in key learning and cognitive theories, yielding a holistic, adaptive, and accessible digital intervention platform designed to effectively support the complex caregiving and learning needs of families affected by autism. CLT, DCT, and CMTL guided the simplification, scaffolding, and chunking of tasks to reduce mental strain for both children and caregivers. LCE principles foster flexibility, autonomy, collaboration, and cultural inclusivity, promoting active caregiver involvement, peer support, and adaptation to diverse contexts.

Teachers and educators

Most teachers in the study were between 42 and 50 years old, with a smaller group aged 51 to 60. The majority were married and had completed a bachelor's degree, with some educators having completed graduate studies. Teaching experience varied widely: most have 6 to 10 years, some 11 to 15 years, and a few over two decades, demonstrating a mix of emerging and seasoned educators. Teaching loads vary by experience, with senior teachers typically handling one class, while junior teachers often manage multiple classes, ranging from three to five and occasionally more. Class sizes range from small groups of 3 to 10 students, which is common in specialized settings, to standard classrooms of 19 to 26 students, reflecting a diverse range of educational environments.

Teachers employed a variety of instructional approaches, from highly structured and routine-based methods using visual schedules and stepwise instructions to adaptive, individualized strategies tailored to students' developmental levels, behaviors, and needs. Emphasis on life skills and practical training was common, alongside behavior management techniques such as reinforcement and emotional regulation supports.

Teachers faced complex challenges managing behavioral, communication, sensory, and engagement difficulties among learners with moderate to severe autism, which are often compounded by limited training, scarce resources, uneven teaching loads, and insufficient institutional and community support. These challenges hinder teachers' ability to provide personalized, consistent instruction, contributing to teacher burnout and reducing student progress. Parental engagement, critical for reinforcing learning beyond the classroom, is often limited by a lack of structured training, poor communication, and resource constraints, further weakening the effectiveness of educational interventions.

To address these interconnected challenges, this study proposed features that could support both educators and families. Key solutions include behavioral and emotional regulation tools such as real-time behavior tracking, emotion regulation boards, individualized reinforcement, and consistent home-school reward systems to reduce disruptions and improve self-regulation. Communication supports include multimodal aids such as PECS and AAC devices, personalized learner profiles, and parent-teacher messaging platforms that enhance collaboration and social understanding. Personalized and visual learning resources, including step-by-step task modeling, video tutorials, individualized learning plans with real-time progress tracking, and AI-assisted intervention templates, enable tailored instruction even in resource-limited settings. Accessibility and equity are ensured through offline functionality, low-spec device compatibility, and print alternatives, making these solutions usable across diverse technological and economic contexts.

These features and interventions were grounded in LCE, informing designs to support the development of autonomy, personalization, and collaboration among learners, parents, and educators. CLT and DCT guided the simplification and multimodal presentation of complex tasks to reduce cognitive strain, while CMTL reinforced instruction through integrated visual, auditory, and interactive content. EDT, WCC, and EPF supported scaffolding of routines, behavior regulation, and sensory management. ToM facilitated social cognition, perspective-taking, and empathetic communication, which are critical for effective partnerships.

The participatory design processes

The design process for a digital health solution to support life skills development of learners with moderate to severe ASD in low-resource settings followed a structured, multi-stage

approach that combined human-centered design, participatory methods, and iterative agile development.

Beginning with comprehensive literature reviews and stakeholder engagement, the study developed user personas and empathy maps following the design thinking framework to ground the design in the lived experiences of children, parents, and teachers. Qualitative surveys and interviews followed, and the data were analyzed using thematic analysis. This informed the ideation of 45 design themes that guided iterative prototype development in collaboration with academic partners and an industry startup.

Development progressed from a native Android platform to a hybrid cross-platform app to enhance manageability and scalability. Throughout the process, ethical considerations around transparency, respect, and contextual sensitivity were prioritized, along with pragmatic decisions to address infrastructural challenges such as limited internet access and digital literacy gaps. The project culminated in successive design iterations that incorporated teacher and parent feedback, resulting in a medium-fidelity design prototype and a technical proof of concept.

Future phases would focus on completing the MVP, conducting usability testing, and ensuring compliance with digital health solution standards.

Recommendations

The journey to creating truly inclusive digital health solution for autism begins with understanding the diverse and nuanced needs of learners, caregivers, and educators. Central to this effort is the need for personalization and adaptability.

For designers, digital tools must be designed to fit into children's lives, helping them navigate their daily routines, transitions, needs, and challenges with confidence. By leveraging participatory design, designers can gain insight into learners' unique interests and capabilities to

envision features that would directly contribute to their overall learning. Gamifying learning activities and tasks could transform studying into an adventure, further enriched by reward systems that motivate building healthy routines and reinforce good behavior. Recognizing the realities of low-resource environments, these solutions must work reliably offline and on low-spec devices, ensuring no child is left behind due to technological barriers. Intelligent, AI-driven planning empowers educators and caregivers alike, offering flexible yet structured lesson templates that respond in real time to learner progress.

For parents and caregivers, social connection must be woven into the solution, with community and family support helping break down isolation and foster belonging. Practical supports, such as building a community for parents where they can share their stories, learnings, and tips, caregiver-focused tools that provide emotional support and wellness resources, and financial aid navigation, are foundational to success. Training and guidance could be provided through micro-modules and virtual coaching, empowering parents to become confident co-educators, with learning opportunities designed to fit their busy lives.

For teachers and school administrators, empowering educators through targeted professional development builds the capacity to use these digital tools effectively. Behavior management systems and monitoring tools could help teachers navigate challenging classroom dynamics, while individualized learning plans with real-time tracking offer structured, individualized learning that caters to each student's needs and learning goals. Communication platforms could bridge the gap between home and school, fostering parent collaboration and consistency through shared goals and coaching. Visual planners and consistent reward systems

would help align efforts across school and home. Culturally inclusive content and advocacy initiatives also help ensure that no community is marginalized, promoting equity across diverse cultural backgrounds.

For policymakers and institutions, there is a need to support the implementation of educational technology and digital health solutions in modern care and education. Public-private partnerships could also be powerful engines for local innovation, ensuring solutions are culturally sensitive and grounded in the communities they serve. Finally, providing financial subsidies will help lower economic hurdles.

Together, these interconnected strategies, rooted in all 45 design themes, create a tapestry of support that not only addresses immediate challenges but also builds a foundation for digitally supported learning in low-resource areas. This foundation could empower learners with autism to thrive, equip caregivers with the tools and confidence to support their child's learning, and enable educators to deliver personalized, effective instruction.

Limitations

This study was bound by several interrelated limitations that impacted both its scope and outcomes. First, direct, live participatory engagement with teachers, parents, and learners was significantly constrained by heavy workloads, limited availability, and resource shortages typical of low-resource educational settings. This necessitated a methodological pivot from planned interactive workshops with learners to qualitative surveys and interviews with parents and teachers acting as their proxies, which, while enabling valuable qualitative insights, reduced opportunities for dynamic co-design, iterative feedback, and real-time collaboration.

In relation to this, the use of proxies also introduced potential recall bias, particularly in retrospective accounts of learner behaviors; contextual mismatch between home and school environments when comparing parent and teacher perspectives; social desirability bias, especially in reporting caregiving practices or learner abilities; and over- or under-estimation of abilities, influenced by caregiver expectations, stress, or role. The researcher tried to mitigate this by triangulating across proxy types (parents and teachers), allowing comparison of perspectives across home and school contexts; in addition, the use of multiple data sources and methods (surveys, interviews, and participatory design activities) reduced reliance on any single account. Transcript-level member checking, in which participants reviewed their transcripts for accuracy before analysis, was conducted, including reflexive analysis, such as ongoing attention to researcher positionality and interpretive assumptions during coding and synthesis.

Second, the sample size was relatively small and limited to a specific city, which reduced the diversity of perspectives and limited the generalizability of the findings to broader populations or different cultural contexts.

Third, most participating parents had male children, and in fact, there was only one parent with a female child. This limitation constrained the study's ability to explore potential gender-based differences in learning profiles or behavioral expressions among children with ASD. Since ASD is more commonly diagnosed in males, the predominance of male participants reflected broader demographic trends but also limited the generalizability of findings to females with ASD, who may present distinct social, sensory, or developmental characteristics.

Consequently, the design insights and recommendations generated through this study may be

more reflective of the experiences and needs of male learners with moderate to severe ASD, with less representation of perspectives related to female learners' unique challenges and strengths.

Fourth, infrastructural challenges, including unreliable internet connectivity, limited access to appropriate digital devices, and low digital literacy among some participants, hampered effective interaction with prototypes, degraded the quality of user feedback, and posed ongoing barriers to both development and future deployment. Fifth, technical challenges during development, such as shifting technology stacks and the complexities of multimedia processing, slowed progress and delayed the full implementation of envisioned features, including AI-driven personalization and real-time analytics.

While these limitations cannot be prevented in exploratory case studies conducted in marginalized and low-resource contexts, addressing them in future research phases would be critical to enhancing the robustness, usability, and scalability of the digital health solution.

Future Directions

Building upon this foundational work, several activities emerge for future implementation:

- Completion of the Android MVP, which encompasses design themes prioritized as Must-Have. This included the incorporation of capabilities for offline access and compatibility with low-powered devices and poor internet connectivity. Adaptive machine learning engines that could help personalize and create instructional content based on learner profiles, learning progress, and parent and teacher input would also be added.
- The MVP would also need to align with accessibility and interoperability standards, as well as relevant digital health solution and security standards, such as HIPAA

compliance, data encryption, and privacy. This would help establish the foundation for recognition by education authorities, integration within school systems, and eligibility for government or insurance funding programs.

- Once the MVP is completed, usability testing would be conducted with parents and teachers, and observations would be conducted with students, to gain direct feedback on how actual users interact with the application.
- A service design model would also need to be developed to map the end-to-end user journey, align stakeholder roles and touchpoints, and ensure that both technical and non-technical support structures are in place for sustainable adoption and scaling.

Conclusion

This study yielded an understanding of the diverse and interrelated needs of learners with moderate to severe autism, their caregivers, and educators, particularly within low-resource contexts.

The findings showed that learners who were predominantly young children with moderate to severe autism, and possessed notable strengths in creative domains, yet faced significant challenges in daily living, behavioral regulation, and communication.

Parents, who often balanced multiple roles with limited financial and social support, used adaptive caregiving strategies but faced ongoing challenges related to managing behaviors, accessing services, and sustaining well-being. Educators similarly encountered obstacles in managing diverse learner needs, limited training, resource scarcity, and inconsistent parental involvement, which contributed to burnout and hampered educational outcomes.

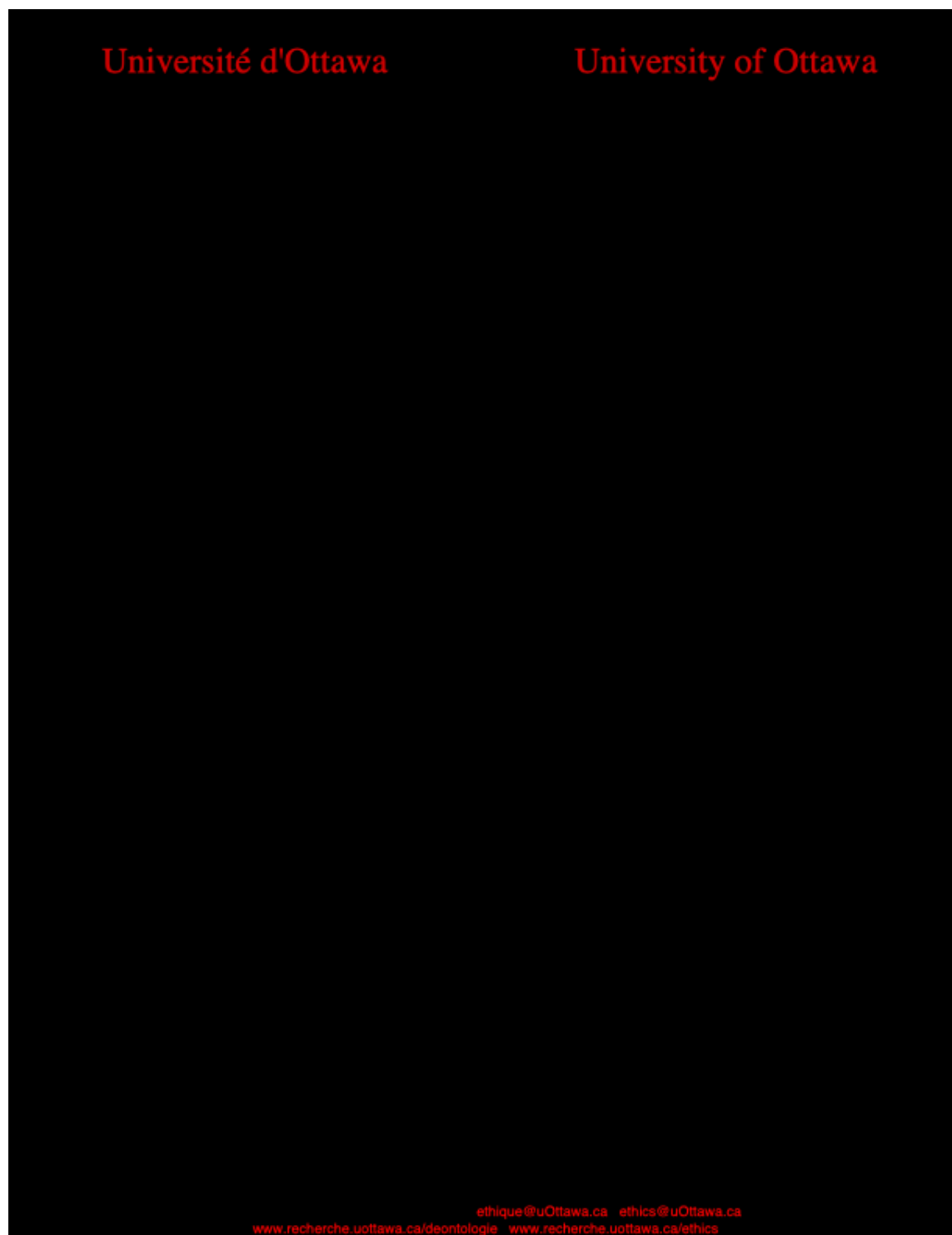
Through a participatory design process that combined human-centered, inclusive, and agile methodologies, the research team co-designed a digital health solution grounded in key cognitive and learning theories. This solution was composed of 45 design themes that integrated customizable visual activities informed by video modelling and task analysis, positive reinforcement systems through gamification, visual scheduling, behavior and emotion regulation tools, individualized learning plans, learning platforms, communication tools, and a platform to build a digital community for ASD.

Despite inherent limitations, including the relatively small sample, indirect data collection from learners, and limited prototype testing, the study provided a robust foundation for future development. Planned next steps included completing the MVP along with comprehensive usability testing.

Ultimately, this research contributed in the field of digital health solution and ed tech for ASD by providing potential digital capabilities and features that could help in providing more accessible evidence based interventions and learning to individuals with ASD in low resource areas, supported caregivers in reducing burnout and empowering them to teach their children and home, and equipped educators with practical, flexible tools to alleviate the challenges of teaching in resource-constrained setting. These contributions held promise for fostering more equitable, sustainable, and impactful autism services globally, especially in under-resourced communities where traditional supports were scarce.

Appendix

Appendix 1: Ethics Board Review Approvals



Université d'Ottawa

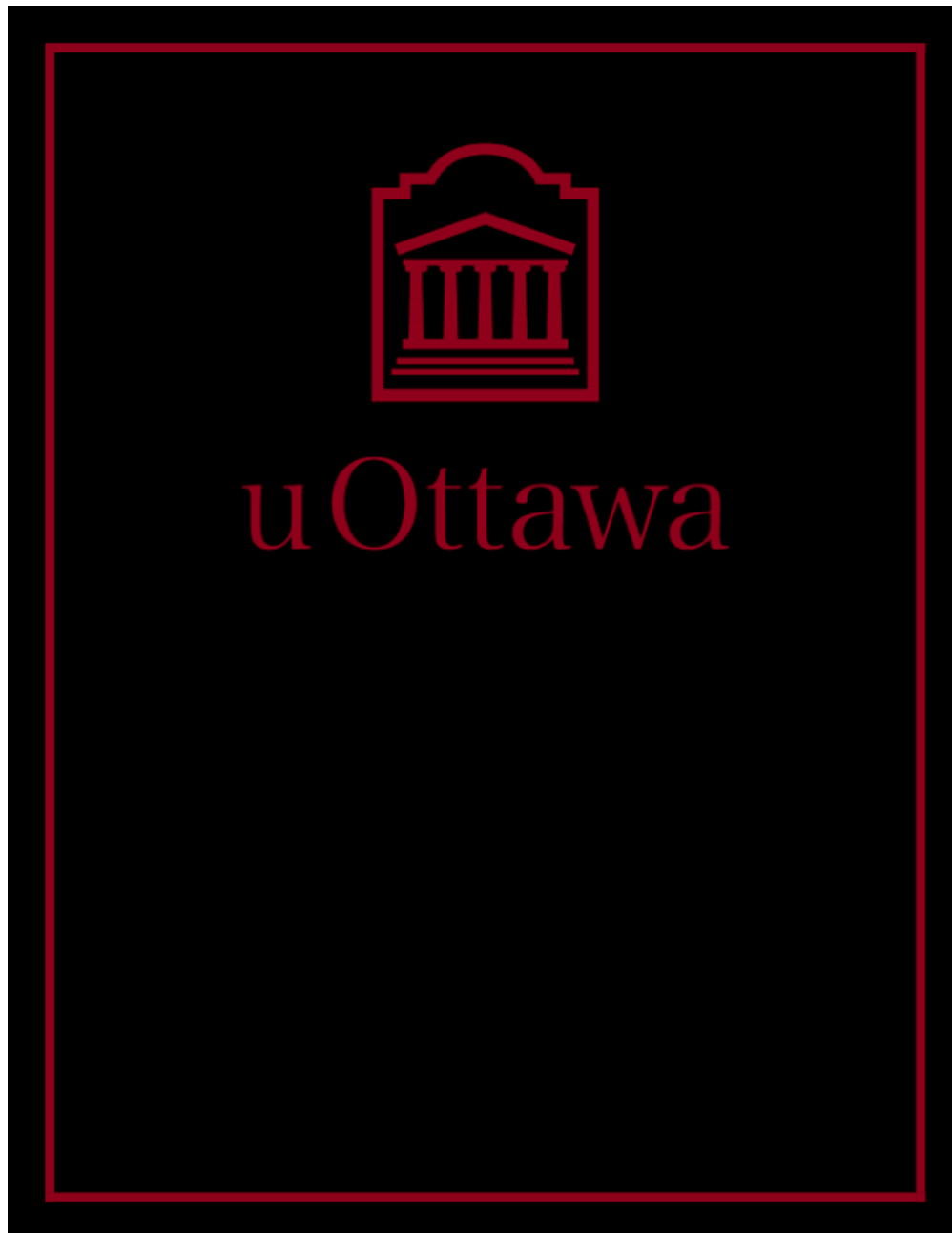
University of Ottawa

ethique@uOttawa.ca ethics@uOttawa.ca
www.recherche.uottawa.ca/deontologie www.recherche.uottawa.ca/ethics

Appendix 2: Research collaboration report 1

Research Report from collaboration with MDTI student Raj Baldania

[Empowering Children with Severe Autism- Designing a Mobile Application for Digital Interventions.pdf](#)

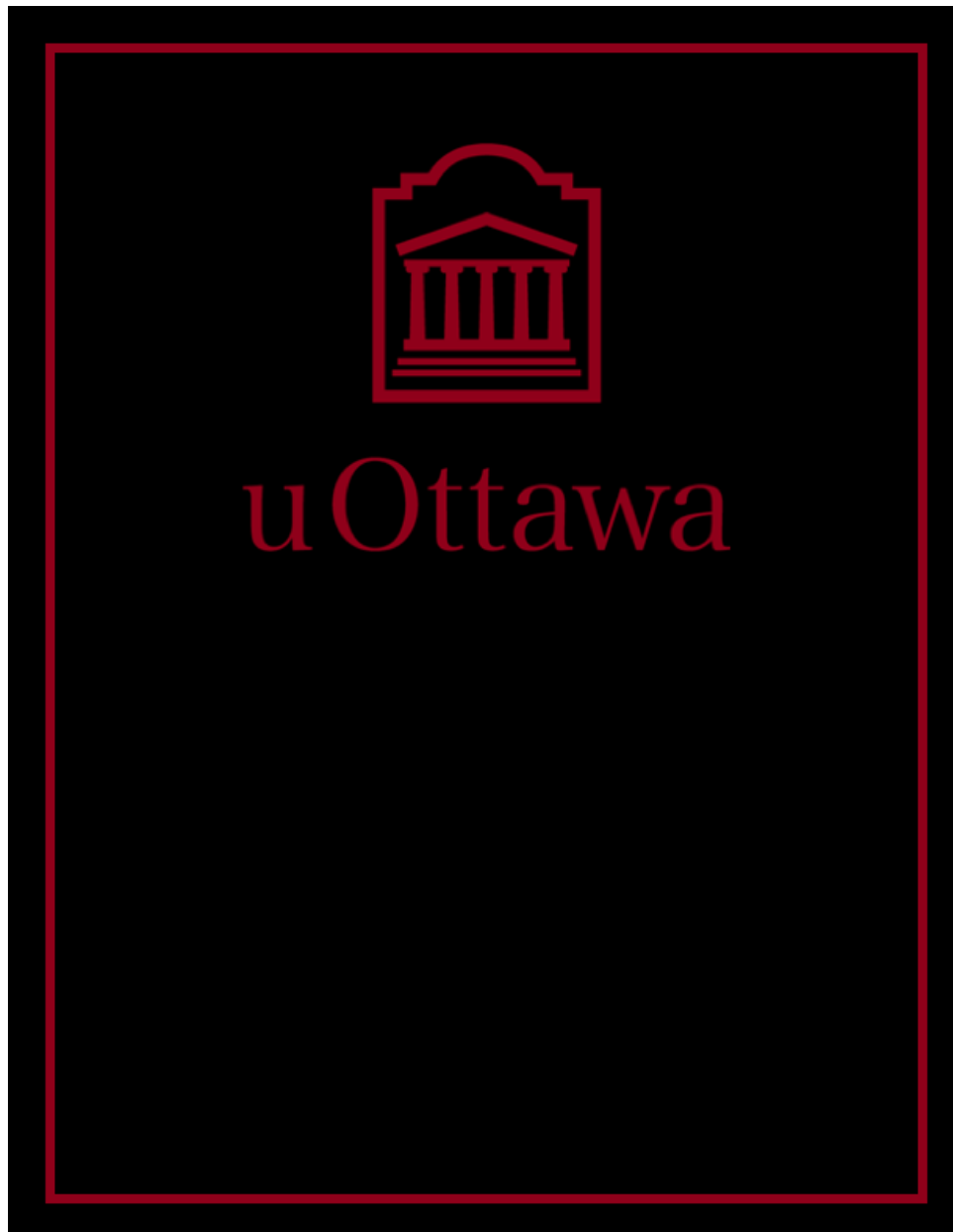


Appendix 3: Research collaboration report 2

Research Report from collaboration with MDTI student Ankit Arora

[Empowering Children with Severe Autism- Designing a Mobile Application for Digital](#)

[Interventions Ankit Arora 300220629.pdf](#)



Appendix 4: Research collaboration report 3

Research Report from collaboration with MDTI student Malavika Mahesh

[DTI6997 Report_Malavika Mahesh.pdf](#)

**Designing a Mobile E-Learning App:
Supporting Educators, Parents, and Autistic Children**

Malavika Mahesh

A project report submitted for the DTI6997 course
Master's degree in Digital Transformation and Innovation (UX)

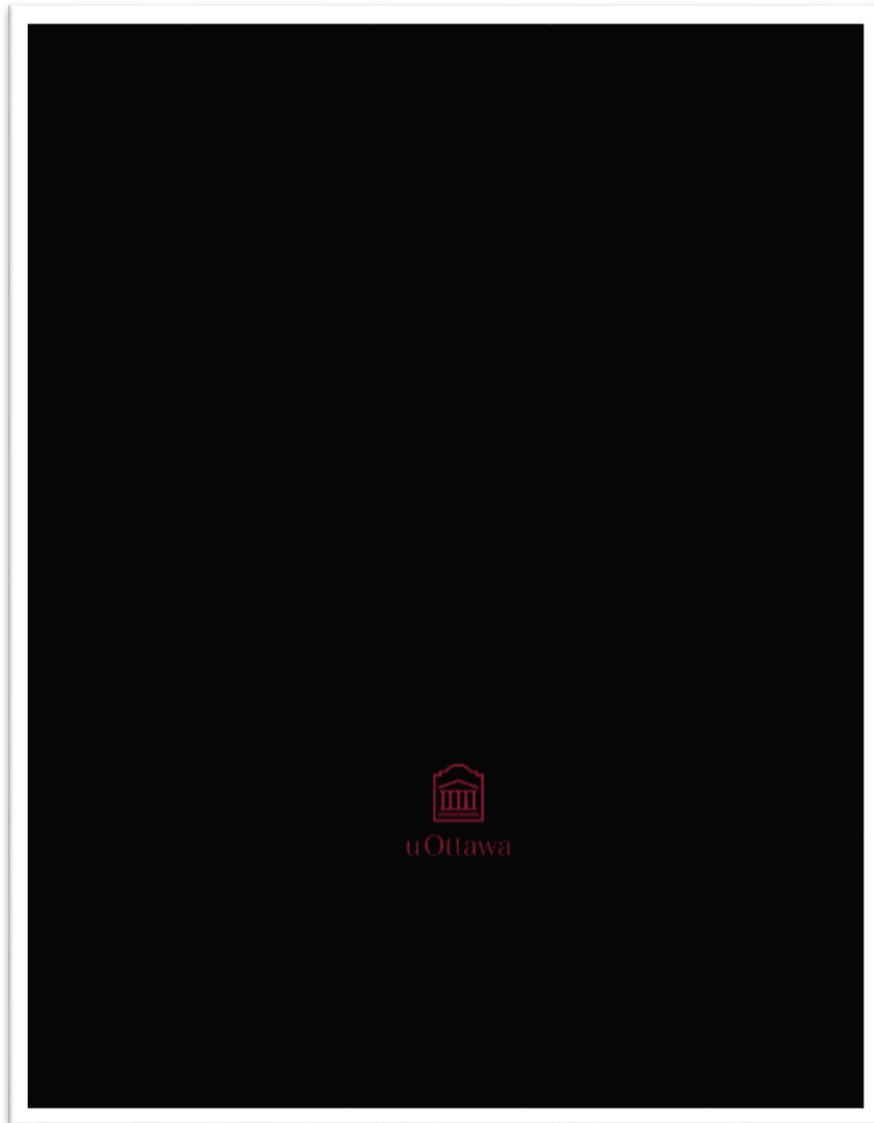
School of Engineering Design and Teaching Innovation
Faculty of Engineering
University of Ottawa

© Malavika Mahesh, Ottawa, Canada, 2025

Appendix 5: Research collaboration report 4

Research Report from collaboration with MDTI student Samiha Din

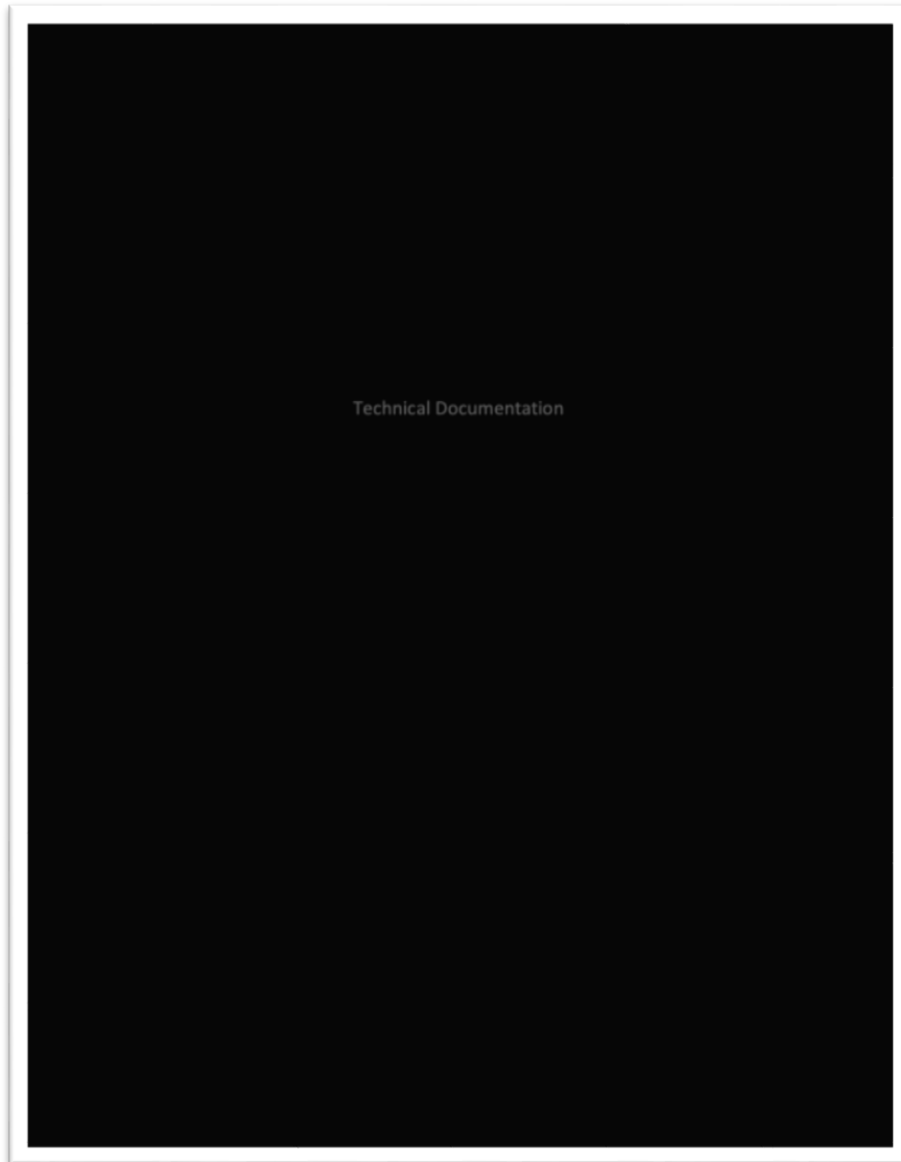
[DTI6997_OdysseyParent_300333147.pdf](#)



Appendix 6: Technical documentation

Odyssey Mobile Application Technical Documentation

[Odyssey Mobile App Technical Documentation.docx](#)



Appendix 7: Individual learner profiles

Figure 56

Profile of Ann

 Ann Age 6 Years Old Gender Female Siblings 1 Education Behavioral Therapy Speech Therapy Special Needs Education (SNED)	Bio Ann is a 6-year-old girl with a love for drawing, coloring, and books. Despite challenges like meltdowns and low sitting tolerance, Ann is making progress through interventions like Behavioral Therapy, Speech Therapy, and SNED. She is learning essential life skills such as toileting, dressing up, and household tasks. Ann enjoys playing with dolls, exploring her dollhouse, running, swinging, and solving puzzles. She adores shows like Bluey and Gabby's Dollhouse and delights in favorite foods such as chicken, spaghetti, and pumpkin.
Capabilities • Drawing • Coloring • Taking a shower • Eating on her own • Reading	Needs and Challenges <i>"The challenge that I face is her behavior. She cannot control her madness. Me and my family need more patience to understand her" – Rose, Ann's mother</i> • Toileting • Bathing • Dressing up • Learning to cook • Learning to clean the house • Managing frustrations and meltdowns • Low sitting tolerance
Interests • Drawing • Books • Puzzle	Morning Routine • Have breakfast • Take a shower • Go to school
Favorite Games • Dolls & doll house • Running • Hide and seek • Swing	Afternoon Routine • Have lunch • Play with brother • Take a shower • Take a nap • Have afternoon snack
Favorite Foods • Egg • Chicken • Noodles • Burger patties • Rice • Spaghetti • French fries • Pumpkin	Evening Routine • Have dinner • Watch TV • Do school assignment • Go to bed
Favorite Cartoons  Gabby's Doll House Bluey Spongebob  Mickey & Friends Little Pony	Future Aspiration <i>"My future aspiration for my child is someday she can do things in her own without help of other. Or she can live her life like a normal kid" – Rose, Ann's Mother</i>
Feature Recommendations • DT #1: Visual Task Modelling for Daily Living Skills • DT #2: Emotional Regulation & Behavior Cueing • DT #5: Gamified Motor Skills & Movement Integration • DT #6: Attention and Focus Support Through Gamified Tasks • DT #8: Interest-Driven Learning and Creative Expression • DT #12: Customizable Visual Routines for Home Transitions • DT # 45: Gamified Learning with Rewards and Challenges	

Figure 57

Profile of Reg & Roy

 Reg and Roy Age 6 Years Old Gender Male Siblings 1 Educational Special Needs Education (SNED)	Bio Reg and Roy are energetic 6-year-old twin brothers with unique personalities and abilities. Both are enrolled in the SNED program and are working to develop life skills such as dressing, bathing, and managing frustrations. Reg and Roy face challenges like picky eating and tantrums but excel in activities like singing, dancing, and baking. They enjoy building robots with Lego, playing with clay, and exploring their favorite characters like Spiderman and Bluey. With the support of their family and teachers, they are steadily growing in confidence and independence.
Capabilities • Singing • Dancing • Baking	Needs and Challenges <i>"Bathing is the most challenging. They tend to push each other and are hyperactive. One of them is also a picky eater, and they have very different personalities, one is quite talkative, while the other is quieter"</i> – Rex, Father of Reg and Roy • Dressing up • Bathing • Managing frustrations • Picky eating • Sensory sensitivities • Tantrums
Interests • Lego • Clay	Morning Routine • Breakfast • Going to school • Playing • Watching TV
Favorite Games • Playing with cars • Building robots	Afternoon Routine • Taking a nap
Favorite Foods • Oatmeal • Bread • Spaghetti • Burger	Evening Routine • Have dinner • Prepare their beds
Favorite Cartoons  Spiderman Bluey Superman	Future Aspiration <i>"I hope that they will always be happy in all the things that they do, we will always support them to do the things that they love as long as it is for their overall well being"</i> – Rex, Father of Reg and Roy
Feature Recommendations • DT #1: Visual Task Modelling for Daily Living Skills • DT #2: Emotional Regulation & Behavior Cueing • DT # 4: Personalized Sensory Regulation Tools • DT # 8: Interest-Driven Learning and Creative Expression • DT # 11: Nutrition Education Through Visual and Reinforced Tools • DT #12: Customizable Visual Routines for Home Transitions • DT # 45: Gamified Learning with Rewards and Challenges	

Figure 58

Profile of Anthony

 Anthony Age 6 Years Old Gender Male Siblings None Education Occupational Therapy Special Needs Education (SNED)	Bio Anthony is a spirited 9-year-old boy who loves arts, puzzles, and outdoor adventures like biking and playing on the beach. He delights in creating with clay and enjoys playing basketball games on his phone. Anthony is fond of characters like JJ from Cocomelon, Dino, and the Jollibee Mascot, which spark his imagination and engagement. Despite challenges with shouting and sitting tolerance, he excels in following instructions and communicates through hand leading. Enrolled in SNED and occupational therapy, he is developing independence in bathing and learning to cook. His favorite meals include sinigang, beef nilaga, and lugaw, reflecting his Filipino roots.
Capabilities • Following instructions • Communicating through hand leading • Eating on his own	Needs and Challenges <i>"It is difficult to go out because he might have tantrums"</i> - Amy, Anthony's mother • Bathing • Sitting tolerance • Learning to cook • Tantrums / shouting
Interests <i>"He loves to go to the beach, he can stay in the pool for 5 hours straight. He likes to play on the sand"</i> - Amy, Anthony's mother • Arts • Puzzle • Clay • Going to the beach	Morning Routine • Going to the toilet • Drinking water and sitting for a while • Take breakfast • Preparing for school • Going to school
Favorite Games • Bowling • Running • Biking • Basketball (smartphone) • Swimming	Afternoon Routine • Eating lunch on his own • Playing puzzle • Playing with his phone for 1-2 hours
Favorite Foods • Egg • French Fries • Sinigang • Beef Nilaga • Lugaw • Sotanghon with rice	Evening Routine • Have dinner • Playing with cats • Playing with toys • Sleeping by 11pm
Favorite Cartoons & Characters  Cocomelon Ms Rachel Jollibee  10 Indians Dino the Dinosaur	Future Aspiration <i>"I hope someday he can talk or have a conversation with me. I also hope he can do daily living activities on his own"</i> - Amy, Anthony's mother
Feature Recommendations • DT #1: Visual Task Modelling for Daily Living Skills • DT #2: Emotional Regulation & Behavior Cueing • DT #3: Multimodal Communication and Expressive Language Support • DT #5: Gamified Motor Skills and Movement Integration • DT # 6: Attention and Focus Support Through Gamified Tasks • DT # 8: Interest-Driven Learning and Creative Expression • DT #12: Customizable Visual Routines for Home Transitions • DT # 45: Gamified Learning with Rewards and Challenges	

Figure 59

Profile of Alfie

 Alfie Age 6 Years Old Gender Male Siblings None Education ABA Therapy Special Needs Education (SNED)	Bio Alfie, is a lively 6-year-old boy with a love for playful activities like running, chasing his cousins, and pretending to be a ghost. He enjoys making clay figures, stacking toys, and building towers with blocks and LEGO. Aja has a deep interest in TV characters like Peppa Pig, Oggy the cockroach, along with Thomas and friends, which captivate his imagination. Despite challenges such as not having a sense of danger and getting lost easily, Alfie excels at memorizing and is enrolled in ABA therapy and SNED to support his development. His favorite foods include fried chicken, rice, and lumpia.
Capabilities • Memorization • Making clay figures	Needs and Challenges <i>"When inside the house, he needs a little supervision, but outside we cannot let him roam around as he doesn't have a sense of danger. He can easily get lost and gets very curious of things around him" - Donna, Alfie's mother</i> • Toileting • Dressing • Cooking • Household chores • Following instructions • Doesn't have a sense of danger • Can easily get lost • Doesn't have a sense of direction
Interests • Lego • Clay • Swimming	Morning Routine • Wakes up at 7am and will play right away with clay • Sometimes goes to her aunt and wakes her up • Prepares for school • Go to school
Favorite Games • Playing what's missing • Pretending to be a ghost • Running and chasing • Building blocks • Small balls • Stacking toys	Afternoon Routine • Attend his therapy • Playing with toys • Watching YouTube
Favorite Foods • Fried chicken • Nuggets • Sliced apples • Fries • Lumpia • Rice • Hotdog	Evening Routine • Dinner between 7:00 - 8:00 pm • Play with toys until 10:30 PM • Have dinner again when his Mom arrives from work • Get ready to sleep around 12:00 pm
Favorite Cartoons  Peppa Pig Oggy Angry Birds  Teletubies Tayo Thomas	Future Aspiration <i>"I just hope for him to live independently. Just enough to take care of himself" - Donna, Alfie's mother</i>
Feature Recommendations • DT #1: Visual Task Modelling for Daily Living Skills • DT #2: Emotional Regulation & Behavior Cueing • DT # 6: Attention and Focus Support Through Gamified Tasks • DT # 8: Interest-Driven Learning and Creative Expression • DT #12: Customizable Visual Routines for Home Transitions • DT # 45: Gamified Learning with Rewards and Challenges	

Figure 60

Profile of Ken

	Bio Ken is a bright and creative 12 year old boy with a love for drawing, singing, and exploring the world through activities like skateboarding and swimming. He enjoys mobile games like Roblox, collecting wheeled toy vehicles, and watching his favorite shows, including Minions and We Bare Bears. Ken excels in music and art but is working on improving frustration tolerance and focus. With the help of SPED and Non-Graded Transition SNED programs, Kit is learning essential life skills such as cooking, cleaning, and computer literacy. His favorite foods include fried chicken, pasta, and iced tea, reflecting his vibrant personality.
Ken Age 12 Years Old Gender Male Siblings None Education Occupational Therapy Behavioral, Speech Therapy, Regular School (Kinder 1 and 2 to Grade 1), SPED, and now is Non-Graded Transition SNED	Needs and Challenges <i>"There are times that he shows poor frustration tolerance specially if he is not meeting his expectations or getting what he wants. He easily gets mad, make annoying noises, then do tantrums. Meltdowns are shown sometimes, reasons are not identified for this one. My child can be seen alone in a room, he is silent with tears"</i> - Edward, Ken's father - Improve tolerance to frustrations and be more patient - Improve focus on things - Learn computer skills - Learn to play a musical instrument - Learn a sport (ex. running, swimming, cycling) - Learn to cook simple foods - Prepare his own meals - Wash his own dishes - Clean his place - Improve frustration tolerance - Manage behavioral problems such (ex. meltdowns)
Capabilities - Drawing - Singing	
Interests - Skateboarding - Swimming - Drawing - Travelling and going to places	
Favorite Games - Roblox and subway surf (mobile games) - Toy Bus - Any wheeled toy vehicles	
Favorite Foods - Fried chicken - French Fries - Beef (pepper lunch) - Fish (tilapia, galungong) - Pizza - Noodles - Pasta (carbonara) - Pancit Canton - Iced tea for beverage	Morning Routine - During weekends, if there is no school, he looks for his own meal and have breakfast - Watches tv or watch and play on his phone - Do drawings - Take a bath before lunch. - During school days, he wakes early - Eats his breakfast - Takes a bath - Dress up for school
Favorite Cartoons  Minions We Bare Bears	Afternoon Routine - Eats his lunch - Watches tv or watch and play on his phone - Takes a nap
	Evening Routine - Eats his dinner - Watches tv or watch and play on his phone - Do some drawings - Goes to bed
	Future Aspiration <i>"I wish my child could learn to live and survive on his own. Have his own job, make money, live in his own house. For him to not become a burden to those who might look after him in the future."</i> - Edward, Ken's father
Feature Recommendations - DT #1: Visual Task Modelling for Daily Living Skills - DT #2: Emotional Regulation & Behavior Cueing - DT #3: Multimodal Communication and Expressive Language Support - DT #4: Personalized Sensory Regulation Tools - DT #5: Gamified Motor Skills and Movement Integration - DT # 6: Attention and Focus Support Through Gamified Tasks - DT # 7: Flexible, Interest-Based Academic Learning Tools - DT # 8: Interest-Driven Learning and Creative Expression - DT #10: Peer Interaction Through Storytelling and Turn-Taking - DT #12: Customizable Visual Routines for Home Transitions - DT # 45: Gamified Learning with Rewards and Challenges	

Figure 61

Profile of Greg



Greg

Age	10 Years Old
Gender	Male
Siblings	2
Education	Occupational Therapy Speech Therapy (11 Months Ago)

Bio

Greg is a 10-year-old boy with a vibrant personality and a love for creativity. Despite challenges with aggression and frustration, he thrives in activities that allow him to express his skills in music, drawing, and building structures. Greg enjoys playing with Lego, marble toys, and molding materials like Play Dough, and has a fondness for Lightning McQueen and Blippi. He excels at tracing, cutting, and creating imaginative designs. Greg's favorite foods include matcha or chocolate treats, tuna sandwiches, and Korean-style seaweed noodles. Although he paused his therapies due to financial constraints, Greg's determination shines through in his everyday journey.

Capabilities

- Music
- Structures
- Drawing

Interests

- Lego
- Clay
- Drawing
- Molding, tracing & cutting
- Going to the store

Favorite Games

- Jenga
- Car
- Marble toys
- Therapy ball

Favorite Foods

- Matcha or Chocolate Take It
- Tuna sandwich with a lot of mayo
- Tuna spaghetti
- Seaweeds (Korean noodles)
- Chicken

Favorite Cartoons



Lightning McQueen Blippi

Needs and Challenges

"When he stopped his Therapy sessions, he regressed and wouldn't focus on table activities" - Joy, Greg's mother

- Doing everyday household tasks
- Communication
- Toileting
- Managing frustrations
- Aggression
- Destruction

Morning Routine

- Wake up and eat breakfast,
- Go to variety store for his morning walk. The morning schedule changes depending on her mother's due to her mother's work hours
- Play

Afternoon Routine

- Play
- Do some table activities
- Go to variety store for his afternoon walk
- He also goes to the grocery store thrice a week

Evening Routine

- Youtube browsing
- Play Minecraft, ASMR
- Prepare hot chocolate
- Listen to sounds that puts him to sleep

Future Aspiration

"My hope is for him to learn life skills and to discover his God given talent." - Joy, Greg's mother

Feature Recommendations

- DT #1: Visual Task Modelling for Daily Living Skills
- DT #2: Emotional Regulation & Behavior Cueing
- DT # 3: Multimodal Communication and Expressive Language Support
- DT # 6: Attention and Focus Support Through Gamified Tasks
- DT # 7: Flexible, Interest-Based Academic Learning Tools
- DT # 8: Interest-Driven Learning and Creative Expression
- DT # 11: Nutrition Education Through Visual and Reinforced Tools
- DT #12: Customizable Visual Routines for Home Transitions
- DT # 45: Gamified Learning with Rewards and Challenges

Figure 62

Profile of Chris

 Chris Age 30 Years Old Gender Male Siblings 5 Education Homeschooled, currently in Pre-Vocational Level 1	Bio Chris is a 30-year-old adult-child, thriving under the care and guidance of his loving family. Homeschooled and currently in Pre-Vocational Level 1, Chris communicates in phrases and words that are self-taught. He loves creative design using digital tools and is good with digital exploration. His passion for pop music, dancing, and digital art reflects his vibrant personality. Chris' favorite activities include basketball, creative play, and arranging scattered items into aesthetic displays. While he faces challenges with daily living skills and sensory sensitivities, his unique talents and interests shine through.
Capabilities • Learned speech independently through exposure to TV and conversations. • Skilled in searching YouTube for music and songs he likes. • Demonstrates creativity in arranging scattered items with a sense of design and aesthetics. • Capable of engaging in repetitive tasks when guided.	Needs and Challenges <i>"His compliance needs improvement, to stop scattering things, our house is a mess. He's a picky eater. He has lost weight recently"</i> - Lyane, Chris' mother • Improvement in daily living skills, particularly hygiene and eating properly. • Development of employable skills, such as housekeeping tasks. • Tools for sensory integration, particularly for sound sensitivities. • Outdoor and recreational activities to support his physical and social development. • Scattering clothes, toys, and food, leading to household disruptions. • Sensory sensitivity, especially to sounds. • Picky eating habits, leading to weight loss. • Difficulty integrating new routines or tasks independently.
Interests • Music (especially pop music) and dancing. • Drawing and digital picture editing. • Exploring creative and hands-on activities.	Morning Routine • Drinks Nestea juice and eats hot cup noodles or French fries. • Watches TV or uses a smartphone to listen to music on YouTube.
Favorite Games • Basketball • Helicopter-flying • Car-racing • Stuffed toy-babying • Interactive games with family, like "I Have Two Hands" and "Teddy Bear-Teddy Bear."	Afternoon Routine • Has lunch and sits beside his father while watching TV. • Scatters items, jumps around, or uses his laptop or smartphone for music. • Snacks on fries or biscuits.
Favorite Foods • Spaghetti • Fried chicken • Chocolate cake • Halo-halo • Arroz caldo • Pizza • Burger	Evening Routine • Goes to the bathroom, brushes teeth, and washes his face. • Sleeps at around 10 PM.
Favorite Cartoons & Personalities  SpongeBob Mark Raffy Tuto  Willy Revillame Almy Perez Kris Aquino	Future Aspiration <i>"For him to learn an employable skill, like folding linens, making a bed so he can be part of housekeeping team in an inn or hotel."</i> - Lyane, Chris' mother
Feature Recommendations • DT #1: Visual Task Modelling for Daily Living Skills • DT #2: Emotional Regulation & Behavior Cueing • DT #3: Multimodal Communication and Expressive Language Support • DT #4: Personalized Sensory Regulation Tools • DT #5: Gamified Motor Skills and Movement Integration • DT #6: Attention and Focus Support Through Gamified Tasks • DT #7: Flexible, Interest-Based Academic Learning Tools • DT #8: Interest-Driven Learning and Creative Expression • DT #11: Nutrition Education Through Visual and Reinforced Tools • DT #12: Customizable Visual Routines for Home Transitions • DT #45: Gamified Learning with Rewards and Challenges	

Appendix 8: Individual parent profiles

Figure 63

Profile of Rose



Rose

Age	38 Years Old
Gender	Female
Marital Status	Common Law
Residence	Paranaque Manila
Education	College Graduate
Employment	Housewife
Family Income	PHP 210,000 – 23,9000
Household Support	Sister & mother in law helps in child's daily living

Bio

Rose is a 38-year-old mother devoted to raising her child. A college graduate, Rose balances her responsibilities as a primary caregiver with the support of her extended family. She faces challenges in managing her child's behavioral issues but remains focused on finding solutions to improve his quality of life. Rita values family collaboration and strives to create a nurturing environment for her child's growth. Her dedication drives her to participate in initiatives that offer innovative interventions, aiming to equip her child with the skills needed for greater independence and community participation.

Parenting Style

"What I think is needed is more acceptance and knowledge about their status"

- Rita's parenting approach is nurturing and proactive, focusing on addressing her child's behavioral and developmental challenges.
- She collaborates with extended family members to provide consistent care and seeks effective strategies to help her child thrive.

Feature Recommendations

- DT # 13: Financial Aid Navigation and Subsidized Support
- DT #14: Parental Tools for Managing Behavior at Home
- DT #15: Caregiver Wellness and Emotional Support Tools
- DT # 16: Home-Based Life Skills Coaching and Virtual Guidance
- DT # 18: Micro-Training Modules for Parent Empowerment
- DT # 19: Family and Peer Support Integration
- DT # 20: Local Service and Policy Support Directory
- DT #23: On-Demand Learning Aligned with Parent Schedules
- DT #24: User-Friendly Interface with Guided Tutorials
- DT #25: Curated Digital Content with Parental Controls
- DT # 26: Goal Tracking and Progress Reporting Tools
- DT # 29: Customizable Intervention Resource Library
- DT #30: Interactive Parent-Child Learning Activity Hub

Pain Points

- Difficulty managing her child's behavioral challenges, which require ongoing attention and intervention.
- Balancing her responsibilities while ensuring her child receives the necessary support and therapy.
- Financial strain and limited access to advanced autism resources.

Needs and Goals

"Assistance from government and more therapy facilities so that all children with special needs can undergo therapy sessions"

- Strategies and tools for effectively managing her child's behavior.
- Enhanced support for her child's development in daily living skills, such as independent eating and dressing.
- Strengthened collaboration with family members to ensure a consistent care routine.
- Long-term goal to prepare her child for independent living and integration into the community.

Figure 64

Profile of Rex

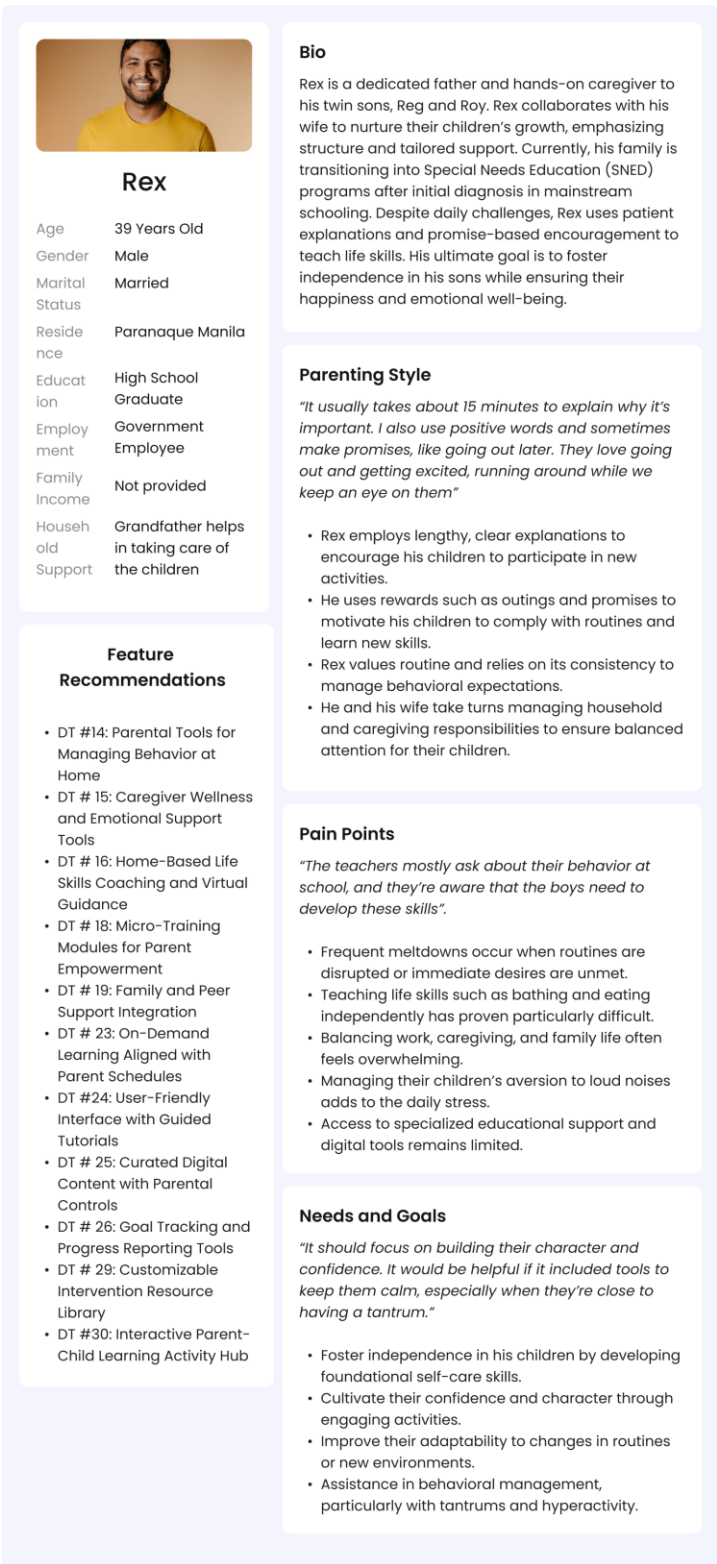


Figure 65

Profile of Amy

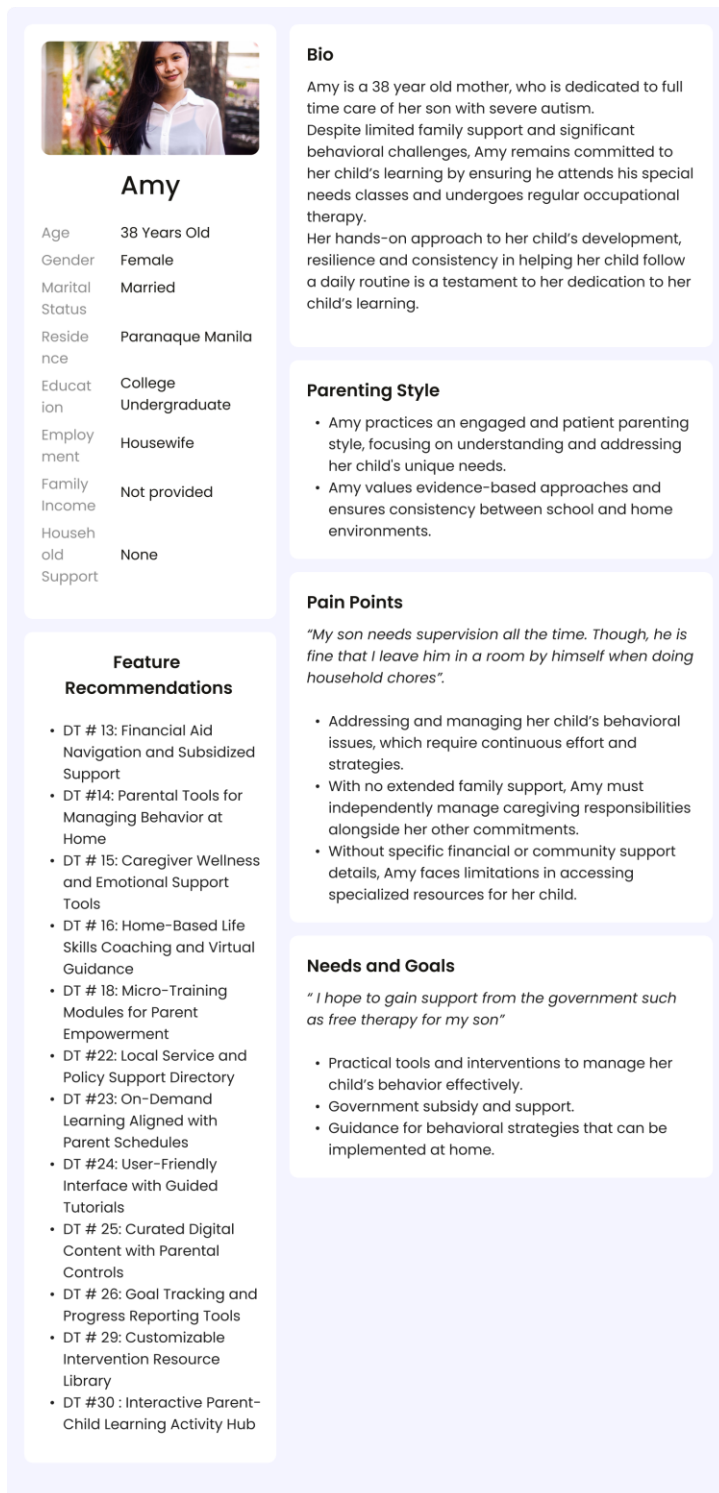


Figure 66

Profile of Edward



Edward

Age 42 Years Old

Gender Male

Marital Status Married

Residence Dasmarinas Cavite

Education College Graduate

Employment Private Sector Employee

Family Income Not provided

Household Support Occasionally receives assistance from nearby relatives

Feature Recommendations

- DT #13: Financial Aid Navigation and Subsidized Support
- DT #14: Parental Tools for Managing Behavior at Home
- DT #15: Caregiver Wellness and Emotional Support Tools
- DT #16: Home-Based Life Skills Coaching and Virtual Guidance
- DT #17: Life Skills and Vocational Readiness Toolkit
- DT #18: Micro-Training Modules for Parent Empowerment
- DT #19: Family and Peer Support Integration
- DT #22: Local Service and Policy Support Directory
- DT #23: On-Demand Learning Aligned with Parent Schedules
- DT #24: User-Friendly Interface with Guided Tutorials
- DT #25: Curated Digital Content with Parental Controls
- DT #26: Goal Tracking and Progress Reporting Tools
- DT #27: Parent-Teacher Sharing and Communication Tools
- DT #28: Picture-Based Parent-Child Communication Tools
- DT #29: Customizable Intervention Resource Library
- DT #30: Interactive Parent-Child Learning Activity Hub

Bio

Edward, a 42-year-old father is the primary caregiver for his 12-year-old son, Kit. A college graduate, Edward dedicates his time to supporting Kit's development while balancing financial and caregiving challenges. He focuses on teaching life skills like cooking and hygiene, leveraging Kit's interests in drawing and cooking to enhance learning. Edward manages behavioral challenges such as frustration and meltdowns with patience and consistency, creating structured environments for growth. Despite limited resources, he strives to prepare Kit for an independent future and seeks accessible tools to simplify caregiving and teaching routines.

Parenting Style

I create a controlled environment. I corner him and say, Let's just focus on this. Look at the sink, nowhere else. I also make sure the TV and other distractions are off. I guide his head gently to ensure he's looking at what he needs to.

- Uses verbal reinforcement like "good job" instead of tangible rewards to normalize tasks.
- Stays firm and consistent in guiding Kit through routines, even when Keith is resistant.
- Encourages Kit's autonomy in tasks like food preparation but ensures close supervision for safety.
- Manages meltdowns by patiently setting expectations and creating a calm environment.
- Plans Keith's activities around his interests, such as cooking or drawing, to keep him engaged.

Pain Points

"We moved him out of his previous school because the tuition fee was too expensive, and my wife was disappointed. She felt he wasn't learning new things, and there were behavioral problems. Before the end of the school year, he stopped studying altogether".

- Struggles to balance caregiving duties with personal activities like exercising or pursuing hobbies.
- Limited time for consistent teaching or skill-building for Kit due to a hectic schedule.
- High costs associated with therapies, specialized education, and preparing for Kit's future.
- Limited income sources and high dependency on family resources.
- Absence of structured tools or guidance to create effective learning routines for Keith at home.
- Need for simple, accessible tools or apps to aid Kit's learning.
- Limited external help from caregivers or teachers due to scheduling conflicts.

Needs and Goals

"I think having more structured tools or a clearer plan for daily tasks would help. Apps that could guide him through tasks or help him with his emotions would be useful, especially if they were tailored to his interests. If I had more resources to help with that, I think it would make managing his behavior and learning easier."

- More structured time and resources to manage caregiving and personal well-being.
- Access to government assistance for financial and educational support.
- Simplified tools to integrate into caregiving routines, like an app to guide son's activities.
- Build a stronger support system with relatives and caregivers trained to understand autism.
- Increase collaboration with educators to align on strategies for son's development.

Figure 67

Profile of Donna

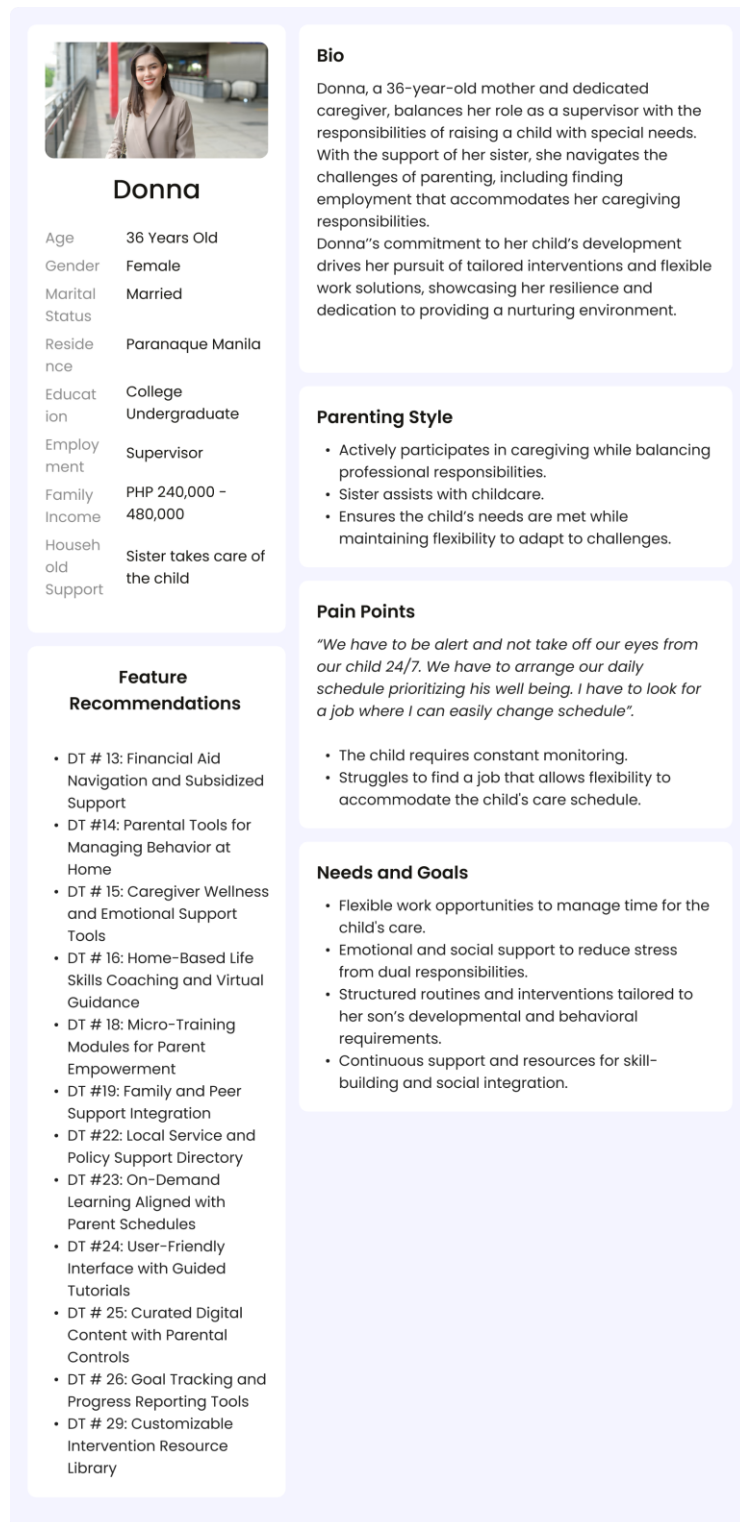


Figure 68

Profile of Joy



Joy

Age	49 Years Old
Gender	Female
Marital Status	Separated
Residence	Muntinlupa Manila
Education	College Graduate
Employment	Small business owner
Family Income	PHP 240,000 – 480,000
Household Support	Financial support from relatives

Bio

Joy a dedicated single mother, exemplifies resilience and devotion as the primary caregiver for her son Greg. With a degree in business and entrepreneurial experience, Jane manages to provide for her family while navigating the challenges of parenting. She dreams of enabling Gab to learn essential life skills and develop his talents in music, art, and structure-building. Despite financial constraints, she remains optimistic and resourceful, striving to balance her work with the demands of raising a child with special needs. Her strength and commitment define her inspiring journey as a mother.

Parenting Style

"I just give him crayons and bond paper so he could draw and color . It's better than not doing anything at all"

- Jane assumes 24/7 responsibility for Gab's care.
- Highly attentive to her child's needs, managing his routines, therapy, and learning activities.
- Balances therapeutic and play activities such as Lego, drawing, and sensory games.

Feature Recommendations

- DT # 13: Financial Aid Navigation and Subsidized Support
- DT #14: Parental Tools for Managing Behavior at Home
- DT # 15: Caregiver Wellness and Emotional Support Tools
- DT # 16: Home-Based Life Skills Coaching and Virtual Guidance
- DT # 18: Micro-Training Modules for Parent Empowerment
- DT #20: Culturally Inclusive Autism Awareness and Advocacy
- DT #22: Local Service and Policy Support Directory
- DT # 25: Curated Digital Content with Parental Controls
- DT # 26: Goal Tracking and Progress Reporting Tools
- DT #28: Picture-Based Parent-Child Communication Tools
- DT # 29: Customizable Intervention Resource Library
- DT #30: Interactive Parent-Child Learning Activity Hub

Pain Points

"Unfortunately , I'm the only one who's taking care of my son who has autism. Im juggling work and at the same time take care of my child. Since I'm always busy , I no longer have time to help my child remember his activities ".

- Struggles to afford therapies and potential caregiving help.
- Difficulty juggling work and Gab's full-time supervision needs.
- Managing Gab's aggression and destructive tendencies.
- Limited extended family involvement, with occasional financial help.

Needs and Goals

"I need more income so I can hire a caregiver that could help me out".

- Additional income or government support to hire a caregiver.
- Strategies to improve Gab's communication and daily living skills (e.g., toileting).
- Equip Gab with life skills and help him discover his unique talents.
- Foster a supportive and enriching environment for his growth and learning.

Figure 69

Profile of Lyane



Lyane

Age

69 Years Old

Gender

Female

Marital Status

Married

Residence

Dasmariñas Cavite

Education

University Graduate; Master's Degree Units

Employment

Freelancer

Family Income

PHP 240,000 - PHP 480,000

Household Support

Emotional support and prayers, but no direct involvement in daily care or education

Feature Recommendations

- DT #13: Financial Aid Navigation and Subsidized Support
- DT #14: Parental Tools for Managing Behavior at Home
- DT #15: Caregiver Wellness and Emotional Support Tools
- DT #16: Home-Based Life Skills Coaching and Virtual Guidance
- DT #17: Life Skills and Vocational Readiness Toolkit
- DT #18: Micro-Training Modules for Parent Empowerment
- DT #19: Family and Peer Support Integration
- DT #20: Culturally Inclusive Autism Awareness and Advocacy
- DT #22: Local Service and Policy Support Directory
- DT #24: User-Friendly Interface with Guided Tutorials
- DT #25: Curated Digital Content with Parental Controls
- DT #26: Goal Tracking and Progress Reporting Tools
- DT #28: Picture-Based Parent-Child Communication Tools
- DT #29: Customizable Intervention Resource Library
- DT #30: Interactive Parent-Child Learning Activity Hub

Bio

Lyane is a devoted mother and freelance writer. With a strong educational background and rich life experiences, Lynn dedicates herself to raising her son Chris. She champions a parenting approach rooted in love, acceptance, and active engagement, focusing on fostering his child's creativity and independence. Despite challenges like caregiving fatigue and limited resources, Lyane remains hopeful, working tirelessly to equip his son with essential life skills. Her dream is to see his son thrive as a confident individual, capable of contributing to society in his unique way.

Parenting Style

"I am enthusiastic myself, I'm happy and eager to accompany him in writing, drawing, reading, playing"

- Emphasizes love, acceptance, and patience as the foundation of her parenting.
- Encourages learning through exploration and self-discovery, allowing her child independence in safe environments (e.g., grocery shopping).
- Uses positive reinforcement, storytelling, and engaging activities to teach and build skills.
- She aligns her teaching with Caleb's interests, such as pop music and creative activities, and adjusts routines based on his mood and energy levels.

Pain Points

"My husband and I takes care of our son who needs about 80% care through out the day. I experience fatigue and depression".

- Managing Caleb's sensory sensitivities (e.g., dislike of bright lights and noise).
- Addressing daily living challenges, including hygiene and proper eating habits.
- Caleb's tendency to scatter items around the house, leading to physical and emotional fatigue.
- Limited support network and resources to alleviate the family's caregiving burden.
- Concerns about Caleb's transition to adulthood and independence.

Needs and Goals

"I try to cope by rest, self care, and through my spiritual life"

- Rest, self-care, and spiritual support for emotional well-being.
- Practical tools for teaching hygiene, eating, and basic chores.
- Accessible government programs for adult transition and vocational skills training.
- Equip Caleb with employable skills (e.g., housekeeping tasks).
- Foster his independence and confidence.
- Expand Caleb's engagement in creative and outdoor activities.

Appendix 9: Individual teacher profiles

Figure 70

Profile of Gemma



Gemma

Age	32 Years Old
Gender	Female
Marital Status	Married
Specialization	Special Education
Education	University Graduate; Masters Degree units
Yrs. Teaching	Nine
Class Size	1 Class, 23 Students

Bio

A dedicated special education teacher with nine years of experience teaching children with special needs. Armed with a master's degree units, she specializes in creating structured and nurturing classroom environments. She excelled in tailoring her approach to meet each child's unique needs, using visual schedules and personalized routines to foster learning and emotional regulation. Passionate about empowering parents as partners in education, she actively sought innovative strategies to address behavioral challenges and teach life skills. Outside work, she values rest and rejuvenation to maintain her unwavering dedication to her students.

Teaching Style

"I check if they're okay, not sick and ready to participate. If the child is not well in a day, I will not force him/her to do tasks that I know would agitate them that would lead to tantrums and unproductive activities. Letting them stay in a peace corner to relax and observe would help them know that they are respected and well loved in the classroom"

- Created structured routines and visual schedules for predictability.
- Focused on individualized approaches based on students' behaviors, moods, and well-being.
- Provided a nurturing environment with tools like "peace corners" to support emotional regulation.

Pain Points

"I face different challenges everyday, everyday challenges varies to the mood and behaviors of each students"

- Managing unpredictable mood and behaviors

Needs and Goals

- Behavior management tools
- Parent collaboration to enhance learning of their child

Feature Recommendations

- DT #31: Behavior Management and Monitoring Tools for Teachers
- DT #33: Individualized Learning Plans with Real-Time Tracking
- DT #35: Teacher and Parent Digital Training Community
- DT #36: Parent-Teacher Communication and Coaching Platform
- DT #37: Screen Time Monitoring and Hybrid Learning Features
- DT #38: Intervention Templates and AI-Based Planning Tools
- DT #41: Collaborative Visual Daily Planner
- DT #44: Personalized Lesson Creation Using Child Profiles

Perspective on Digital Education Tools

While she acknowledged that many children were naturally inclined toward gadgets and sees potential benefits in using apps as teaching tools, she raised concerns about:

- Prolonged use of devices in school could lead to behavioral issues and dependency on gadgets.
- Overexposure to screens may affect children's eyesight and overall well-being.
- The need to limit screentime and use mobile applications as part of a balanced approach that includes non-digital, hands-on activities.

Figure 71

Profile of Michelle



Figure 72

Profile of Leah



Figure 73

Profile of Charise



Charise

Age	33
Gender	Female
Marital Status	Married
Specialization	Special Education
Education	College Graduate
Yrs. Teaching	Ten
Classes Handled & Size	5 Classes of 3 to 7 students

Feature Recommendations

- DT #31: Behavior Management and Monitoring Tools for Teachers
- DT #33: Individualized Learning Plans with Real-Time Tracking
- DT #35: Teacher and Parent Digital Training Community
- DT #36: Parent-Teacher Communication and Coaching Platform
- DT #38: Intervention Templates and AI-Based Planning Tools
- DT #41: Collaborative Visual Daily Planner
- DT #44: Personalized Lesson Creation Using Child Profiles

Perspective on Digital Education Tools

- Saw the potential of using mobile applications to teach life skills to children with severe autism, although believes the effectiveness of such tools depends on the individual learner.
- For parents, she viewed mobile applications as an essential tool for supporting the implementation of interventions at home, particularly those of non-verbal children, to understand their child's needs and provide a consistent approach to skill development.
- However, if parents do not cooperate or actively engage in the process, it could hinder the success of these interventions.

Bio

Charise have 10 years of experience in special education, with a focus on routine establishment and compromise teaching. She created secure and engaging environments for her students, through consistency, patience, and individualized instruction to promote independence. Charise believed in the power of parent-teacher collaboration and parent-implemented interventions; she was also passionate about empowering students and families to support learning both at school and home.

Teaching Style

"I provide activities and have a long patience to teach them on how to be independent".

- Focused on building structured routines to help students feel secure and engaged. This is particularly essential for students with severe autism, who often thrive in predictable environments.
- Believed in being consistent with instructions and maintaining long patience to support students' development of independence.
- Provided specific activities designed to help students with severe autism develop essential daily living skills, ensuring that each student progresses towards greater independence.

Pain Points

"I deal with their different behaviors every day, and I find it challenging"

- The varied behaviors of students with severe autism can present challenges, requiring flexibility and quick adaptation.

Needs and Goals

- Training to improve her effectiveness in managing classroom behaviors and promoting student learning.
- Needs tools and resources that can be adjusted to keep her students engaged and help them learn in different ways.

Figure 74

Profile of Mara

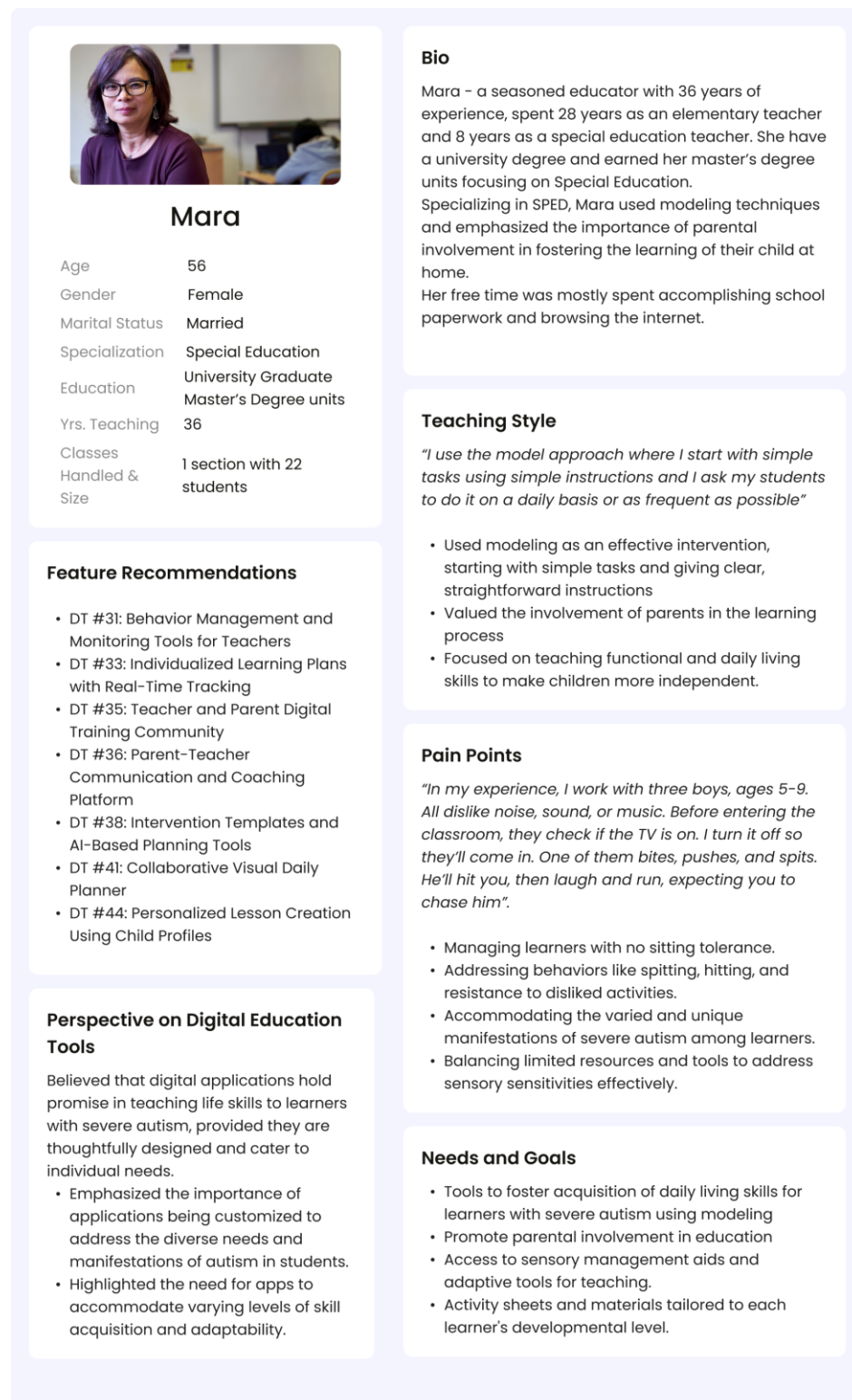


Figure 75

Profile of Nadine



Figure 76

Profile of Aster



Figure 77

Profile of Cherry

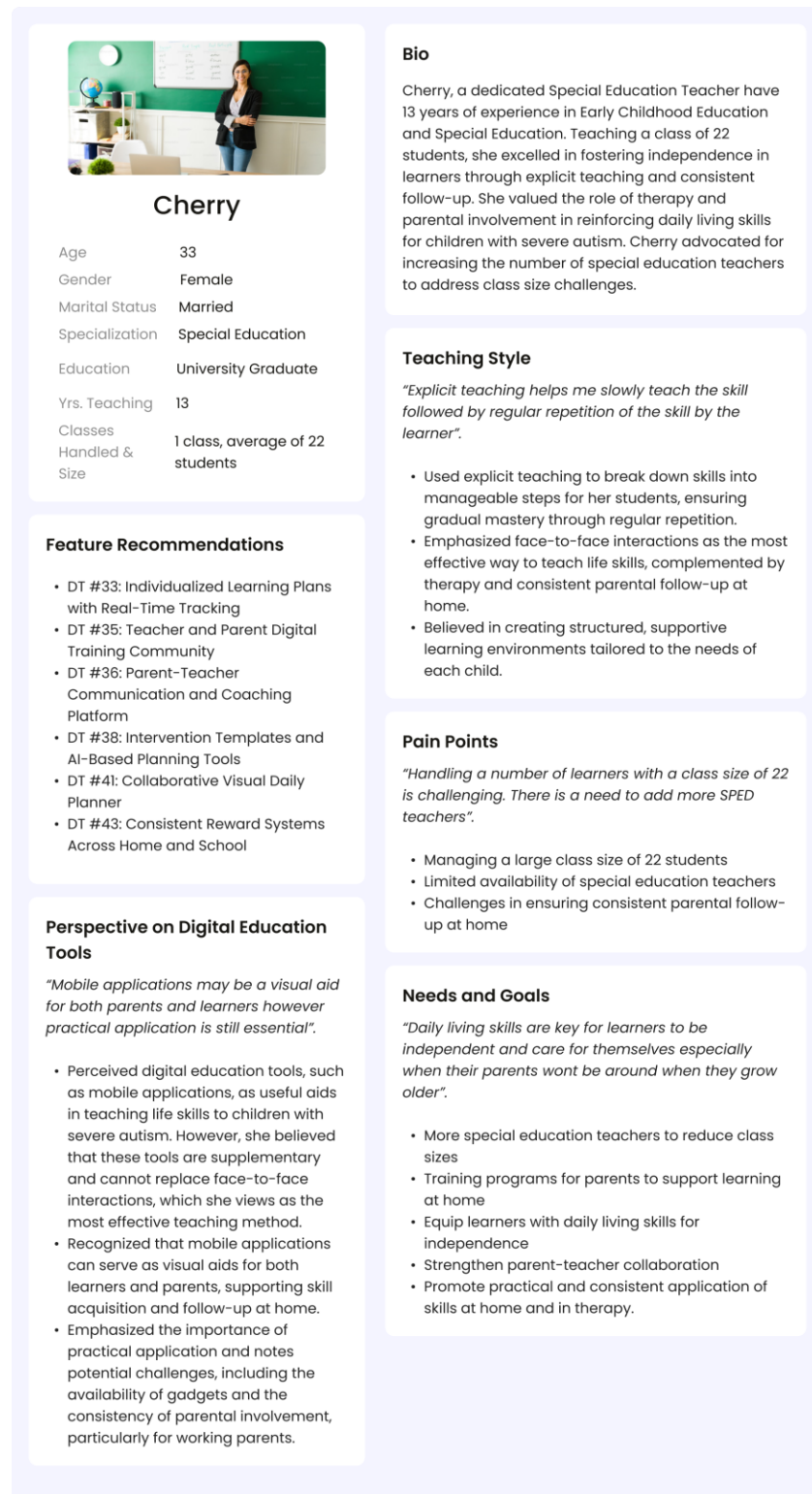


Figure 78

Profile of Ashley

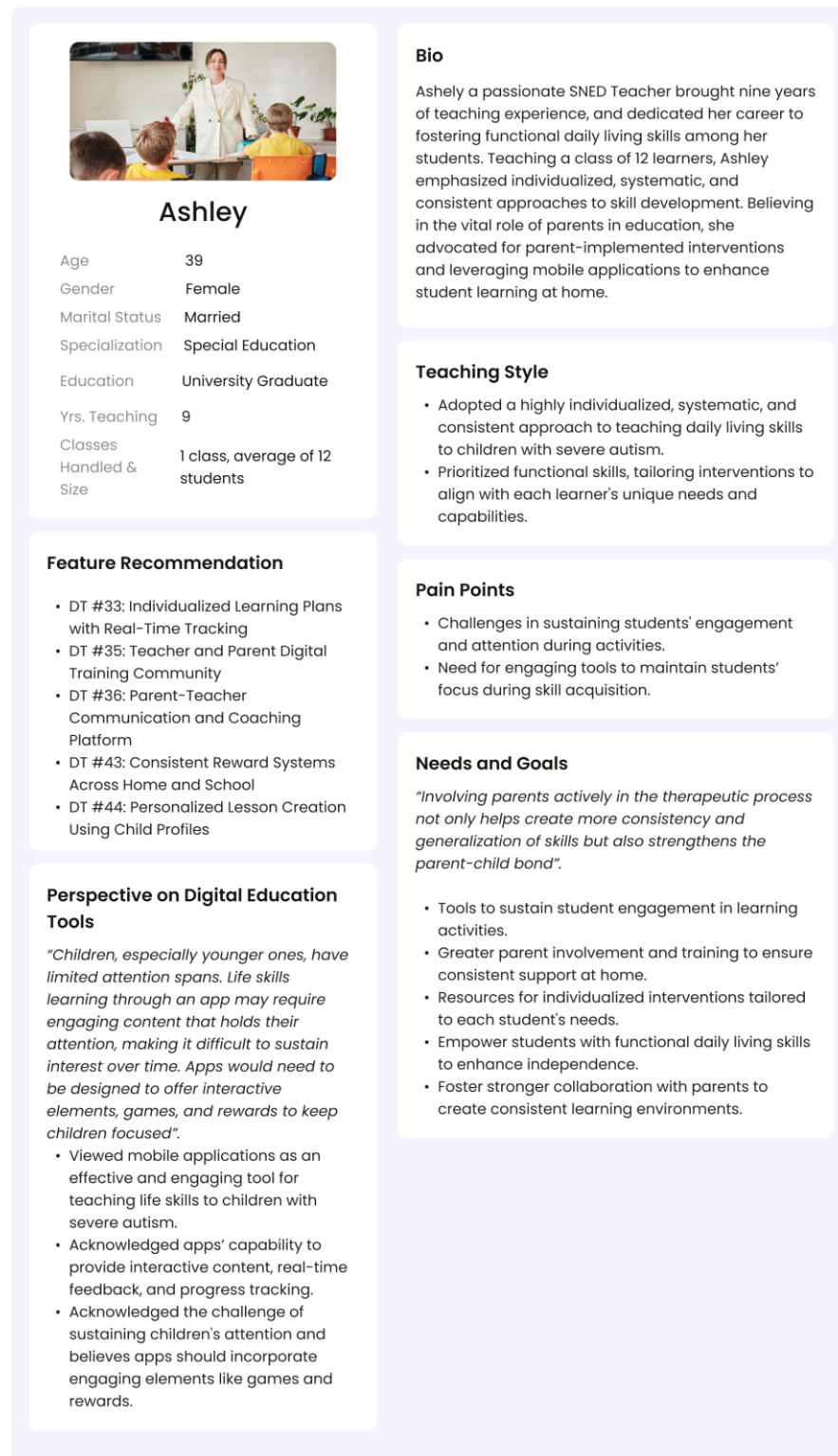
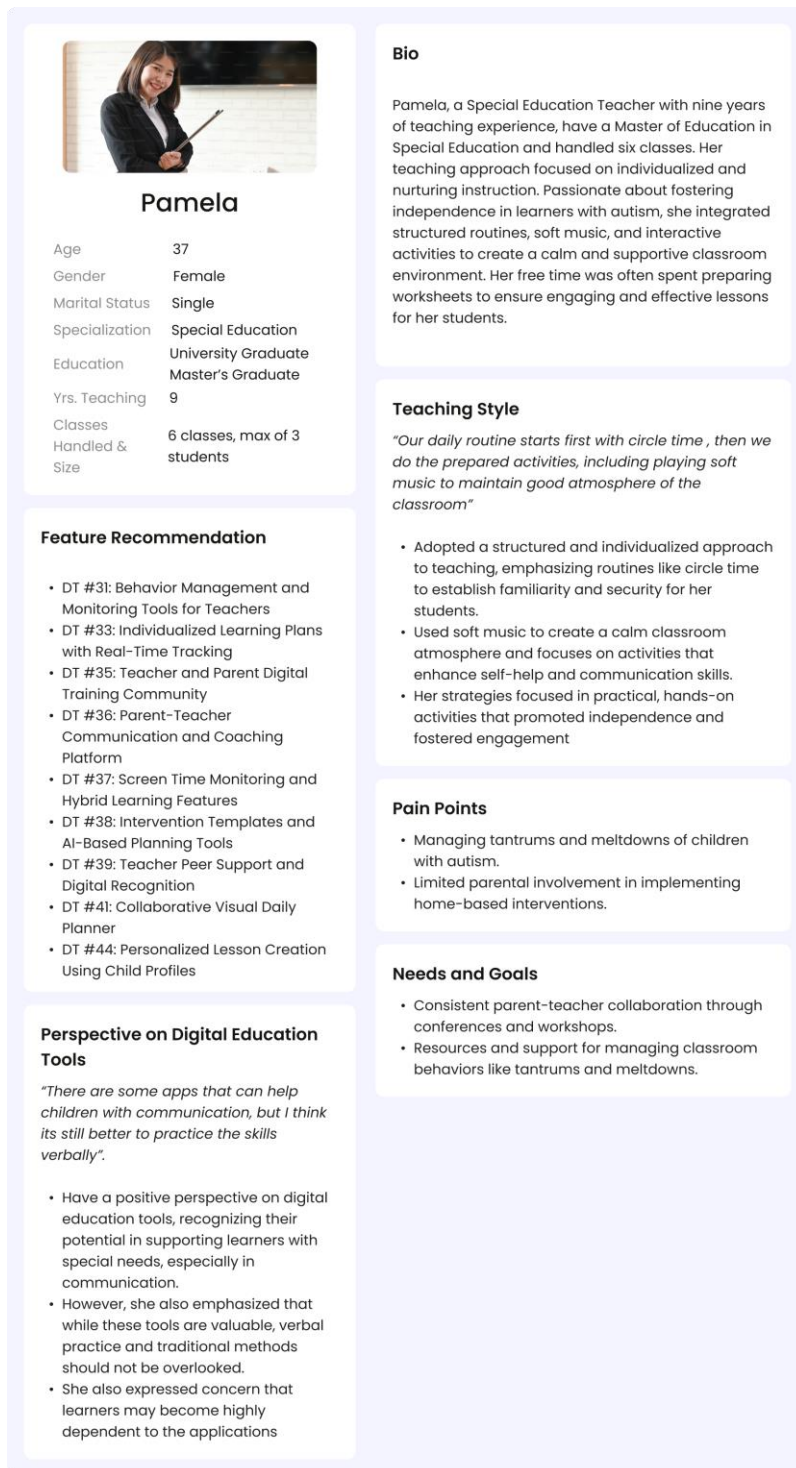


Figure 79

Profile of Pamela



Appendix 10: Capabilities and features from literature review

Table 38

Capabilities derived from literature review

ID	Capabilities	Description
CSD # 1	Enable teachers to create digital interventions using video modeling and task analysis by creating learning content incorporating multimedia elements such as video clips, pictures, and graphics, along with voice recordings or music and breaking it down into small tasks	• This capability would provide a supplementary tool to support the education of learners; and aid in reducing the barriers to education access, by providing an opportunity for remote learning. • It would also enable the creation of tailored interventions that are personalized to meet the individual learner's profile, needs, and interests.
CSD # 2	Enable teachers to create digital intervention templates using video modeling and task analysis that can be used by parents in creating and/or improving digital interventions that can be used by their children at home	• This capability would enable parents to play a more active role in the learning of their child; and increase in retention of concepts learned in the classroom through continued practice and engagement at home. • It would also enable parents to create and/or modify interventions using guided steps and instructions from templates created by teachers.
CSD # 3	Enable teachers to set up contingency contracts or reward systems based on the learner's personal interests, hobbies, and background; which can be redeemed upon successful completion of assigned tasks and/or objectives	• This capability would enhance student motivation and engagement, fostering a more personalized and effective learning environment. • It would also provide a rewards system that can be personalized for each learner.
CSD # 4	Enable teachers to set-up calendar of tasks and activities that the learner will perform on a regular basis	• This capability would enhance learners' understanding of what is expected of them and what will happen next, which can help them navigate their environment more effectively • It would also help build predictability on the children's day-to-day lives through setting up schedules and routines.
CSD # 5	Enable teachers to create individual learning plans for	• This capability would help track progress, identify areas for improvement, and ensures that

	each learner based on their strengths, challenges, interests, and learning style	the student's ILP is consistently updated and aligned with their evolving needs • It would also provide a centralized location to define students' specific learning goals, strategies, accommodations, and interventions to support the student's academic, social, communication, and behavioral needs.
CSD # 6	Enable teachers to create and upload instructional content for parents, providing them with the necessary guidance and resources to effectively implement digital interventions set by the teachers at home (also known as PII)	• This capability would provide training and support to parents without the need to travel increasing accessibility and convenience. • It would also provide a platform for teachers to remotely teach how to implement PII on demand.
CSD # 7	Provide a platform for parents to access instructional content created by teachers, enabling them to effectively implement and/or further improve digital interventions at home	• This capability would allow parents to take training at their own pace and schedule, helping to reduce barriers to access such as distance or time constraints. • It would also provide a learning platform for parents to learn how to implement PII.
CSD # 8	Facilitate seamless communication between parents and teachers within the platform	• This capability would enhance collaboration and partnership in the learner's education, leading to improved learning outcomes, increased parent satisfaction, and a stronger school-parent relationship. • It would also provide a platform where teachers and parents can send and receive messages.
CSD # 9	Gather feedback from parents, teachers, and other stakeholders in addressing the student's needs, as well as suggestions for improvement	• This capability would help identify areas of improvement, enhance user satisfaction, and drive product innovation, ultimately leading to increased customer loyalty and retention It would also provide a process to regularly prompt users to provide feedback on their experience, including satisfaction levels, perceived effectiveness, and suggestions for improvement.
CSD # 10	Provide audio-visual prompts for learners to indicate the start of their day and the beginning of activities or tasks, assist with transitioning	• This capability would enhance learners' ability to independently navigate daily routines and tasks, reducing the need for constant supervision. This can lead to improved time management, task completion, and overall

	to the next activity, and offer support when they encounter challenges in completing tasks	learning outcomes, while also promoting a sense of autonomy and self-confidence among learners. • It would also provide a prompting mechanism represented by a digital character, graphics and or sounds that capture the learner's attention and would encourage them to take action.
CSD # 11	Provide a platform for learners to access instructional content created by teachers at school and at home	• This capability would improve the learning experience for individuals with autism by providing a clear and structured visual representation of their daily activities. • This would also provide a platform that will show visual schedules, incorporating objects, photographs and icons.
CSD # 12	Provide a platform for learners to view their activities and tasks for the day	• This capability would improve the learning experience for individuals with autism by providing a clear and structured visual representation of their daily activities. • It would also provide a platform that will show visual schedules, incorporating objects, photographs and icons.
CSD # 13	Create a mobile user interface design that will make learners with severe autism feel that they will embark on an epic adventure every time they do their routine activities and tasks	• This capability would improve intervention effectiveness by enhancing engagement and comprehension, leading to increased learning outcomes, better retention of information, and a more positive user experience. • It would also provide a user interface for a digital intervention for autism that aligns with how learners with autism perceive the world and learn.

Appendix 11: Features derived from literature review

Table 39

Features derived from literature review

ID	Features	Description
----	----------	-------------

FSD #1	Multimedia creation and integration	- Teachers could easily create, upload and embed multimedia files into the content creation interface such as video clips, pictures, graphics, voice recordings, and music. - The platform should allow teachers to integrate these multimedia elements to form a digital intervention.
FSD #2	Task breakdown	- The platform should provide tools for teachers to break down multimedia content into small, manageable tasks, following the principles of task analysis. - Teachers should be able to tie together different tasks, define their sequence and specify their dependencies.
FSD #3	Accessibility features	- Digital interventions should incorporate accessibility features to accommodate learners with diverse needs, such as options for audio descriptions, text-to-speech functionality, and customizable font sizes and colors. - Accessibility features should be easy to enable and configure within the template.
FSD #4	Template creation	- The platform should allow teachers to create digital intervention templates based on task analysis, outlining the sequence of tasks and activities. - Templates should be customizable, allowing teachers to adjust the content to fit the specific needs of individual learners.
FSD #5	Setting of learning objectives and task descriptions	- Templates should include detailed descriptions of each task, along with the learning objectives associated with completing the task. - Task descriptions should be clear and concise, providing guidance for parents on how to implement the intervention at home.
FSD #6	Parent-friendly instructions	- Templates should include parent-friendly instructions for implementing the intervention at home, including step-by-step guidance on how to engage the child in the tasks. - Instructions should be easy to understand and follow, even for parents without prior training in special education.
FSD #7	Customization options	- Templates should be customizable, allowing parents to adapt the intervention to suit the needs and preferences of their child. - Customization options should include the ability to add or remove tasks, adjust the difficulty level, and personalize the content based on the child's interests.
FSD #8	Progress tracking and reporting	- Digital interventions should include tools for tracking learner progress and reporting back to teachers and parents on the effectiveness of the intervention. - Progress tracking should be simple and intuitive, allowing teachers and parents to monitor their learners' progress over time.

Appendix 12: Design theme prioritization and feature implementation

Table 40

Design theme prioritization and feature implementation

DT #	DT name	Priority	Odyssey feature	Remarks
1	Visual Task Modeling for Daily Living Skills	Must Have	Adventures	Aligned with Video Modelling and Task Analysis intervention types and could directly contribute to teaching life skills
2	Emotional Regulation and Behavior Cueing for Children	Must Have	Mood Captain	Necessary due to most learners with ASD facing behavioral challenges
3	Multimodal Communication and Expressive Language Support	Must Have	To be designed	Necessary due to most learners with ASD are not capable of verbal communication
4	Personalized Sensory Regulation Tools	Must Have	To be designed	Necessary due to most learners with ASD facing behavioral challenges due to sensory sensitivities
5	Gamified Motor Skills and Movement Integration	Could Have	To be designed	Would require a new backend implementation
6	Attention and Focus Support Through Gamified Tasks	Could Have	To be designed	Would require a new backend implementation
7	Flexible, Interest-Based Academic Learning Tools	Should Have	To be designed	This could be implemented as this will use the same features as DT#1. Educational content can be created and/or customized by parent and/or teacher
8.	Interest-Driven Learning and Creative Expression	Could Have	To be designed	Would require a new backend implementation
9	Offline and Low-Bandwidth Accessibility Tools	Must Have	To be implemented in the backend	Necessary so the app can be used in areas with poor internet and devices are low powered
10	Peer Interaction Through Storytelling and Turn-Taking	Should Have	To be designed	This could be implemented as this will use the same features as DT#1. Educational content can be

				created and/or customized by parent and/or teacher
11	Nutrition Education Through Visual and Reinforced Tools	Should Have	To be designed	This could be implemented as this will use the same features as DT#1. Educational content can be created and/or customized by parent and/or teacher
12	Customizable Visual Routines for Home Transitions	Must Have	Adventures	This is necessary as learners with ASD thrive with routines. In addition, both TEACCH and LCE recommend structured learning environments.
13	Financial Aid Navigation and Subsidized Support	Could Have	To be designed	Would require a government and industry collaboration, service design, and a new backend implementation
14	Parental Tools for Managing Behavior at Home	Must Have	Mood Captain	Necessary due to most learners with ASD facing behavioral challenges
15	Caregiver Wellness and Emotional Support Tools	Should Have	To be designed	This could be implemented as this will use the same features as DT#16. Educational content can be created and/or customized by the teacher or provided by the app.
16	Home-Based Life Skills Coaching and Virtual Guidance	Must Have	Learning	Necessary as parents would need to have the proper training and coaching to teach their child at home.
17	Life Skills and Vocational Readiness Toolkit	Should Have	To be designed	This could be implemented as this will use the same features as DT#1. Educational content can be created and/or customized by parent and/or teacher
18	Micro-Training Modules for Parent Empowerment	Should Have	To be designed	This could be implemented as this will use the same features as DT#16. Educational content can be created and/or customized by the teacher or provided by the app.

19	Family and Peer Support Integration	Could Have	To be designed	Would require a new backend implementation
20	Culturally Inclusive Autism Awareness and Advocacy	Could Have	To be designed	Would require a new backend implementation
23	On-Demand Learning Aligned with Parent Schedules	Should Have	To be designed	This could be implemented as this will use the same features as DT#16. Educational content can be created and/or customized by the teacher or provided by the app.
26	Goal Tracking and Progress Reporting Tools	Could Have	To be designed	Would require a new backend implementation
27	Parent-Teacher Sharing and Communication Tools	Could Have	To be designed	Would require a new backend implementation
28	Picture-Based Parent-Child Communication Tools	Should Have	To be designed	This could be implemented as this will use the same features as DT#3. The same PECS-based tool can be customized by the parent to align with the capabilities and needs of their child
29	Customizable Intervention Resource Library	Should Have	Adventures	This could be implemented as this will use the same features as DT#1. The app will curate interventions that were created by users and show them as part of a library.
30	Interactive Parent-Child Learning Activity Hub	Should Have	To be designed	This could be implemented as this will leverage the features of DT #36
31	Behavior Management and Monitoring Tools for Teachers	Should Have	To be designed	This could be implemented as this will use the same features as DT#14.
32	Personalized Communication Tools & Profile for Classroom Use	Should Have	To be designed	This could be implemented as this will use the same features as DT#3. The same PECS-based tool can be customized by the teacher to align with the ILPs of the students.
33	Individualized Learning Plans with Real-Time Tracking	Must Have	Voyage Path	This is necessary as this is a simplified individual learning plan that will help

				provide a structured learning trajectory for the learner
34	Low-Spec Device Compatibility and Print Alternatives	Must Have	To be implemented backend	Necessary so the app can be used in areas with poor internet and devices are low powered
35	Teacher and Parent Digital Training Community	Should Have	To be designed	This could be implemented as this will leverage the features of DT #36
36	Parent-Teacher Communication and Coaching Platform	Must Have	Learning, Chat	This is necessary so that the parents and teachers can work together to ensure learning continues from school to home.
38	Intervention Templates and AI-Based Planning Tools	Must Have	Adventures	This is necessary as the creation of digital intervention could be tedious and time consuming. Adding an AI component could help both teachers and parents in customizing the app for the learners needs.
39	Teacher Peer Support and Digital Recognition	Could Have	To be designed	Would require government and industry collaboration, service design, and a new backend implementation
40	Admin Collaboration and Multi-User Access	Could Have	To be designed	Would require a new backend implementation
41	Collaborative Visual Daily Planner	Must Have	Scheduler	This is necessary as this is needed to build the child's learning routine. This would also leverage the same features as DT#12. The visual planner can be customized by the teacher or provided by the app.
43	Consistent Reward Systems Across Home and School	Must Have	Rewards	This is necessary as positive reinforcement is key to the successful learning of individuals with ASD
44	Personalized Lesson Creation Using Child Profiles	Must Have	Voyage Path	This could be implemented as this will use the same features as DT#1. Educational content can be

				created and/or customized by parent and/or teacher
45	Gamified Learning with Rewards and Challenges	Must Have	Rewards	This is necessary as this was tied to DT #43, which is a feature to accumulate tokens to the successful execution of Adventures, and provide a capability to redeem the tokens once the goal has been reached.

Appendix 13: Code Book

Table 41

Code/ID	Theme	Strategy	Description
1.1	Demographic	Deductive	Demographic information.
1.2	Child Rearing	Inductive	How parents take care of their child considering obligations.
1.3	Autism Symptoms	Inductive	Signs observed leading to diagnosis.
1.4	Autism Detection	Inductive	Experience of autism identification through consultation.
1.5	Autism Diagnosis Process	Inductive	End-to-end diagnosis process.
1.6	Parent's Emotion	Inductive	Overall emotional state of the parent.
1.7	Parent's Goal	Inductive	Parents' aspirations and objectives.
1.8	Child Current State	Inductive	Current status of the child's life skills, routines, well-being.
1.9	Schools' Current State	Deductive	Parent perspective on schools in the Philippines.
2.1	Parental Challenges	Inductive	Material/emotional challenges in raising the child.
2.2	Child Behavior Challenges	Inductive	Sporadic or general child behaviors.
2.3	Bad Habits	Inductive	Repetitive unfavorable behaviors.
2.4	Socialization	Inductive	Difficulty engaging with other children.
2.5	Skill Deficit Challenges	Inductive	Challenges due to missing skills.
2.6	External Challenges	Inductive	Environmental challenges beyond control.
2.7	Institutional Challenges	Inductive	Challenges caused by societal institutions.
2.8	Social Stigma	Inductive	Negative societal perceptions of autism.
2.9	Cognitive and Attention Challenges	Inductive	Focus, sitting tolerance, multi-step task learning.

2.1	Communication and Social Challenges	Inductive	Expressing needs/emotions, social interaction difficulties.
2.11	Emotional and Behavioral Regulation Challenges	Inductive	Frustration, meltdowns, aggression.
2.12	Sensory and Food-Related Challenges	Inductive	Sensory sensitivities and picky eating.
2.13	Safety and Awareness Challenges	Inductive	Lack of danger awareness, getting lost.
2.14	Learning and Academic Challenges	Inductive	Following instructions, perseverance.
3.1	Mastered Life Skill	Deductive	Independently repeated skill without prompting.
3.2	Eating Alone	Inductive	Capability to eat independently.
3.3	Maintaining Focus	Inductive	Ability to complete tasks continuously.
3.4	Established Routines	Inductive	Consistent daily activity patterns.
3.5	Using Technology	Inductive	Use of phones, computers, TV.
3.6	Personal Hygiene	Inductive	Bathing, toothbrushing, self-care.
3.7	Leisure	Inductive	Enjoyable activities alone or with others.
3.8	Cleaning	Inductive	Tidying and household cleaning tasks.
3.9	Cooking	Inductive	Meal preparation or independent cooking.
3.1	Sorting	Inductive	Grouping similar objects.
3.11	Helping around the house	Inductive	General household chores.
3.12	Memory retention	Inductive	Remembering routines and commitments.
3.13	Gap in Current Life Skills	Deductive	Inconsistencies in skill execution.
3.14	Missing Life Skills	Deductive	Skills parents wished the child had.
3.15	Toileting Skills	Inductive	Independence in toileting and hygiene.
3.16	Dressing Skills	Inductive	Ability to dress independently.
3.17	Bathing Skills	Inductive	Independent bathing with reduced supervision.
3.18	Household Independence Skills	Inductive	Preparing meals, washing dishes, cleaning.
4.1	Child Learning	Inductive	How the child executes acquired skills.
4.2	Parental Learning	Inductive	How parents learn to teach life skills.
4.3	Gaps in Child Learning	Inductive	Areas for improvement in present skills.
4.4	Gaps in Parental Learning	Inductive	Problems in parent's capability to teach at home.
4.5	Time to Learn	Inductive	Time it takes to learn a skill with minimal supervision.
4.6	Lessons Learned	Inductive	Major lessons parents acquired raising their child.
5.1	Parent's Teaching Approach	Inductive	How parents teach life skills at home.

5.2	Gap in Parent's Teaching Approach	Inductive	Areas parents need to improve in teaching.
5.3	School's Teaching Approach	Inductive	How educators teach life skills at school.
5.4	Gap in School's Teaching Approach	Inductive	Areas parents identified needing improvement in schools.
6.1	Teaching through Modelling	Inductive	Show-and-tell demonstration approach.
6.2	Teaching through Repetition	Inductive	Repetition through daily routine and schedules.
6.3	Teaching through Positive Reinforcement	Inductive	Reward-based encouragement.
6.4	Teaching through Task Reduction	Inductive	Breaking tasks into very small steps.
6.5	Teaching through Task Sequencing	Inductive	Ordering tasks into sequence.
6.6	Teaching through Prompting	Inductive	Providing verbal or visual instructions.
6.7	Teaching through Encouraged Independence	Inductive	Letting the child try tasks on their own.
6.8	Teaching through Authority Figure	Inductive	Using authority roles for consistency.
6.9	Teaching through Leveraging Interests	Inductive	Using child interests to motivate learning.
6.1	Teaching through Leveraging Natural Inclinations	Inductive	Using child preferences (routines, cleanliness).
6.11	Teaching through Giving Sufficient Time	Inductive	Allowing enough time for execution.
6.12	Teaching through Technology	Inductive	Learning tasks through technological aids.
7.1	Creative Capabilities	Inductive	Drawing, crafting, Lego, digital arts.
7.2	Physical and Motor Capabilities	Inductive	Running, biking, swimming, sports.
7.3	Cognitive and Problem-Solving Capabilities	Inductive	Puzzles, memorization, tracing.
7.4	Communication and Social Capabilities	Inductive	Role play, hand-leading, phrases.
7.5	Learner Interests	Inductive	Preferred hobbies and motivating activities.
7.6	Preferred Games and Play Activities	Inductive	Physical, pretend, building, digital play.
7.7	Favorite Foods and Eating Preferences	Inductive	Preferred meals, snacks, picky eating.
7.8	Favorite Cartoons and Media Preferences	Inductive	Cartoons, YouTube, personalities.

8.1	Morning Routine Activities	Inductive	Waking, breakfast, hygiene, school prep.
8.2	Afternoon Routine Activities	Inductive	Lunch, play, therapy, naps, errands.
8.3	Evening Routine Activities	Inductive	Dinner, relaxation, bedtime preparation.
8.4	Routine-Based Support Needs	Inductive	Points requiring prompting or structure.
9.1	Nurturing and Proactive Parenting	Inductive	Active engagement and seeking solutions.
9.2	Structured and Routine-Based Parenting	Inductive	Consistency through schedules.
9.3	Interest-Driven and Adaptive Parenting	Inductive	Leveraging interests and flexibility.
10.1	Behavioral Challenges and Sensory Sensitivities	Inductive	Managing meltdowns, aggression, sensory issues.
10.2	Caregiving Fatigue and Work-Life Balance	Inductive	Exhaustion and balancing work.
10.3	Financial Constraints and Limited Access to Services	Inductive	High therapy costs and limited services.
10.4	Limited Support System and Community Involvement	Inductive	Isolation and lack of support.
10.5	Educational and Learning Challenges	Inductive	Need for structured tools/interventions.
11.1	Child Independence and Life Skills	Inductive	Goals for hygiene, toileting, autonomy.
11.2	Financial and Government Support	Inductive	Need for programs and income support.
11.3	Parental Well-Being and Support System	Inductive	Need for rest and emotional support.
11.4	Educational and Behavioral Support	Inductive	Professional guidance and behavior strategies.
11.5	Future Readiness and Vocational Skills	Inductive	Preparing children for employability.
12.1	Structured and Routine-Based Teaching	Inductive	Schedules, repetition, predictable routines.
12.2	Individualized and Adaptive Teaching	Inductive	Adjusting instruction based on mood/ability.
12.3	Behavior Management and Reinforcement Strategies	Inductive	Positive reinforcement and regulation supports.
12.4	Life Skills and Practical Training	Inductive	Functional independence and self-care skills.
12.5	Parent Collaboration and Home-Based Learning	Inductive	Coaching parents and reinforcing learning at home.

13.1	Managing Student Behaviors and Sensory Sensitivities	Inductive	Aggression, meltdowns, engagement issues.
13.2	Limited Teaching Resources and Workload	Inductive	Large class sizes, insufficient materials.
13.3	Parental Engagement and Home Reinforcement Challenges	Inductive	Limited therapy access and home consistency.
13.4	Lack of Institutional and Community Support	Inductive	Need for partnerships, training, systemic support.
14.1	Health Concerns	Inductive	Dependency and prolonged screen exposure concerns.
14.2	Limited Capacity and Device Affordability	Inductive	Barriers due to gadget access.
14.3	Need for Personalization	Inductive	Importance of individualized content.
14.4	Good for Skill Building	Inductive	Apps beneficial for daily living skills.
14.5	Supplementary Tool Only	Inductive	Digital tools supportive but not primary.
14.6	Hybrid Approach	Inductive	Combination of traditional and digital.
14.7	Need for Interactive Elements	Inductive	Gamification, rewards, engagement features.
DT #1	Visual task modeling for daily living skills	Deductive	Provide structured, visual-based task sequences such as digital schedules, step-by-step instructions, and video-based modelling to teach life skills.
DT #2	Emotional regulation and behavior cueing for children	Deductive	Provide digital emotion boards, calming tools, breathing videos, and social stories to reduce anxiety and support appropriate behavior.
DT #3	Multimodal communication and expressive language support	Deductive	Provide multimodal communication supports such as PECS and AAC integration with AI-driven anticipatory prompts.
DT #4	Personalized sensory regulation tools	Deductive	Provide customizable sensory-friendly settings and digital sensory spaces for soothing and gradual desensitization.
DT #5	Gamified motor skills and movement integration	Deductive	Gamify gross and fine motor tasks with movement suggestions tied to child interests.
DT #6	Attention and focus support through gamified tasks	Deductive	Embed short, visually guided tasks with progress indicators and role-playing games for focus training.
DT #7	Flexible, interest-based academic learning tools	Deductive	Allow flexible pacing, interest-based modules, and reminders for scheduled learning tasks.
DT #8	Interest-driven learning and creative expression	Inductive	Leverage child interests (music, drawing, games) as entry points for engagement and motivation.

DT #9	Offline and low-bandwidth accessibility tools	Deductive	Include offline access, low-bandwidth modes, and printable resources for limited connectivity contexts.
DT #10	Peer interaction through storytelling and turn-taking	Deductive	Enable social storytelling, peer buddy matching, and group-based collaborative play.
DT #11	Nutrition education through visual and reinforced tools	Deductive	Provide meal prep simulations and reinforcement strategies tied to favorite foods.
DT #12	Customizable visual routines for home transitions	Deductive	Provide customizable step-by-step routines with timers, alarms, and calming transition supports.
DT #13	Financial aid navigation and subsidized support	Deductive	Provide service navigation tools, subsidized pricing, and intelligent caregiver assistants.
DT #14	Parental tools for managing behavior at home	Deductive	Provide behavioral management guides, calm-down buttons, and ABC logging tools.
DT #15	Caregiver wellness and emotional support tools	Deductive	Develop self-care prompts, emotional check-ins, and access to mindfulness supports.
DT #16	Home-based life skills coaching and virtual guidance	Deductive	Enable parents to create routines and provide virtual teacher avatar guidance.
DT #17	Life skills and vocational readiness toolkit	Deductive	Guide parents in simulating job-readiness training and future planning.
DT #18	Micro-training modules for parent empowerment	Deductive	Embed localized micro-modules and training videos with rewards for consistency.
DT #19	Family and peer support integration	Deductive	Integrate family task sharing and peer support groups for caregiver connection.
DT #20	Culturally inclusive autism awareness and advocacy	Deductive	Feature culturally diverse narratives, testimonials, and resilience stories.
DT #21	Multilingual and low-literacy accessible content	Deductive	Provide content in multiple languages with icons and voice guidance.
DT #22	Local service and policy support directory	Deductive	Provide directories of local autism support organizations.
DT #23	On-demand learning aligned with parent schedules	Inductive	Provide flexible training materials and scheduling aligned with caregiver routines.
DT #24	User-friendly interface with guided tutorials	Deductive	Design simple UI with walkthroughs, tooltips, and reduced cognitive load.
DT #25	Curated digital content with parental controls	Inductive	Allow content curation with locking features and safe access boundaries.
DT #26	Goal tracking and progress reporting tools	Deductive	Customizable learning goals with dashboards, charts, and integrity checks.
DT #27	Parent-teacher and parent-to-parent communication tools	Inductive	Messaging and sharing functionality for updates and trusted parent chat.
DT #28	Picture-based parent-child communication tools	Deductive	Enable customizable picture-symbol communication and parent training.

DT #29	Customizable intervention resource library	Inductive	Repository of interventions with parent-uploaded personalized videos.
DT #30	Interactive parent-child learning activity hub	Inductive	Repository of bonding activities with step-by-step video guides.
DT #31	Behavior management and monitoring tools for teachers	Deductive	Implement individualized behavior plans, reinforcement, and sharing reports.
DT #32	Personalized communication tools and profile for classroom use	Deductive	Develop learner communication profiles accessible to educators.
DT #33	Individualized learning plans with real-time tracking	Deductive	Enable teachers to customize learning plans with measurable goals and progress tracking.
DT #34	Low-spec device compatibility and print alternatives	Deductive	Ensure offline functionality, printable versions, and low-spec compatibility.
DT #35	Teacher and parent digital training community	Deductive	Provide tutorials and professional collaboration communities.
DT #36	Parent-teacher communication and coaching platform	Deductive	Provide structured home intervention guides, workshops, and mentoring.
DT #37	Screen time monitoring and hybrid learning features	Deductive	Built-in alerts for breaks and hybrid real-world engagement activities.
DT #38	Intervention templates and AI-based planning tools	Deductive	Provide templates, ML-driven planning support, and auto progress trackers.
DT #39	Teacher peer support and digital recognition	Deductive	Digital peer sharing spaces and recognition for milestones.
DT #40	Admin collaboration and multi-user access	Deductive	Enable exportable reports and teacher-aide collaboration.
DT #41	Collaborative visual daily planner	Deductive	Shared visual planner distinguishing school vs home tasks with reminders.
DT #42	Secure data handling and privacy compliance	Deductive	Encrypt sensitive information and add anonymization features.
DT #43	Consistent reward systems across home and school	Deductive	Align reward systems across environments with low-resource options.
DT #44	Personalized lesson creation using child profiles	Deductive	Collect learner profile data and enable customized lessons and templates.
DT #45	Gamified learning with rewards and challenges	Deductive	Achievement badges, mini-games, and incentives to motivate mastery.

Appendix 14: Consent form - parents

Name of student researcher: Genevieve R. Villamin

Coordinates: -; Email: -

Name of Advisor: Rocci Luppigini, Ph.D.

Affiliation: Faculty of Arts, University of Ottawa

Coordinates: -; Email: -

Invitation to participate:

I am invited to participate in the research study to co-design mobile applications that will help learners with severe autism in their daily living activities conducted by Genevieve R. Villamin, supervised by Dr. Rocci Luppigini for her doctoral thesis at the University of Ottawa.

Purpose of the study: I understand that the purpose of the study is to know how to co-design mobile assistive technologies for learners with severe autism using strength-based and participatory-design approaches to assist in their life skills development.

Participation: My participation in this study will be through surveys and interviews. Specifically:

- Answering a parent survey, wherein I will share information about my self and my child, my experience and challenges as a parent, and my thoughts about using digital technology for autism.
- Participate in a 45 minute to 1 hour interview wherein I will answer follow-up questions based on my survey response.

Risks: I understand that since my participation in this study will entail that I volunteer very personal information about myself and my child, it may cause me to feel emotional inconvenience. I have received assurance from the researcher that every effort will be made to minimize these risks. To mitigate these risks, I can choose whether or not to answer certain questions at any time during the interview; and refuse to answer questions in the survey that I am not comfortable to.

I can also choose to withdraw completely, in which by then, all my responses will be deleted and will not be used in the study.

Benefits: My participation in this study will contribute to the goal of making evidence-based interventions for autism more accessible and affordable. My participation will also greatly contribute to innovating the practice of providing interventions to learners with autism.

Confidentiality and anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. The contents will be used only for her doctoral thesis – THD 9999. Anonymity will be protected by assuring that in written reports, my name (and organization) will be disguised.

Conservation of data: Data collected from the participants along with any related research and reference documents will be kept in a secure manner. Digital data will be stored on a computer with a secure password; and all hard copies of data and research documents will be safely stored in a locked cabinet. Only the student researcher and her supervisor will have access to the data. All data collected will be stored for 10 years. Digital data will be deleted after 10 years; while physical data will be destroyed, using a paper shredder after 10 years.

Voluntary participation: I am under no obligation to participate and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be deleted.

Acceptance: By writing my name below, I agree to participate in the above research study conducted by Genevieve R. Villamin, whose research is under the supervision of Dr. Rocci Luppisini. I understand that by accepting to participate I am in no way waiving my right to withdraw from the study.

If I have any questions about the study, I may contact the student and/or the course professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca.

I will be furnished a copy of this consent form once it has been successfully completed.

First Name: _____

Last Name: _____

I consent to these activities/procedures

- ☐ Yes
- ☐ No

Date: MM/DD/YYYY

Appendix 15: Consent form – teachers

Name of student researcher: Genevieve R. Villamin

Coordinates: ; Email: -

Name of Advisor: Rocci Luppisini, Ph.D.

Affiliation: Faculty of Arts, University of Ottawa

Coordinates: -; Email: -

Invitation to participate:

I am invited to participate in the research study to design and create mobile applications that will

help learners with severe autism in their daily living activities conducted by Genevieve R. Villamin, supervised by Dr. Rocci Luppigini for her doctoral thesis at the University of Ottawa.

Purpose of the study: I understand that the purpose of the study is to know how to co-create mobile assistive technologies for learners with severe autism using strength-based and participatory-design approaches to assist in their life skills development.

Participation: My participation in this study will be through filling-in information forms, answering a survey and participating in an interview. Specifically:

- Filling in an information form, wherein I will provide details about myself and profession
- Answer a survey, wherein I will share insights about my experiences and challenges as a teacher for children with special needs
- When my time permits, participate in a short interview

Risks: I understand that since my participation in this study will entail that I volunteer very personal information about myself and my students, it may cause me to feel emotional inconvenience. I have received assurance from the researcher that every effort will be made to minimize these risks. To mitigate these risks, I can choose whether or not to answer certain questions at any time and refuse to fill-in the forms and survey.

I can also choose to withdraw completely, in which by then, all my responses will be deleted and will not be used in the study.

Benefits: My participation in this study will contribute to the goal of making evidence-based interventions for autism more accessible and affordable. My participation will also greatly contribute to innovating the practice of providing interventions to learners with autism.

Confidentiality and anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. The contents will be used only for her doctoral thesis – THD 9999. Anonymity will be protected by assuring that in written reports, my name (and organization) will be disguised.

Conservation of data: Data collected from the participants along with any related research and reference documents will be kept in a secure manner. Digital data will be stored on a computer with a secure password; and all hard copies of data and research documents will be safely stored in a locked cabinet. Only the student researcher and her supervisor will have access to the data. All data collected will be stored for 10 years. Digital data will be deleted after 10 years; while physical data will be destroyed, using a paper shredder after 10 years.

Voluntary participation: I am under no obligation to participate and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be deleted.

Acceptance: By writing my name below, I agree to participate in the above research study

conducted by Genevieve R. Villamin, whose research is under the supervision of Dr. Rocci Luppicini. I understand that by accepting to participate I am in no way waiving my right to withdraw from the study.

If I have any questions about the study, I may contact the student and/or the course professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca.

I will be furnished a copy of this consent form once it has been successfully completed.

First Name: _____

Last Name: _____

I consent to these activities/procedures

- ☐ Yes
- ☐ No

Date: MM/DD/YYYY

Appendix 16: Qualitative survey questions – parents

1. Please provide your:
 - a. First and last name
 - b. First and last name of your child
2. Around what age does your child first start receiving therapy or start attending formal education?
3. What therapies and/or learning did your child is taking/have taken as of date?
4. So far, how effective do you think these therapies and education are for your child?
5. How many children do you have?
6. How many of your children have been diagnosed with autism?
7. Do you live with or close to your relatives?
8. How does your family / extended family participate in the care and education of your child with autism?
9. Who in your family has the primary responsibility to take care of your child with autism?
10. Can you describe the amount of care or supervision your child with autism requires?
11. What are the challenges faced by you and your family in taking care of your child with autism?
12. What do you think is needed to address or alleviate these challenges?
13. What assistance from the government would you hope to receive for your child with autism?
14. What are your future aspirations for your child with autism?
15. What is your child good at doing?

16. Are there any activities that you see your child struggle with?
17. What is your child's favorite game to play with you?
18. What daily living skills would you like to see your child gain (ex. Taking a bath, toileting, eating alone, etc.)
19. Does your child have any behavioral challenges? Can you describe it if there's any.
20. Is there any behavior in particular you'd like to see improve in your child?
21. What other skills would you like your child to have?
22. Can you describe the morning routines of your child?
23. Can you describe the afternoon routines of your child?
24. Can you describe the evening routines of your child?
25. Can you describe the family outing routines of your child?
26. Can you give the top five foods for mealtime or snacks that your child loves the most? Feel free to add if you can think of more.
27. Can you give the top five games for play routines that your child loves the most? Feel free to add if you can think of more.
28. Can you give the top five toys for play routines that your child loves the most? Feel free to add if you can think of more.
29. Can you give the top five activity routines that your child loves the most? Feel free to add if you can think of more.
30. Can you give the top five cartoon characters, actors/actress, or artists that your child loves the most? Feel free to add if you can think of more.
31. Do you agree to participate in an interview? If yes, please provide at least three (3) dates and times to participate in a short interview to be conducted online
32. Do you have any questions, concerns or general feedback?

Appendix 17: Qualitative survey questions – teachers

1. Please provide your
 - a. Full name
 - b. Mobile Number
 - c. Email
2. When is your birthday?
3. What is your marital status?
4. What is your highest educational attainment?
5. Please provide the institution where you completed your education
6. When did you complete your education?
7. What is your current profession?
8. What is your specialization?
9. How many years have you been teaching?
10. How many classes are you handling?
11. What is the average number of students that you have per class?
12. What are your typical work hours?
13. What do you like to do during your free time?
14. What are the challenges that you face as a teacher for children with special needs?
15. What do you think should be done to help address these challenges?

16. How important do you think the acquisition of daily living skills is for children with severe autism?
17. Based on your experience, what are the interventions that worked best for learners with severe autism to acquire and maintain daily living skills?
18. Can you describe your approach in teaching daily living skills to children with severe autism?
19. What are your thoughts about using a mobile application to teach life skills to children with severe autism?
20. How important do you think is the parents' role in the learning of their child with severe autism?
21. What are your thoughts about implementing parent-implemented-interventions, so that parents can take a more active role in the learning of their child at home?
22. What are your thoughts about using a mobile application to implement parent-implemented-interventions?
23. What are the challenges that you foresee in using a mobile application for teaching life skills to children; and to teach their parents to continue the learning of their child at home?
24. Do you agree to participate in a short online interview?

Appendix 18: Interview protocol – parent

Interview Protocol: A case study on co-designing a digital health solution for severe autism spectrum disorder life skills development for low-resource populations

Time:	Date:	Place:
Interviewer: Genevieve Villamin	Interviewee:	
	Child:	

Introduction

Thank you for taking time out of your busy schedule to participate in this interview.

Before we begin, I would like to give a brief overview of this study.

This study aims to design together with parents and teachers a digital health solution, such as a mobile application, to help parents and teachers in teaching life skills to children with severe autism.

Life skills pertain to a person's capacity to live a productive life and are categorized into five areas: self-care and domestic living, recreation and leisure, social interaction, employment and community participation.

In low-resource areas such as far provinces or developing countries which are lacking in policies and resources to provide learning to children with disabilities, digital technologies such as mobile phones have a great potential in bridging the gap.

For example, a mobile application can help in creating interventions or teaching materials using videos, pictures, illustrations and sounds to teach basic life skills such as taking a shower, going to the toilet, learning how to eat on their own, dressing on their own, etc.

Over time, the development of various life skills would enable a child with severe autism to live with a certain degree of independence and have a dignified life.

Before we start the interview, do you have any questions?

Thank you and if any more questions come up after the interview, feel free to reach out to me anytime via email, and I will respond to any inquiry that you may have.

Specific needs, challenges, capabilities, and interests do learners with severe ASD

1. From the survey, you mentioned that your child has a (mention routine here from the survey form). What happens if their routine changes?
2. How do your children behave when learning something new?
 - b. Are there ways you keep them interested and focused?
 - c. How do you handle things when they do not want to learn something new?
3. From the survey, you mentioned that you wanted your child to (mention needs/challenges mentioned in the survey form). Which among these do you think your child finds hardest to learn?
 - b. What approach are you taking in teaching them these skills
 - c. Does their teacher also aware that they need to learn these skills
4. From the survey, you mentioned that your children enjoy (mention child interest based on the survey form)
 - a. How did you help them learn these things?
 - b. What are some things your child has learned to do on their own?
5. Are there things your child enjoys that do you think could be used to help him learn new skills?
6. Does your child have any strong likes or dislikes with things like sounds, textures, or lights?
 - a. How does this affect what they do each day?
7. How do you help your child remember the things they have already learned?

Challenges do parents encounter when teaching life skills to their children

1. How much time are you able to spend each day working on skills with your child?
 - a. How do you manage your time doing other daily tasks?
2. What help from teachers, has been useful?
 - b. What help do you feel you are still missing?
3. How do you manage transportation to and from school?
 - a. Does getting there cost too much or take too much time?
4. What other challenges are being faced by your family in taking care of your children?
5. What help or tools would you like for other parents to have for the learning of children with severe autism?

Processes, features, and capabilities are essential for a digital health solution that effectively supports learners, parents, and teachers in teaching, enhancing, and maintaining life skills

1. How could an app help you as a parent?
2. What might make it hard for you to use an app for the child

3. What would make this app fun and comfortable for your child to use?

Closing Remarks

This brings us to the end of the interview.

Thank you

Appendix 19: Interview protocol – teacher

Interview Protocol: A case study on co-designing a digital health solution for severe autism spectrum disorder life skills development for low-resource populations

Time:	Date:	Place:
Interviewer: Genevieve Villamin	Interviewee: Child:	

Introduction

Thank you for taking time out of your busy schedule to participate in this interview.

Before we begin, I would like to give a brief overview of this study.

This study aims to design together with parents and teachers a digital health solution, such as a mobile application, to help parents and teachers in teaching life skills to children with severe autism.

Life skills pertain to a person's capacity to live a productive life and are categorized into five areas: self-care and domestic living, recreation and leisure, social interaction, employment and community participation.

In low-resource areas such as far provinces or developing countries which are lacking in policies and resources to provide learning to children with disabilities, digital technologies such as mobile phones have a great potential in bridging the gap.

For example, a mobile application can help in creating interventions or teaching materials using videos, pictures, illustrations and sounds to teach basic life skills such as taking a shower, going to the toilet, learning how to eat on their own, dressing on their own, etc.

Over time, the development of various life skills would enable a child with severe autism to live with a certain degree of independence and have a dignified life.

Before we start the interview, do you have any questions?

Thank you and if any more questions come up after the interview, feel free to reach out to me anytime via email, and I will respond to any inquiry that you may have.

Individual Learning Plan Creation

1. How do you currently create or manage learning plans for students with moderate to severe autism?
2. What was your experience when looking at the Voyage Path or ILP feature in the app?

Adventure Creation (Step-by-Step Interventions)

1. How do you usually break down life skills routines for your learners?
2. What are your thoughts on using step-by-step “adventures” to teach life skills?

Reward and Treasure System

1. How do you currently motivate or reinforce life skills learning among your students?
2. What was your reaction to the reward or treasure feature in the prototype?

Parent eLearning Materials

1. What role do parents play in supporting life skills learning outside of school in your experience?
2. What are your thoughts on having training materials or courses for parents within the app?

Viewing and Tracking Student Progress

1. How do you currently monitor or document student progress in life skills?
2. What was your impression of the student progress tracking and dashboard feature?

Closing Reflection Questions

1. What stood out to you most about the prototype overall?
2. What improvements would you recommend to make the design more practical and meaningful for your learners?

Closing Remarks

This brings us to the end of the interview.

Thank you

Bibliography

- Abear, K. Q., Buncalan, K. D., Juson, L. S. & Poralan, P. S. (2017). Lived Experiences of Parents with Children Diagnosed with Autism Spectrum Disorder. *ARETE*, 5(1).
- Abdallah, W., Vella, F., Vigouroux, N., Van den Bossche, A., & Val, T. (2019). A collaborative talking assistive technology for people with autism spectrum disorders. *Paper presented at international conference on human-computer interaction, Orlando FL*. https://doi.org/10.1007/978-3-030-23563-5_1
- Abdullah, M. & Brereton, M. (2017). Mycalendar: Supporting children on the autism spectrum to learn language and appropriate behaviour. *Presented at OZCHI '17: Proceedings of the 29th Australian conference on computer-human interaction, Queensland, Brisbane, Australia*. <https://doi.org/10.1145/3152771.3152793>.
- Ajoc, I. (2019). The Special Education Program (SPED) in the Province of Surigao del Sur, Philippines. *SMCC Higher Education Research Journal*, 1(1). <https://doi.org/10.18868/sherjte.01.060119.12>
- Akmanoğlu, N., & Pektaş-Karabekir, E. (2019). The effectiveness of video prompting in teaching children with autism the skill of drawing a six-part person. *Journal of developmental and physical disabilities*, 32 (4), 617-631. 10.1007/s10882-019-09709-w
- Albert, N., Daniels, J., Schwartz, J., Du, M., & Wall, D. P. (2017). GapMap: Enabling Comprehensive Autism Resource Epidemiology. *JMIR Public Health and Surveillance*, 3(2), e27. <https://doi.org/10.2196/publichealth.7150>
- Alexander, P. A., & Murphy, P. K. (1998). Profiling the differences in students' knowledge, interest, and strategic processing. *Journal of Educational Psychology*, 90(3), 435–447. <https://doi-org.proxy.bib.uottawa.ca/10.1037/0022-0663.90.3.435>
- Alhazbi, S., Aboeleneen, A., Kamal, N., Khader, M., Azzouza, A., Al-Kababji, A., Hassen, A., & Zaza, A. (2018). Faheem: A tablet-based application to improve receptive language for Arab autistic children. *Paper presented at international conference on computer and applications, Beirut, Lebanon*. 10.1109/COMAPP.2018.8460413
- An Act Expanding The Positions Reserved For Persons With Disability, Amending For The Purpose Republic Act No. 7277, As Amended, Otherwise Known As The Magna Carta For Persons With Disability – RA 10524 | National Council on Disability Affairs.* (n.d.). National Council on Disability Affairs. <https://ncda.gov.ph/disability-laws/republic-acts/republic-act-no-10524-an-act-expanding-the-positions-reserved-for-persons-with-disability-amending-for-the-purpose-republic-act-no-7277-as-amended-otherwise-known-as-the-magna-carta-for-persons/>

- American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). American Psychiatric Association Publishing.
<https://doi.org/10.1176/appi.books.9780890425787>
- Antony, C., Campbell, M., Côté, S., Bruno, G., Tinglin, C., & Lai, J. (2022). Informing care pathways and policies for children and youth with Indigenous perspectives to advance Canada's National Autism Strategy. *Frontiers in Psychiatry*, 13.
<https://doi.org/10.3389/fpsy.2022.916256>
- Aslan, S., & Reigeluth, C. M. (2016). Investigating “The Coolest School in America”: How technology is used in a learner-centered school. *Educational Technology Research and Development*, 64(6), 1107–1133. <https://doi-org.proxy.bib.uottawa.ca/10.1007/s11423-016-9450-9>
- Atchulo K., Kwadwo A. K., & Farhan, A. A. (2025). Parents' Perspectives on the Quality of Life of Adolescents living with Autism Spectrum Disorder in Ghana. *Women and Children Nursing*. <https://doi.org/10.1016/j.wcn.2025.05.002>
- Ayres, K. M., Mechling, L., & Sansosti, F. J. (2013). The use of mobile technologies to assist with life skills/independence of students with moderate/severe intellectual disability and/or autism spectrum disorders: Considerations for the future of school psychology. *Psychology in the schools*, 50(3), 259–271. <https://doi.org/10.1002/pits.21673>
- Autism Society PH. (2022, January 24). *AOK Pilipinas: Autism Interventions*. [Webcast Recording]. Facebook. <https://fb.watch/aPFwRVKV9R/>
- Bailey, S., Boddy, K., Briscoe, K. and Morris, C. 2014. Involving disabled children and young people as partners in research: a systematic review. *Child: Care, health and development*, 41, 505–514.
- Baker, E., Stavropoulos, K. K. M., Baker, B. L., & Blacher, J. (2021). Daily living skills in adolescents with autism spectrum disorder: Implications for intervention and independence. *Research in Autism Spectrum Disorders*, 83(101761), 101761.
<https://doi.org/10.1016/j.rasd.2021.101761>
- Bakhai, A., Constantin, A., & Alexandru, C. (2020). Motivateme!: An Alexa skill to support higher education students with autism. *Paper presented at international conferences interfaces and human computer interaction 2020; and game and entertainment technologies 2020, Zagreb, Croatia*. Zagreb Croatia: Internal association for development of the information society.
- Bal, V. H., Kim, S.-H., Cheong, D., & Lord, C. (2015). Daily living skills in individuals with autism spectrum disorder from 2 to 21 years of age. *Autism*, 19(7), 774–784.

- Balading, J., Malicdem, J. A. M., Rayla, N. A., Ancheta, G. J., Alejandro, A., Blanco, J., Buenaflor, N. B., Evangelista, C. B., Fulgencio, L., & Tus, J. (2023). The lived experiences and challenges faced by SPED teachers amidst the new normal of education. *Psychology and Education: A Multidisciplinary Journal*, 7, 44-50
- Balbin, M. , Corpus, A. , Magtibay, G. , Rivera, M. , Santos, G. & Catamio, J. (2022). A Literature Analysis on the Quality of Life in Adults with Autism. *Psychology and Education: A Multidisciplinary Journal*, 4(8), 1-11.
<http://doi.org/10.5281/zenodo.7152894>
- Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 364(1522), 1377–1383. <https://doi.org/10.1098/rstb.2008.0337>
- Barta,E., Guzsvinecz,T., Lanyi,C., & Szucs, V. (2017). Android-based daily routine organizing application for elementary school students living with ASD. *Studies in health technology and informatics*, 242, 283–290. 10.3233/978-1-61499-798-6-283
- Bassette, L., Bouck, E., Shurr, J., Park, J., & Cremeans, M. (2019). Comparison of concrete and app-based manipulatives to teach subtraction skills to elementary students with autism. *Education and training in autism and developmental disabilities*, 2019, 54(4), 391– 405.
- Bauman, M. L. (2010). Medical comorbidities in autism: Challenges to diagnosis and treatment. *Neurotherapeutics*, 7(3), 320–327. <https://doi.org/10.1016/j.nurt.2010.06.001>
- Benton, L., Johnson, H., Ashwin, E., Brosnan, M., and Grawemeyer, B. 2012. Developing IDEAS: Supporting Children with Autism within a Participatory Design Team, *CHI '12: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Association for Computing Machinery, Austin Texas USA, 5-10 May 2012, New York, NY United States: Association for Computer Machinery.
- Benton, L., and Johnson, H. 2014. Structured approaches to participatory design for children: can targeting the needs of children with autism provide benefits for a broader child population? *Instructional Science*, 42, 47-65.
- Benton, L., Vasalou, A., Khaled, R., Johnson, H., and Gooch, D. 2017. Diversity for Design: A Framework for Involving Neurodiverse Children in the Technology Design Process, *ACM CHI Conference on Human Factors in Computing Systems*, Edinburgh United Kingdom, 10-14 June 2017, New York, NY United States: Association for Computing Machinery.
- Berenguer, C., Roselló, B., Colomer, C., Baixauli, I., & Miranda, A. (2018). Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and

- executive function, theory of mind, and behavioral problems. *Research in Developmental Disabilities*, 83, 260–269. <https://doi.org/10.1016/j.ridd.2018.10.001>
- Bersales, L. (2019 May 03). *Disability Spares No One: A New Perspective*. Philippine Statistics Authority. <https://psa.gov.ph/ndps/disability-survey-id/138567>
- Bonsignore, E., Quinn, A., Druin, A., & Bederson, B. (2013). Sharing stories “in the wild”: A mobile storytelling case study using storykit". *ACM transactions on computer-human interaction*, 20(3), 1–38. <https://doi.org/10.1145/2491500.2491506>
- Börjesson, P., Barendregt, W., Eriksson, E., & Torgersson, O. (2015). Designing technology for and with developmentally diverse children. *ACM*. <https://doi.org/10.1145/2771839.2771848>
- Borghi, A. M., Barca, L., Binkofski, F., Castelfranchi, C., Pezzulo, G., & Tummolini, L. (2019). Words as social tools: Language, sociality and inner grounding in abstract concepts. *Physics of Life Reviews*, 29, 120–153. <https://doi.org/10.1016/j.plrev.2018.12.001>
- Bolis, D., & Schilbach, L. (2020). ‘I interact therefore I am’: The self as a historical product of dialectical attunement. *Topoi*, 39, 521–534. <https://doi.org/10.1007/s11245-018-9574-0>
- Boyd, L. E., Jiang, X., and Hayes, G. R. (2017). *ProCom: Designing and Evaluating a Mobile and Wearable System to Support Proximity Awareness for People with Autism*. 2865–2877. <https://doi.org/10.1145/3025453.3026014>
- Boyle, B., and Arnedillo-Sanchez, I. (2022). The Inclusion of Children on the Autism Spectrum in the Design of Learning Technologies: A Small-Scale Exploration of Adults’ Perspectives. *Frontiers in Education*, 7. <https://doi.org/10.3389/feduc.2022.867964>
- Boulé, M. & Rivard, M. (2023). Emotional Experience of Families With an Immigrant Background Throughout the Autism Service Trajectory in Early Childhood. *Families in Society-the Journal of Contemporary Social Services*, 104438942311676-104438942311676. <https://doi.org/10.1177/10443894231167640>
- Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3, 77-101.
- Bradbury-Jones, C. , Ishama L., and Taylora, J. 2018. The complexities and contradictions in participatory research with vulnerable children and young people: A qualitative systematic review. *Social Science & Medicine*, 215, 80–91
- Brereton, M., Sitbon, L., Abdullah, M. H. L., Vanderberg, M., and Koplick, S. (2015). Design after design to bridge between people living with cognitive or sensory impairments, their friends and proxies. *CoDesign*, 11(1), 4–20. <https://doi.org/10.1080/15710882.2015.1009471>

- Brodhead, M., Rispoli, M., Wendt, O., Akers, J., Gerencser, A., and Kim, S. 2017. Treatment of Core Symptoms of Autism Spectrum Disorder. In Matson, J. *Handbook of Treatments for Autism Spectrum Disorder*. Baton Rouge, LA: Springer Cham, pp.127-144.
- Bruel, J.-M., Ebersold, S., & Naumcheva, M. (2025). *Applying requirements and business analysis*. Springer Nature Switzerland. <https://doi.org/10.1007/978-3-031-92160-5>
- Bruno, G., Chan, T. A., Zwaigenbaum, L., Coombs, E., & Nicholas, D. (2023). Indigenous Autism in Canada: A Scoping Review. *Journal of Autism and Developmental Disorders*. <https://doi.org/10.1007/s10803-023-06045-z>
- Cabiell-Hernandez, D., Perez-Perez, R., Paule-Ruiz, M., & Fernandez-Fernandez, S. (2017). Specialized intervention using tablet devices for communication deficits in children with autism spectrum disorders. *IEEE trans. learn. technol*, 10 (2), 182-193, 10.1109/TLT.2016.2559482
- Cariveau, T., & Fetzner, D. (2021). Experimental control in the adapted alternating treatments design: A review of procedures and outcomes. *Behavioural interventions*, 1(14), 1-4. 10.1002/bin.1865
- Carr, T., & Lord, C. (2016). A pilot study promoting participation of families with limited resources in early autism intervention. *Research in Autism Spectrum Disorders*, 25, 87–96. <https://doi.org/10.1016/j.rasd.2016.02.003>
- Capote, J. B., Guevara, B. O., Lacaba, C. & Lismoras, L. (2016). Maternal Challenges of Raising a Child with Autism Spectrum Disorder. *ARETE*, 4(1).
- Casale, L.M., Gentles, S. J., McLaughlin, J., & Schneider, M. (2023). Service access experiences of immigrant and refugee caregivers of autistic children in Canada: A scoping review. *PLOS ONE*, 18(11), e0293656–e0293656. <https://doi.org/10.1371/journal.pone.0293656>
- Catubigan, R. V. (2023). *Mothers' Voices on Autism Spectrum Disorder: Leaning Towards Sustainable Inclusive Education in Maragusan, Philippines*. 14(1), 57–71. <https://doi.org/10.2478/dcse-2023-0006>
- Cesario, L., Delnevoy, G., Malavasi, M., Desideri, L. & Mirri, S. (2022). On designing a mobile app to support people with cognitive disabilities in daily activities. *Paper presented at 7th international workshop on accessible devices and services, Las Vegas, NV*. 10.1109/CCNC49033.2022.9700683.
- Chang, S.-H. H., & Smith, R. A. (2008). Effectiveness of Personal Interaction in a Learner-Centered Paradigm Distance Education Class Based on Student Satisfaction. *Journal of Research on Technology in Education*, 40(4), 407–426. <https://doi.org/10.1080/15391523.2008.10782514>

- Chiang, H.-M., Ni, X., & Lee, Y.-S. (2017). Life skills training for middle and high school students with autism.” *Journal of autism and developmental disorders*, 47(4), 1113–1121. <https://doi.org/10.1007/s10803-017-3028-1>
- Chong, L. (2016, May 6). *Strategies for Including Students with Autism Spectrum Disorder in Mainstream Classrooms*. Scholaris.ca. <https://utoronto.scholaris.ca/items/352e7709-b2f9-499f-82a9-cc4aa295987c>
- Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review*, 3(3), 149–210. doi:10.1007/BF01320076
- Cook, A., & Ogden, J. (2021). Challenges, strategies and self-efficacy of teachers supporting autistic pupils in contrasting school settings: a qualitative study. *European Journal of Special Needs Education*, 37(3), 1–15. <https://doi.org/10.1080/08856257.2021.1878659>
- Colin Gibson, R., D. Dunlop, M., and Bouamrane, M.-M. (2020). Lessons from Expert Focus Groups on how to Better Support Adults with Mild Intellectual Disabilities to Engage in Co-Design. *The 22nd International ACM SIGACCESS Conference on Computers and Accessibility*, [Virtual Event Greece October 26 - 28, 2021](#), 1–12.
- Congress of the Philippines. (1992 March 24). RA 7277 – *An Act Providing For The Rehabilitation, Self-Development And Self-Reliance Of Disabled Person And Their Integration Into The Mainstream Of Society And For Other Purposes*. National Council on Disability Affairs. <https://www.ncda.gov.ph/disability-laws/republic-acts/republic-act-7277/>
- Congress of the Philippines (2013 April 23). RA 10524 – *An Act Expanding The Positions Reserved For Persons With Disability, Amending For The Purpose Republic Act No. 7277, As Amended, Otherwise Known As The Magna Carta For Persons With Disability*. National Council on Disability Affairs. <https://www.ncda.gov.ph/disability-laws/republic-acts/republic-act-no-10524-an-act-expanding-the-positions-reserved-for-persons-with-disability-amending-for-the-purpose-republic-act-no-7277-as-amended-otherwise-known-as-the-magna-carta-for-persons/>
- Congress of the Philippines (1982 December 7). Batas Pambansa Blg. 344 – *An Act to Enhance the Mobility of Disabled Persons by Requiring Certain Buildings, Institutions, Establishments and Public Utilities to install Facilities and Other Devices*. National Council on Disability Affairs. <https://www.ncda.gov.ph/disability-laws/batas-pambansa/batas-pambansa-blg-344/>
- Congress of the Philippines (2022 March 11). *Republic Act No. 11650. An Act Instituting a Policy of Inclusion and Services for Learners with Disabilities in Support of Inclusive Education*. GovPh. <https://mirror.officialgazette.gov.ph/2022/03/11/republic-act-no-11650/>

- Çorlu, D., Taşel, S., Turan, S., Gatos, A., Yantaç A. (2017). Involving Autistics in User Experience Studies: A Critical Review, *DIS '17: Proceedings of the 2017 Conference on Designing Interactive Systems*, Association for Computing Machinery, pp. 43–55. <https://doi.org/10.1145/3064663.3064771>
- Country context | UNIDO. (2020). UNIDO. <https://www.unido.org/sub-sites/unido-worldwide/asia-and-pacific/offices/philippines/country-context>
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.
- Cox, K. (2022). *Business analysis, requirements, and project management: A guide for computing students*. CRC Press. <https://doi.org/10.1201/9781003168119>
- Cruz-Torres, E., Duffy, M., Brady, M., Bennett, K. & Goldstein, P. (2019). Promoting daily living skills for adolescents with autism spectrum disorder via parent delivery of video prompting. *Journal of autism and developmental disorders*, 50 (1), 212-223. 10.1007/s10803-019-04215-6
- Cuaresma, C. D., Tan, A. F. & Trinidad, K. (2014). Emotional Intelligence, Attachment Style and Lived Experiences of Fathers with Children with Special Needs: A Descriptive Study. *ANTORCHA*, 1(1).
- Cuascota, L.; Pachacama, P., & Guerrero, G. (2020). A context aware application to support the execution of daily tasks of people with cognitive disabilities. *Paper presented at 2020 15th Iberian conference on information systems and technologies (CISTI), Seville, Spain*. 10.23919/CISTI49556.2020.9141076.
- DaCosta, B., and Seok, S. (2010a). Managing Cognitive Load in the Design of Assistive Technology for Those with Learning Disabilities. In Seok, S., Meyen, E., and DaCosta, B. *Handbook of Research on Human Cognition and Assistive Technology: Design, Accessibility and Transdisciplinary Perspectives* (p.21-42). Medical Information Science Reference.
- DaCosta, B., and Seok, S. (2010b). Multimedia Design of Assistive Technology for Those with Learning Disabilities. In Seok, S., Meyen, E., and DaCosta, B. *Handbook of Research on Human Cognition and Assistive Technology: Design, Accessibility and Transdisciplinary Perspectives* (p.21-42). Medical Information Science Reference.

- Delafield-Butt, J., Trevarthen, C., Rowe, P., & Gillberg, C. (2019). Being misunderstood in autism: The role of motor disruption in expressive communication, implications for satisfying social relations. *Behavioral and Brain Sciences*, 42. <https://doi.org/10.1017/s0140525x1800242x>
- Dawe, M. (2007). “Let me show you what i want”: Engaging individuals with cognitive disabilities and their families in design. *CHI '07 Extended Abstracts on Human Factors in Computing Systems*, 2177–2182. <https://doi.org/10.1145/1240866.1240976>
- De Oliveira, C. & Tanner, B. (2023). The health care costs of caring for children and adolescents with autism spectrum disorder: A population-based analysis. *Research in Autism Spectrum Disorders*, 108, 102255–102255. <https://doi.org/10.1016/j.rasd.2023.102255>
- Dreesen, K., and Schepers, S. (2018). The roles of adult-participants in the back- and frontstage work of Participatory Design processes involving children, *Proceedings of the 15th Participatory Design Conference - Volume 1*, Association for Computing Machinery, pp.1-12. <https://doi.org/10.1145/3210586.3210602>
- Druin, A. (1999). Cooperative Inquiry: Developing New Technologies for Children with Children, *CHI '99: Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, Association for Computing Machinery, pp. 592–599. <https://doi.org/10.1145/302979.303166>
- Divan, G., Bhavnani, S., Leadbitter, K., Ellis, C., Dasgupta, J., Abubakar, A., Elsabbagh, M., Hamdani, S. U., Servili, C., Patel, V., & Green, J. (2021). Annual Research Review: Achieving universal health coverage for young children with autism spectrum disorder in low- and middle-income countries: a review of reviews. *Journal of Child Psychology and Psychiatry*, 62(5), 514–535. <https://doi.org/10.1111/jcpp.13404>
- Edmunds, S. R., Tagavi, D. M., Harker, C. M., DesChamps, T., & Stone, W. L. (2025). Quality of life in caregivers of toddlers with autism features. *Research in Developmental Disabilities*, 161, 104999. <https://doi.org/10.1016/j.ridd.2025.104999>
- European Parliament and Council of the European Union. (2016). *Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 (General Data Protection Regulation)*. Official Journal of the European Union, L119, 1–88. <https://eur-lex.europa.eu/eli/reg/2016/679/oj>
- Figma, Inc. (2025). *Figma* [Computer software]. Retrieved February 12, 2026, from <https://www.figma.com>
- Fini, C., Bardi, L., Bolis, D., Fusaro, M., Lisi, M. P., Michalland, A. H., & Era, V. (2023). *The social roots of self development: From a bodily to an intellectual interpersonal dialogue*. *Psychological Research*, 87, 1683–1695. <https://doi.org/10.1007/s00426-022-01785-6>
- Florentino, E. M., Gabest, C. M., Galang, L. B., Mozo, M. A., Quimba Jr, E. D., Sakthikumar

- Pai, A. , Salonga, G. S., Shashi, S. , Silva, R. B., Sivaji, P. , Umpa, S. P., Valdez, C. L., Varma, M. , Villanueva, J. M., Yaptangco, J. E. & Raboc, M. B. (2022). “Ilaw ng Tahanan”: A Phenomenological Study of the Lived Experiences of Mothers Raising a Child with Autism Spectrum Disorder. *Philippine Scientific Journal*, 55(1), 29-36.
- Flores, J. G. (2023). Extent Use of Video Modeling Strategies in Teaching Daily Living Skills to Students with Autism Spectrum Disorder. *AIDE Interdisciplinary Research Journal*, 3, 269–278. <https://doi.org/10.56648/aide-irj.v3i1.68>
- Frauenberger C., Good, J., Fitzpatrick G., Iversen, O. (2015). In pursuit of rigour and accountability in participatory design. *Int. J. Human-Computer Studies*, 74, pp. 93–106. <http://dx.doi.org/10.1016/j.ijhcs.2014.09.004>
- Frauenberger, C., Makhaeva, J., Spiel, K., (2017). Blending Methods: Developing Participatory Design Sessions for Autistic Children, *16th International ACM Conference on Interaction Design and Children*, Association for Computing Machinery, pp.39-49. <http://dx.doi.org/10.1145/3078072.3079727>
- Frauenberger,C., Makhaeva,J. and Spiel, K. (2016). Designing Smart Objects with Autistic Children Four Design Exposès, *CHI '16: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, Association for Computer Machinery, pp. 130-139. <http://dx.doi.org/10.1145/2858036.2858050>
- Frith, U., & Happé, F. (1994). Autism: beyond “theory of mind.” *Cognition*, 50(1-3), 115–132. [https://doi.org/10.1016/0010-0277\(94\)90024-8](https://doi.org/10.1016/0010-0277(94)90024-8)
- Fong, V. C., McLaughlin, J., Schneider, M., & Bruno, G. (2024). Comparing the autism service needs and priorities of Indigenous and newcomer families in Canada: Qualitative insights. *Research in Autism Spectrum Disorders*, 111, 102314. <https://doi.org/10.1016/j.rasd.2023.102314>
- Fong, M., Kaner, E., Rowland, M., Graham, H., McEvoy, L., Hallsworth, K., Gabriel Grizzo Cucato, Gibney, C., Nedkova, M., Prentis, J., & Madigan, C. (2023). The effect of preoperative behaviour change interventions on pre- and post-surgery health behaviours, health outcomes, and health inequalities in adults: A systematic review and meta-analyses. *PLOS ONE*, 18(7), e0286757–e0286757. <https://doi.org/10.1371/journal.pone.0286757>
- Geurts, H. M., de Vries, M., & van den Bergh, S. F. W. M. (2013). Executive Functioning Theory and Autism. *Handbook of Executive Functioning*, 121–141. https://doi.org/10.1007/978-1-4614-8106-5_8
- Gioia, D.A., Corley, K.G. & Hamilton, A.L. 2012. Seeking qualitative rigor in inductive research: notes on the Gioia methodology. *Organizational Research Methods*, 16(1) 15-31.

- Grant, M.J. and Booth, A. (2009), A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26: 91-108. DOI: 10.1111/j.1471-1842.2009.00848.x
- Gray, D. E. (1993). Perceptions of stigma: the parents of autistic children. *Sociology of Health and Illness*, 15(1), 102–120. <https://doi.org/10.1111/1467-9566.ep11343802>
- Gorlin, J., McAlpine, C., Garwick, A., & Wielding, E. (2016). Severe childhood autism: The family lived experience. *Journal of pediatric nursing* 31(2016), 580-597. 10.1016/j.pedn.2016.09.002.
- Government of Canada. (2021, February 24). *Building Understanding: The First Report of the National Advisory Council on Poverty*. www.canada.ca. <https://www.canada.ca/en/employment-social-development/programs/poverty-reduction/national-advisory-council/reports/2020-annual.html>
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Sage Publications, Inc.
- Gulsrud, A., Lee, H. S., Hassrick, E. M., Iadarola, S., Pellecchia, M., Shih, W., Vejnaska, S., Morgan, E. H., Hochheimer, S., Crabbe, S., Li, J., Hauptman, L., Castellon, F., Nuske, H., Garcia, C., King, R., Luelmo, P., Carley, K., Smith, T., & Mandell, D. (2021). It's who you know: Caregiver social networks predict service use among under-resourced children with autism. *Research in Autism Spectrum Disorders*, 88, 101843. <https://doi.org/10.1016/j.rasd.2021.101843>
- Halder, S., Bruyere, S. M., & Gower, W. S. (2023). Perceived Strengths of Autistic People and Roadmap for Intervention. *The Routledge Handbook of Inclusive Education for Teacher Educators*, 191–205. <https://doi.org/10.4324/9781003266068-14>
- Hall, J. Gaved, M & Sargent. (2021). Participatory Research Approaches in Times of Covid-19: A Narrative Literature Review. *International Journal of Qualitative Methods*, 20: 1–15. DOI: 10.1177/16094069211010087
- Hasson, L., Keville, S., Gallagher, J., Onagbesan, D., & Ludlow, A. K. (2022). Inclusivity in Education for Autism Spectrum disorders: Experiences of Support from the Perspective of parent/carers, School Teaching Staff and Young People on the Autism Spectrum. *International Journal of Developmental Disabilities*, 70(2), 201–212. <https://doi.org/10.1080/20473869.2022.2070418>
- Hedges, S & AFIRM Team. (2018). *Technology-aided Instruction & Intervention*. Chapel Hill, NC: National Professional Development Center on Autism Spectrum Disorders, FPG Child Development Center, University of North Carolina. Retrieved from <http://afirm.fpg.unc.edu/Technology-aided-instruction-and-intervention>

- Hennink, M., Hutter, I., & Bailey, A. (2020). *Qualitative research methods, 2nd ed.* Thousand Oaks, CA: Sage.
- Hersh, M. (2016). Designing effective learning technologies for autistic people. *Paper presented at ICCHP 2016, part I, LNCS 9758, Linz, Austria.* 10.1007/978-3-319-41264-1_64
- Happé, F., & Frith, U. (2006). The Weak Coherence Account: Detail-focused Cognitive Style in Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, 36(1), 5–25. <https://doi.org/10.1007/s10803-005-0039-0>
- Hoffman, K., & Falcomata, T. S. (2014). An evaluation of resurgence of appropriate communication in individuals with autism who exhibit severe problem behavior. *Journal of Applied Behavior Analysis*, 47(3), 651–656. <https://doi.org/10.1002/jaba.144>
- Holtgraves, T. M., & Kashima, Y. (2008). *Language, meaning, and social cognition. Personality and Social Psychology Review*, 12(1), 73–94. <https://doi.org/10.1177/1088868307309605>
- Horrell, T., McMillan, D. E., Schultz, A. S. H., & Thompson, G. (2018). Understanding access to healthcare among Indigenous peoples: A comparative analysis of biomedical and postcolonial perspectives. *Nursing Inquiry*, 25(3). <https://doi.org/10.1111/nin.12237>
- Howard, T., Venkatasubramanian, K., Skorinko, J., Bosma, P., Mullaly, J., Kelly, B., Lloyd, D., Wishart, M., Alves, M., Jutras, J., Freark, M., & Alterio, N. (2021). Designing an app to help individuals with intellectual and developmental disabilities to recognize abuse. Paper presented at *the 23rd international ACM SIGACCESS conference on computers and accessibility, New York.* 10.1145/3441852.3471217
- Hughes, M. M., Shaw, K. A., DiRienzo, M., Durkin, M. S., Esler, A., Hall-Lande, J., Wiggins, L., Zahorodny, W., Singer, A., & Maenner, M. J. (2023). The Prevalence and Characteristics of Children With Profound Autism, 15 Sites, United States, 2000–2016. *Public Health Reports*, 138(6), 003335492311635. <https://doi.org/10.1177/00333549231163551>
- Huh, Y., & Reigeluth, C. M. (2017). Self-Regulated Learning: The Continuous-Change Conceptual Framework and a Vision of New Paradigm, Technology System, and Pedagogical Support. *Journal of Educational Technology Systems*, 46(2), 191–214. <https://doi.org/10.1177/0047239517710769>
- Hus, Y. (2023). Frozen in Time, a Focused Review of Autism Prevalence in Canadian Indigenous Communities. *Neuropsychiatric Disease and Treatment*, Volume 19, 2451–2468. <https://doi.org/10.2147/ndt.s439450>
- International Electrotechnical Commission. (2006). *IEC 62304: Medical device software—Software life cycle processes.* IEC. <https://webstore.iec.ch/publication/6792>

- Imanpour, S., McGehee, A., & McMaughan, D. J. (DJ). (2025). “As immigrants we are all lost in our autism journey”: Experiences of raising children with autism, barriers to equal access, and facilitators to accessing autism services among immigrant fathers. *Research in Autism*, 124, 202588. <https://doi.org/10.1016/j.reia.2025.202588>
- International Organization for Standardization. (2016). *ISO 13485:2016: Medical devices—Quality management systems—Requirements for regulatory purposes*. ISO. <https://www.iso.org/standard/59752.html>
- Jaffal, A. M. (2022). Barriers general education teachers face regarding the inclusion of students with autism. *Frontiers in Psychology*, 13(1). <https://doi.org/10.3389/fpsyg.2022.873248>
- Ji, B., Batubara, I. M. S., Batten, J., Peng, X., Chen, S., & Ni, Z. (2025). Digital health solution Interventions Targeting Psychological Health in Parents of Children With Autism Spectrum Disorder: Protocol for a Scoping Review. *JMIR Research Protocols*, 14, e68677. <https://doi.org/10.2196/68677>
- Joseph, R. M., & Tager-Flushberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Development and Psychopathology*, 16(01). <https://doi.org/10.1017/s095457940404444x>
- Kamaruzaman, M., Rani, B., Nor H., and Azahari, M. (2016). Developing user interface design application for children with autism. *Procedia - Social and Behavioral Sciences*, 217, pp. 887 – 894. <https://doi.org/10.1016/j.sbspro.2016.02.022>
- Kellems, R., Rickard, T., Okray, D., Sauer-Sagiv, L., & Washburn, B. (2018). iPad video prompting to teach young adults with disabilities independent living skills: A maintenance study. *Career development and transition for exceptional individuals*, Vol. 41(3), 175–184. <https://doi.org/10.1177/2165143417719078>
- Khan, A., Li, K. & Madden, J. (2018). Mobile aid to assist with care decisions in children with autism spectrum disorder (ASD). *Journal of healthcare engineering*, 2018, 1-7. [10.1155/2018/9703101](https://doi.org/10.1155/2018/9703101)
- Khanlou, N., Haque, N., Mustafa, N., Vazquez, L. M., Mantini, A., & Weiss, J. (2017). Access Barriers to Services by Immigrant Mothers of Children with Autism in Canada. *International Journal of Mental Health and Addiction*, 15(2), 239–259. <https://doi.org/10.1007/s11469-017-9732-4>
- Kilag, O. K., Uy, F., Kilag, O. K., & Arcilla Jr, A. (2024). Empowering education: A learning-goals-centric approach to curriculum development. *International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence (IMJRIS)*, 1(2), 332–339.

- Kilincaslan, A., Kocas, S., Bozkurt, S., Kaya, I., Derin, S., & Aydin, R. (2019). Daily living skills in children with autism spectrum disorder and intellectual disability: A comparative study from Turkey. *Research in Developmental Disabilities*, 85, 187–196. <https://doi.org/10.1016/j.ridd.2018.12.005>
- Kim, S. Y., Crowley, S., & Lee, Y. S. (2021). A Scoping Review of Technology-Based Vocational Interventions for Individuals with Autism. *Career Development and Transition for Exceptional Individuals*, 45(1), 44–56. <https://doi.org/10.1177/21651434211041608>
- Kim, C. K., Hardy, J. K., & Corr, C. (2024). Early Childhood Teachers' Perceptions, Experiences, and Needs Related to the Inclusion of Autistic Children in a Developing Country. *Topics in Early Childhood Special Education*. <https://doi.org/10.1177/02711214241296388>
- Koppenhaver, D. A., & Erickson, K. A. (2003). Natural emergent literacy supports for preschoolers with autism and severe communication impairments. *Topics in Language Disorders*, 23(4), 283–292.
- Koumpouros, Y., & Kafazis, T. (2019). Wearables and mobile technologies in autism spectrum disorder interventions: A systematic literature review. *Research in Autism spectrum disorders*, 66, 1-25. <https://doi.org/10.1016/j.rasd.2019.05.005>
- Kriara, L., Hipp, J., Chatham, C., Nobbs, D., Slater, D., Lipsmeier, F., & Lindemann, M. (2021). Beacon-based remote measurement of social behaviour in ASD clinical trials: A technical feasibility assessment. *Sensors*, 2021 (21), 1-17. <https://doi.org/10.3390/s21144664>
- Kuwabara, A., Su, S., & Krauss, J. (2020). Utilizing Digital health solution Technologies for Patient Education in Lifestyle Medicine. *American Journal of Lifestyle Medicine*, 14(2), 137–142. <https://doi.org/10.1177/1559827619892547>
- Ladaga, N. M. (2023). Implementation of Select Evidence-Based Practices for Students with Autism Spectrum Disorder (AS. *AIDE Interdisciplinary Research Journal*, 2, 67–83. <https://doi.org/10.56648/aide-irj.v2i1.18>
- Lanter, E., Watson, L. R., Erickson, K. A., & Freeman, D. (2012). Emergent literacy in children with autism: An exploration of developmental and contextual dynamic processes. *Language, Speech, and Hearing Services in Schools*, 43(3), 308–324. [https://doi.org/10.1044/0161-1461\(2012/10-0083\)](https://doi.org/10.1044/0161-1461(2012/10-0083))
- Lawrence, K. (2022). Digital health solution Equity. In S. L. Linwood (Ed.), *Digital health solution*. Exon Publications. <https://doi.org/10.36255/exon-publications-digital-health-health-equity>

- Leaf, J. (2017). Assessment of Adaptive Behavior and Autism Spectrum Disorder. In Leaf, J.B., *Handbook of Social Skills and Autism Spectrum Disorder*, Autism and Child Psychopathology Series, 109, Springer International Publishing.
- Lecheler, M., Lasser, J., Vaughan, P. W., Leal, J., Ordetx, K., & Bischofberger, M. (2020). A Matter of Perspective: An Exploratory Study of a Theory of Mind Autism Intervention for Adolescents. *Psychological Reports*, 124(1), 003329411989812. <https://doi.org/10.1177/0033294119898120>
- Lewis, Mirasol & Pinili, Lilibeth & Linos, Dale. (2024). Article Exploring Teacher Awareness and Challenges in Managing Autism Spectrum Disorder (ASD) Behaviors in Inclusive Education Settings. 114-123.
- Leosala, L. (2023). Meeting the Needs of Children with Autism Spectrum Disorder: Early Intervention Experiences of Filipino Parents. *Zenodo (CERN European Organization for Nuclear Research)*. <https://doi.org/10.5281/zenodo.8191312>
- Loth, E., Gómez, J. C., & Happé, F. (2007). Event Schemas in Autism Spectrum Disorders: The Role of Theory of Mind and Weak Central Coherence. *Journal of Autism and Developmental Disorders*, 38(3), 449–463. <https://doi.org/10.1007/s10803-007-0412-2>
- Lu, Z. (2011). ZigADL: An ADL Training system enabling teachers to assist children with intellectual disabilities. *Paper presented at the proceedings of the 13th international ACM SIGACCESS conference on computers and accessibility, New York: October 24-26, 2011*. <https://doi.org/10.1145/2049536.2049633>
- Maich, K., Rutherford, C. & Bishop, C. (2019). Phones, watches, and apps: Engaging everyday mobile assistive technology for adults with intellectual and/or developmental disabilities. *Exceptionality education international*, 29(1), 116-135.
- Magallanes, C. A., Dulan, J. B. A., Masiado, P. E., Pasaol, K. F., & Ignacio, D. F. (2025). The experiences of SPED teachers from rural areas in handling students with special needs. *Journal of Interdisciplinary Perspectives*, 3(8), 15–27. <https://doi.org/10.69569/jip.2025.270>
- Magsambol, N. (2022 March 15). *Duterte signs law on inclusive education for students with disabilities*. Rappler. <https://www.rappler.com/nation/duterte-signs-law-inclusive-education-students-disabilities/>
- Makhaeva, J., Frauenberger, C., Spiel, K. (2016). Creating Creative Spaces for Co-Designing with Autistic Children - The Concept of a “Handlungsspielraum”. *PDC '16: Proceedings of the 14th Participatory Design Conference: Full papers – Volume 1*, Association for Computing Machinery, pp. 51–60. <https://doi.org/10.1145/2940299.2940306>

- Mangonon, I. A. (2023). Extent of Compliance of Public Schools in the Implementation of Curriculum for Children with Autism in Sarangani, Philippines. *AIDE Interdisciplinary Research Journal*, 3, 216–228. <https://doi.org/10.56648/aide-irj.v3i1.64>
- Mangafa, C., Moody, L., Woodcock, A., & Woolner, A. (2015). Teachers' experiences of developing joint attention skills in children with autism using iPads. Paper presented at 7th edulearn international conference on education and new learning technologies, Barcelona, Spain.
- Mapa, D. (2021 July 07). 2020 Census of Population and Housing (2020 CPH) Population Counts Declared Official by the President. Philippine Statistics Authority. <https://psa.gov.ph/ndps/disability-survey-id/138567>
- Mapa, D. (2022 August 15). Proportion of Poor Filipinos was Recorded at 18.1 Percent in 2021. Philippine Statistics Authority. <https://psa.gov.ph/content/proportion-poor-filipinos-wasrecorded-181-percent-2021>
- Mason, D., McConachie, H., Garland, D., Petrou, A., Rodgers, J., & Parr, J. R. (2018). Predictors of quality of life for autistic adults. *Autism research*, 11(8), 1138–1147. <https://doi.org/10.1002/aur.1965>
- Matson, J. L., Wilkins, J., & Macken, J. (2008). The Relationship of Challenging Behaviors to Severity and Symptoms of Autism Spectrum Disorders. *Journal of Mental Health Research in Intellectual Disabilities*, 2(1), 29–44. <https://doi.org/10.1080/19315860802611415>
- Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press. <https://doi-org.proxy.bib.uottawa.ca/10.1017/CBO9780511811678>
- Mccombs, B. L., & Vakili, D. (2005). A Learner-Centered Framework for E-Learning. *Teachers College Record*, 107(8), 1582–1600. <https://doi.org/10.1111/j.1467-9620.2005.00534.x>
- McConkey, R. (2022). Responding to Autism in Low and Middle Income Countries (Lmic): What to Do and What Not to Do. *Brain Sciences*, 12(11), 1475. <https://doi.org/10.3390/brainsci12111475>
- McDougal, E., Riby, D. M., & Hanley, M. (2020). Teacher Insights into the Barriers and Facilitators of Learning in Autism. *Research in Autism Spectrum Disorders*, 79(79), 1–9. <https://doi.org/10.1016/j.rasd.2020.101674>
- Meadan, H., Snodgrass, M. R., Meyer, L. E., Fisher, K. W., Chung, M. Y., & Halle, J. W. (2016). Internet-Based Parent-Implemented Intervention for Young Children With

- Autism. *Journal of Early Intervention*, 38(1), 3–23.
<https://doi.org/10.1177/1053815116630327>
- Memari, A. H., Panahi, N., Ranjbar, E., Moshayedi, P., Shafiei, M., Kordi, R., & Ziaee, V. (2015). Children with Autism Spectrum Disorder and Patterns of Participation in Daily Physical and Play Activities. *Neurology Research International*, 2015, 1–7.
<https://doi.org/10.1155/2015/531906>
- Microsoft. (2025). *Microsoft Teams* (Version 2025) [Computer software]. Microsoft Corporation. <https://www.microsoft.com/en/microsoft-teams/>
- Microsoft. (2025). *Microsoft Outlook* (Version 2025) [Computer software]. Microsoft Corporation. <https://www.microsoft.com/en/microsoft-365/outlook/email-and-calendar-software-microsoft-outlook>
- Miguel, D. M. (2020). Teaching Practices for Children with Autism (CWA) at Baguio SPED Center. *Mountain Journal of Science and Interdisciplinary Research (Formerly Benguet State University Research Journal)*, 80(2), 55–71.
- Millau, M., Rivard, M., Mercier, C., & Mello, C. (2016). *Parenting Stress in Immigrant Families of Children With an Autism Spectrum Disorder: A Comparison With Families From the Host Culture*. <https://doi.org/10.4087/dsri4175>
- Miller, S. A. (2022). Advanced Theory of Mind. In *Oxford University Press eBooks*. Oxford University Press. <https://doi.org/10.1093/oso/9780197573174.001.0001>
- Miles, M.B., Huberman, A.M. & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook, 4th ed.* Thousand Oaks, California: Sage.
- Mintz, J. (2014). The role of user emotional attachment in driving the engagement of children with autism spectrum disorders (ASD) in using a smartphone app designed to develop social and life skill. *Paper presented at international conference on computers for handicapped persons, Paris France*. 10.1007/978-3-319-08596-8_76
- Mintz, J. (2013). Additional key factors mediating the use of a mobile technology tool designed to develop social and life skills in children with autism spectrum disorders: Evaluation of the 2nd HANDS prototype. *Computers & education*, 63 (2013), 17-27.
 10.1016/j.compedu.2012.11.006
- Mintz, J., Branch, C., March, C., & Lerman, S. (2012). Key factors mediating the use of a mobile technology tool designed to develop social and life skills in children with Autistic Spectrum Disorders. *Computers & education*, 58 (1), 53-62.
 10.1016/j.compedu.2011.07.013
- Mira Gobbo, M., Barbosa, C., Morandini, M., Mafort F., & Mioni, J. (2021). ACA game for

- individuals with autism spectrum disorder. *Entertainment computing*, 38(2021), 1-10. <https://doi.org/10.1016/j.entcom.2021.100409>
- Miro. (2025). *Miro: Online collaborative whiteboard platform*. Retrieved February 12, 2026, from <https://miro.com>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS medicine*, 6 (7), 1-6. <https://doi.org/10.1080/09638288.2020.1785023>
- Moreno. G. Moreira, F., Collazos, C., and Fardoun, H. (2020). Recommendations for the design of inclusive apps for the treatment of autism. An approach to design focused on inclusive users, *2020 15th Iberian Conference on Information Systems and Technologies (CISTI)*, IEEE, pp. 1-6. DOI: 10.23919/CISTI49556.2020.9140816
- Morisse, F., Vandemaele, E., Claes, C., Claes, L., & Vandeveldel, S. (2013). Quality of life in persons with intellectual disabilities and mental health problems: An explorative study. *The scientific world journal*. <https://doi.org/10.1155/2013/491918>
- Morrison, G., Ross, S., Kemp, J. & Kalman, H. (2010). *Designing effective instruction*. NY: John Wiley & Sons.
- Mottron, L., Dawson, M., Soulières, I., Hubert, B., & Burack, J. (2006). Enhanced Perceptual Functioning in Autism: An Update, and Eight Principles of Autistic Perception. *Journal of Autism and Developmental Disorders*, 36(1), 27–43. <https://doi.org/10.1007/s10803-005-0040-7>
- Mourière, A., & McKim, J. (Eds.). (2018). *Integrating intensive interaction: Developing communication practice in services for children and adults with severe learning difficulties, profound and multiple learning difficulties and autism*. Routledge.
- Mpangane, E., Maepa, M. P., & Muhadisa, T. (2024). Challenges Faced by Newly Appointed Teachers at Autism- specific School: A Thematic Analysis Study. *The Open Public Health Journal*, 17(1). <https://doi.org/10.2174/0118749445322081241114104043>
- Msonde, S. E. (2021). Revisiting the Idea of Learner-Centered Pedagogy: The Theoretical Perspective. *Journal of Education*, 203(2), 002205742110319. <https://doi.org/10.1177/00220574211031970>
- Munn, Z., Peters, M., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC med res methodology*, (19)18, 1 - 143. 10.1186/s12874-018-0611-x.

- Myburgh, L., Condy, J., & Barnard, E. (2020). Pedagogical approaches to develop social skills of learners with autism spectrum disorder: Perceptions of three foundation phase teachers. *Perspectives in Education*, 38(2), 241–254. <https://doi.org/10.18820/2519593X/pie.v38.i2.16>
- Naithani, L., Sangwan, P., Roy, S. G., Menon, S., Azar, Z., Lakhera, S., Kumar, D., Abhilashi, M. K., Roy, R., Vajaratkar, V., Taylor, C., Patel, V., Green, J., & Divan, G. (2022). From engagement to competency: The pathway to making disability naïve frontline workers competent in the delivery of an evidence-based autism intervention in New Delhi, India. *Frontiers in Psychiatry*, 13. <https://doi.org/10.3389/fpsyt.2022.903341>
- National Council on Disability Affairs. (n.d.). *An Act to Enhance the Mobility of Disabled Persons by Requiring Certain Buildings, Institutions, Establishments and Public Utilities to install Facilities and Other Devices – Batas Pambansa Blg. 344* | National Council on Disability Affairs. National Council on Disability Affairs. <https://ncda.gov.ph/disability-laws/batas-pambansa/batas-pambansa-blg-344/>
- Nielsen Norman Group. (2025). *Design thinking: A definition*. Retrieved February 12, 2026, from <https://www.nngroup.com/articles/design-thinking/>
- Ning, M., Daniels, J., Schwartz, J., Dunlap, K., Washington, P., Kalantarian, H., Du, M., & Wall, D. P. (2019). Identification and Quantification of Gaps in Access to Autism Resources in the United States: An Infodemiological Study. *Journal of Medical Internet Research*, 21(7), e13094. <https://doi.org/10.2196/13094>
- Øhrstrøm, P. (2011). Helping autism-diagnosed teenagers navigate and develop socially using e-learning based on mobile persuasion. *International review of research in open and distance learning*, 12(4), 54–71. <https://doi.org/10.19173/irrodl.v12i4.878>
- Okwara, F. N. O., & Donald, K. A. (2024). Caregiver perspectives, experiences and service satisfaction, and health service utilization among families of children with developmental disorders at a tertiary center in a low-resource setting. *Research in Autism Spectrum Disorders*, 110, 102285. <https://doi.org/10.1016/j.rasd.2023.102285>
- Silveira-Zaldivara, T., Özerk, G., & Özerk, K. (2021). Developing social skills and social competence in children with autism. *International Electronic Journal of Elementary Education*, 13(3), 341–363. <https://doi.org/10.26822/iejee.2021.195>
- Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive Function Deficits in High-Functioning Autistic Individuals: Relationship to Theory of Mind. *Journal of Child Psychology and Psychiatry*, 32(7), 1081–1105. <https://doi.org/10.1111/j.1469-7610.1991.tb00351.x>

- Paas, F., & Sweller, J. (2012). An evolutionary upgrade of cognitive load theory: Using the human motor system and collaboration to support the learning of complex cognitive tasks. *Educational Psychology Review*, 24(1), 27-45.
- Paivio, A. (2014). Intelligence, dual coding theory, and the brain. *Intelligence*, 47(1), 141–158. <https://doi.org/10.1016/j.intell.2014.09.002>
- Papademetris, X., Quraishi, A. N., & Licholai, G. P. (2022). *Introduction to medical software : foundations for digital health solution, devices, and diagnostics*. Cambridge University Press.
- Pascua, N. M. C., & Dizon, C. A. (2022). Recurring Emotions and Coping Mechanisms of Parents with Children having Autism. In M. Shelley & I. Sahin (Eds.), *Studies on Education, Science, and Technology 2021* (pp. 147-184). ISTES Organization.
- Patrick, M. E., Williams, A. R., Shaw, K. A., Durkin, M., Hall-Lande, J., Vehorn, A., & Hughes, M. (2025). Social vulnerability and the prevalence of autism spectrum disorder among 8-year-old children, Autism and Developmental Disabilities Monitoring Network, 2020. *Annals of Epidemiology*, 104, 8–14. <https://doi.org/10.1016/j.annepidem.2025.02.014>
- Pavlov, N. (2014). User Interface for People with Autism Spectrum Disorders. *Journal of Software Engineering and Applications*, 7, pp.128-134. <http://dx.doi.org/10.4236/jsea.2014.72014>
- Petersson-Bloom, L., & Holmqvist, M. (2022). Strategies in Supporting Inclusive Education for Autistic students—A Systematic Review of Qualitative Research Results. *Autism & Developmental Language Impairments*, 7(1), 1–15. <https://doi.org/10.1177/23969415221123429>
- Philippine Statistics Authority. (2021, July 7). *2020 Census of Population and Housing (2020 CPH): Population counts declared official by the President*. <https://psa.gov.ph/statistics/poverty/node/167972>
- Philippine Statistics Authority. (2022, August 15). *Proportion of poor Filipinos was recorded at 18.1 percent in 2021*. <https://psa.gov.ph/statistics/poverty/node/167972>
- Poovizhi,P., Immanuel, D., Subramani, K., Dhavamani, L., Dhanapal, R. (2022). M-Learning First Word Android Application to support Autistic Children with their Education, 2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS), IEEE, pp. 411- 417. DOI: 10.1109/ICAIS53314.2022.9742808
- Prez-Fuster,P., Sevilla,J., & Herrera, G. (2019). Enhancing daily living skills in four adults with autism spectrum disorder through an embodied digital technology-mediated intervention. *Research in autism spectrum disorders*, 58 (2019), 54-67. 10.1016/j.rasd.2018.08.006

- Quilendrino, M. I. O., Castor, M. A. R., Mendoza, N. R. N. P., Veal, J. R., & Castillo-Carandang, N. T. (2015). Parents' perceptions of autism and their health-seeking behaviors. *Clinical Epidemiology and Global Health*, 3, S10–S15. <https://doi.org/10.1016/j.cegh.2015.11.003>
- Qu, L., Liu, Q., Zheng, S., Zhou, A., Yin, T., Zhang, Y., Wang, X., Colombi, C., & Ulrich, D. (2025). From first concern to autism diagnosis: Parental experiences and satisfaction in autism identification in China. *Research in Autism*, 123, 202544. <https://doi.org/10.1016/j.reia.2025.202544>
- Rahman, A., and Hamdani, S. (2018). Supporting Intervention Providers and Families in South Asia. In Siller, M., Morgan, L. *Handbook of Parent-Implemented Interventions for Very Young Children with Autism* (393-402). Springer.
- Rea, H., LaMotte, K., & Burrell, T. L. (2018). What Is Autism Spectrum Disorder? *Handbook of Parent-Child Interaction Therapy for Children on the Autism Spectrum*, 3–26. https://doi.org/10.1007/978-3-030-03213-5_1
- Reigeluth, Charles. (Ed.). (2013). Instructional-design theories and models: A new paradigm of instructional theory. NY: Routledge.
- Reis H., Eusbio, I., Sousa, M., Ferreira, M., Pereira, R., Dias, S. & Reis, C. (2021). Regul-a: A technological application for sensory regulation of children with autism spectrum disorder in the home context.” *International journal of environmental research and public health*, 18 (19), 1-11. 10.3390/ijerph181910452
- Republic Act No. 7277 | Senate of the Philippines Legislative Reference Bureau. (2022). Senate.gov.ph. <https://issuances-library.senate.gov.ph/legislative%20Bissuances/Republic%20Act%20No.%207277>
- Resurreccion, R. R. (2013). Best Practices of Parents and Interventionists of Children with Autism. *Philippine Journal of Counseling Psychology*, 15(1).
- Richardson, S., Lawrence, K., Schoenthaler, A. M., & Mann, D. (2022). A framework for digital health solution equity. *Npj Digital Medicine*, 5(1). <https://doi.org/10.1038/s41746-022-00663-0>
- Richmond, A. S., Morgan, R. K., Slattery, J. M., Mitchell, N. G., & Cooper, A. G. (2018). Project Syllabus: An Exploratory Study of Learner-Centered Syllabi. *Teaching of Psychology*, 46(1), 6–15. <https://doi.org/10.1177/0098628318816129>
- Robinson, S., Hannuna, S., and Metatla, O. (2020). Not On Any Map: Co-Designing a Meaningful Bespoke Technology with a Child with Profound Learning Difficulties, IDC '20: Proceedings of the Interaction Design and Children Conference,

- Association for Computing Machinery, pp. 135–147.
<https://doi.org/10.1145/3392063.3394427>
- Roxas, M., Hernandez, A., Francisco, M., Buenaventura, M., Valencia, M., Roxas, M., Hernandez, A., Francisco, M., Laarni, M., Buenaventura, D., & Siena, M. (2022). Analysis of the Lived Experiences of Filipino Parents of Children with ASD. *International Multidisciplinary Research Journal*, 4(2), 202–211.
<https://doi.org/10.54476/4216870>
- Russell, A., Scriney, A., & Smyth, S. (2022). Educator attitudes towards the inclusion of students with autism spectrum disorders in mainstream education: A systematic review. *Review Journal of Autism and Developmental Disorders*, 10(1). <https://doi.org/10.1007/s40489-022-00303-z>
- Sam, A. M., Cox, A. W., Savage, M., Waters, V., & Odom, S. L. (2019). Disseminating Information on Evidence-Based Practices for Children and Youth with Autism Spectrum Disorder: AFIRM. *Journal of Autism and Developmental Disorders*, 50(6), 1931–1940.
<https://doi.org/10.1007/s10803-019-03945-x>
- Schlebusch, L., Chambers, N., John-Joe Dawson-Squibb, Harty, M., Franz, L., & Petrus. (2020). Challenges and opportunities of implementing early interventions for autism spectrum disorders in resource-limited settings: A South African example. *Elsevier EBooks*, 99–132. <https://doi.org/10.1016/b978-0-12-819749-3.00005-1>
- Senate of the Philippines Legislative Reference Bureau. (2022). *Republic Act No. 7277*.
<https://issuances-library.senate.gov.ph/legislative%2Bissuances/Republic%20Act%20No.%207277>
- Senoo, E.J., Oti-Boadi, M., Efua Vivian Senoo-Dogbey, Ohenewa Josephine Bampoe, & Laari, L. (2024). Barriers to inclusive education of children with autism: Ghanaian teachers' perspective. *Discover Education*, 3(1). <https://doi.org/10.1007/s44217-024-00242-3>
- Shepley, S., Spriggs, A., Samudre, M., & Elliot, M. (2018). Increasing daily living independence using video activity schedules in middle school students with intellectual disability. *Journal of special education technology*, 33 (2), 71-82.
10.1177/0162643417732294
- Silveira-Zaldivara, T., Özerk, G., & Özerk, K. (2021). Developing social skills and social competence in children with autism. *International Electronic Journal of Elementary Education*, 13(3), 341–363. <https://doi.org/10.26822/iejee.2021.195>
- Sivayokan, B., Sivayokan, S., Kumanan, T., Sathiadas, G., & Sreeharan, N. (2023). Establishing a novel partnership model to deploy health services for children with autism in a low-

- resource setting – experience from Sri Lanka. *The Lancet Regional Health - Southeast Asia*, 100255. <https://doi.org/10.1016/j.lansea.2023.100255>
- Skillen, K., Donnelly, M., Nugent, C. & Booth, N., (2016). LifePal: A mobile self-management tool for supporting young people with autism. *Paper presented at XIV Mediterranean conference on medical and biological engineering and computing*, 016, Paphos, Cyprus. https://doi.org/10.1007/978-3-319-32703-7_228
- Shabalina, O. Guriev, V., Kosyakov, S., Voronina, A. & Moffat, D. (2019). Adaptable mobile software for supporting daily activities of people with intellectual disabilities. *Presented at CIT&DS 2019: Creativity in intelligent technologies and data science*, Volgograd, Russia. https://doi.org/10.1007/978-3-030-29750-3_37
- Shafi, F., Karunakaran, A., & Ahmad, F. (2024). Autism, Stigma, and South Asian Immigrant Families in Canada. *International Journal of Environmental Research and Public Health/International Journal of Environmental Research and Public Health*, 21(3), 369–369. <https://doi.org/10.3390/ijerph21030369>
- Smart, K. L., Witt, C., & Scott, J. P. (2012). Toward Learner-Centered Teaching. *Business Communication Quarterly*, 75(4), 392–403. <https://doi.org/10.1177/1080569912459752>
- Smith, K., Shepley, S., Alexander, J., Davis, A., & Ayres, K. (2015). Self-instruction using mobile technology to learn functional skills. *Research in autism spectrum disorders*, 11 (2015): 93-100. 10.1016/j.rasd.2014.12.001
- Sodian, B. Schuwerk, T., & Kristen, S. (2015). Implicit and Spontaneous Theory of Mind Reasoning in Autism Spectrum Disorders. *InTech EBooks*. <https://doi.org/10.5772/59393>
- SurveyMonkey. (2025). *SurveyMonkey: Online survey and form tool*. Retrieved February 12, 2026, from <https://www.surveymonkey.com>
- Sweller, J. (1988), Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science*, 12, 257-285. 10.1207/s15516709cog1202_4
- S.2561 - 100th Congress (1987-1988): *Technology-Related Assistance for Individuals With Disabilities Act of 1988*. (2019). Congress.gov. <https://www.congress.gov/bill/100th-congress/senate-bill/2561>
- Thiemann-Bourque, K. S., Brady, N. C., & Fleming, K. K. (2012). Symbolic play of preschoolers with severe communication impairments with autism and other developmental delays: More similarities than differences. *Journal of Autism and Developmental Disorders*, 42(5), 863–873. <https://doi.org/10.1007/s10803-011-1317-7>
- Topol, E. J. (2019). High-performance medicine: the Convergence of Human and Artificial Intelligence. *Nature Medicine*, 25(1), 44–56. <https://www.nature.com/articles/s41591-018-0300-7>

- Towle, H. (2015). *Disability and inclusion in Canadian education: Policies, procedures, and practices*. Canadian Electronic Library. <https://coilink.org/20.500.12592/jhqk64>
- Trentacosta, C. J., Irwin, J. L., Crespo, L. M., & Beeghly, M. (2018). Financial Hardship and Parenting Stress in Families with Young Children with Autism: Opportunities for Preventive Intervention. *Handbook of Parent-Implemented Interventions for Very Young Children with Autism*, 79–91. https://doi.org/10.1007/978-3-319-90994-3_5
- Ulgado, R., Nguyen, K., Custodio, V., Waterhouse, A., Weiner, R. & Hayes, G. (2013). VidCoach: A mobile video modeling system for youth with special needs. *Presented at IDC '13: Proceedings of the 12th international conference on interaction design and children*, New York. <https://doi.org/10.1145/2485760.2485870>
- United Nations Industrial Development Organization. (2020). *Country context: Philippines*. <https://www.unido.org/sub-sites/unido-worldwide/asia-and-pacific/offices/philippines/country-context>
- U.S. Congress. (1996). *Health Insurance Portability and Accountability Act of 1996 (HIPAA)*, Pub. L. No. 104–191. <https://www.govinfo.gov/content/pkg/PLAW-104publ191/pdf/PLAW-104publ191.pdf>
- Valencia, K., Rusu, C., Quiñones, D., & Jamet, E. (2019). The Impact of Technology on People with Autism Spectrum Disorder: A Systematic Literature Review. *Sensors*, 19(20), 4485. <https://doi.org/10.3390/s19204485>
- Van Laarhoven, T., Carreon, A., Bonneau, W., & Lagerhausen, A. (2018). Comparing mobile technologies for teaching vocational skills to individuals with autism spectrum disorders and/or intellectual disabilities using universally-designed prompting systems. *Journal of autism and developmental disorders*, 2018 (48), 2516–2529. <https://doi.org/10.1007/s10803-018-3512-2>
- Verbeeten, M. J. (2001). Learner-Centered? It's Just a Click Away.... *Journal of Educational Technology Systems*, 30(2), 159–170. <https://doi.org/10.2190/jlnf-p8uh-x2tn-mhm4>
- Vélez-Coto, M., Rodríguez-Fórtiz, M. J., Rodríguez-Almendros, M. L., Cabrera-Cuevas, M., Rodríguez-Domínguez, C., Ruiz-López, T., Burgos-Pulido, N., Garrido-Jiménez, I., & Martos-Pérez, J. (2017). SIGUEME: Technology-based intervention for low-functioning autism to train skills to work with visual signifiers and concepts. *Research in Developmental Disabilities*, 64, 25–36. <https://doi.org/10.1016/j.ridd.2017.02.008>
- Villamin, G., & Luppigini, R. (2024). Digital interventions using mobile technologies for life skills development of learners with autism spectrum disorder: a scoping review. *International Journal of Developmental Disabilities*, 1–14. <https://doi.org/10.1080/20473869.2024.2380947>

Vygotsky, L. S. (2019). *The general laws of child psychological development*. In L. S. Vygotsky's *pedological works* (pp. 85–103). Springer. https://doi.org/10.1007/978-981-15-0528-7_5

Vygotsky, L. S. (2021). *The concept of pedological age*. In L. S. Vygotsky's *pedological works* (Vol. 2, pp. 1–9). Springer. https://doi.org/10.1007/978-981-16-1907-6_1

Waizbard-Bartov E., Fein, D., Lord, C., & Amaral, D. G. (2024). Autism Severity and its Relationship to Disability. *Focus/Focus (American Psychiatric Publishing. Online)*, 22(2), 252–262. <https://doi.org/10.1176/appi.focus.24022007>

Wang, K. & Zhang, B. (2020). Using mobile augmented reality to improve attention in adults with autism spectrum disorder. *Paper presented at Conference on human factors in computing systems, HI Honolulu, April 25-30, 2020*. <https://doi.org/10.1145/3334480.3383090>

Watson, S. L., & Watson, W. R. (2011). The Role of Technology and Computer-Based Instruction in a Disadvantaged Alternative School's Culture of Learning. *Computers in the Schools*, 28(1), 39–55. <https://doi.org/10.1080/07380569.2011.552042>

Weng, P. and Bouck, E. (2019). Comparing the effectiveness of two app-based number lines to teach price comparison to students with autism spectrum disorders. *Disability and rehabilitation: Assistive technology*, 14(3), 281–291. <https://doi.org/10.1080/17483107.2018.1430869>

Williams, D. (2010). Theory of own mind in autism. *Autism*, 14(5), 474–494. <https://doi.org/10.1177/1362361310366314>

Wilkens, L. , Heitplatz ,V., & Bühler, C. (2021). Designing accessible videos for people with disabilities. *Presented at international conference on human-computer interaction, Berlin, Heidelberg*. https://doi.org/10.1007/978-3-030-78095-1_24

Wilson, C., Sitbon, L. Ploderer, B., Opie, J., Brereton, M. (2020). Self-Expression by Design: Co-Designing the ExpressiBall with Minimally-Verbal Children on the Autism Spectrum, *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, Association for Computing Machinery, pp.1–13. <https://doi.org/10.1145/3313831.3376171>

Wilson,C., Brereton,M., Ploderer,B., and Sitbon, L. (2019). Co-Design Beyond Words: ‘Moments of Interaction’ with Minimally-Verbal Children on the Autism Spectrum, *CHI '19: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Association for Computing Machinery, pp. 1–15 <https://doi.org/10.1145/3290605.3300251>

- Wilson, K. P., & Landa, R. J. (2019). Barriers to Educator Implementation of a Classroom-Based Intervention for Preschoolers With Autism Spectrum Disorder. *Frontiers in Education*, 4. <https://doi.org/10.3389/educ.2019.00027>
- Wilson, C., Brereton, M., Ploderer, B. & Sitbon, L. (2018). Myword: Enhancing engagement, interaction and self-expression with minimally-verbal children on the autism spectrum through a personal audio-visual dictionary. *Paper presented at IDC '18: proceedings of the 17th ACM conference on interaction design and children, Trondheim, Norway*. <https://doi.org/10.1145/3202185.3202755>
- Wobbrock, J., Kane, S., Gajos, K., Harada, S., and Froehlich, J. (2011). Ability-Based Design: Concept, Principles and Examples, *ACM Transactions on Accessible Computing*, Association for Computing Machinery, pp 1–27. <https://doi.org/10.1145/1952383.1952384>
- Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., Brock, M. E., Plavnick, J. B., Fleury, V. P., & Schultz, T. R. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of autism and developmental disorders*, 45(7), 1951–1966. <https://doi.org/10.1007/s10803-014-2351-z>
- Woodcock, K. A., Cheung, C., González Marx, D., & Mandy, W. (2020). Social Decision Making in Autistic Adolescents: The Role of Theory of Mind, Executive Functioning and Emotion Regulation. *Journal of Autism and Developmental Disorders*, 50. <https://doi.org/10.1007/s10803-019-03975-5>
- World Health Organization. (2019). *WHO guideline: Recommendations on digital interventions for health system strengthening*. World Health Organization. <https://www.who.int/publications/i/item/9789241550505>
- Yasir, T. (2018). Smart phone based early intervention framework for intellectually disable children of Pakistan. *Presented at 2018 international conference on frontiers of information technology (FIT), Islamabad, Pakistan, December 17-19, 2018*. 10.1109/FIT.2018.00033
- Yakubova, G., Leibowitz, L. , Baer, N., Halawani, N., & Lestremau, L. (2019). Self-directed video prompting and least-to-most Prompting: Examining ways of increasing vocational skill acquisition among students with autism spectrum disorder and intellectual disability. *Advances in neurodevelopmental disorders*, 3(3), 246-258. 10.1007/s41252-019-0097-5
- Yin, R. (2018). *Case Study Research: Design and Methods*, sixth edition. Sage Publications.
- Yucesoy-Ozkan, S. Gulboy E., & Kaya, F. (2018). Teaching children with intellectual disabilities through video prompting: Smartphone vs. tablet. *International journal early childhood. special education*, 10(1): 32-48. 10.20489/intjecse.454433

- Zeidan, J., Fombonne, E., Scorsah, J., Ibrahim, A., Durkin, M. S., Saxena, S., Yusuf, A., Shih, A., & Elsabbagh, M. (2022). Global Prevalence of autism: a Systematic Review Update. *Autism Research*, 15(5), 778–790. <https://doi.org/10.1002/aur.2696>
- Zhu, R., Hardy, D., and Myers, T. (2019). Co-designing with Adolescents with Autism Spectrum Disorder: From Ideation to Implementation, *OZCHI'19: Proceedings of the 31st Australian Conference on Human-Computer-Interaction*, Association for Computing Machinery, pp. 106–116. <https://doi.org/10.1145/3369457.3370914>