Chapter 7 - Using Multi-Stakeholder Perspectives to Enhance Integration of Mobile Technology for Students with Communication Needs

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Chapter Highlights

➢ Describe the background of students in the U.S., specific needs around language learning and the implications of disorders of speech and language learning.

➢ Identify different types and genres of apps and app features that can be used by teachers and SLP practitioners to instruct students with communication needs.

➢ Explain the connection and importance of the collaboration between teachers, speech-language pathologists (SLPs), and app designers/developers in choosing, assessing, implementing, and designing technology to support speech and language learning for individuals with communication needs.

➢ Identify the ways to engage in the use and design of mobile apps using a novel research model and the iRPD ("Research, Practice, and Design for iPad Apps") framework.

➢ Synthesize recommendations for implementing and designing mobile apps for students with communication needs in educational settings.

Introduction

There are more than 50 million students in the U.S. that are enrolled in public pre-K through 12th grade (National Center of Educational Statistics, 2022). Of these students 70% are in pre-K through 8th grade and 30% are in 9th through 12th grade. The students range from diverse backgrounds and include over 5 million who are identified as English Learners (ELs) and participate in language assistance programs to support their educational achievement (National Center for Education Statistics, 2022). The most common home languages for ELs are Spanish, Arabic, Chinese, and Vietnamese.

Among the 50 million K-12 students in the U.S., in 2020-2021, over 7 million received special education services under the Individuals with Disabilities Education Act (IDEA), with the second most prevalent diagnosis being speech or language impairment (SLI). An SLI diagnosis includes disorders in the areas of speech, language, hearing, voice, social communication, and fluency. An SLI diagnosis can co-occur with other developmental disabilities such as a specific learning disability, autism spectrum disorders, or an intellectual disability. Children and students with a communication disorder are served across K-12 grades in the schools, as early as 0-3 years through early intervention programs, and as old as 21 years through adulthood, in transition programs. In addition to speech or language impairments, children can present with feeding and swallowing diagnoses which can require specialized services during the school day.

When students communicate, they are exchanging information and knowledge among the stakeholders (i.e., peers, teachers, administrators) (Friend, 2018). This requires a message, a sender, a receiver, and a channel. In a communication act, the sender formulates a message and the receiver decodes it. This requires linguistic competence on the part of both the sender and the receiver. Breakdowns can happen on the speech level, the language level, or with perception (e.g., hearing). Speech is the behavior of forming and sequencing the sounds of oral language and includes the elements of voice, resonance, articulation, and fluency. Language is the system of symbols that individuals use for communication based on their culture, and can be broken into expressive language (e.g., using words in sentences to express thoughts) and receptive language (e.g., understanding the thoughts expressed in words in sentences). There are five components of language that include the form (i.e., phonology, morphology, syntax), content (i.e., semantics), and function (i.e., pragmatics).

When students struggle with speech and language, their difficulties occur across the entire range of cognitive abilities and can profoundly affect a student's learning (Friend, 2018). There is also a higher risk of reading difficulties for students with speech and language delays (Catts et al., 2002; Snowling et al., 2000; Zipoli & Merrit, 2017). Socially and emotionally these students may be targets of peer teasing (Knox & Conti-Ramsden, 2003; Redmond, 2011). They may experience difficulty in social situations, such as being left out of play (Fujiki, Brinton, & Todd, 1996). Frequently they are at higher risk for behavior problems because of their frustration with communication; for example, withdrawing from peers in the classroom and showing anxiety about social interactions with peers (Hart et al., 2004; Stanton-Chapman et al., 2007). These behavior difficulties can compound and persist. Studies investigating youth offenders in the criminal justice system provide significant evidence that youth offenders perform more poorly on language measures relative to age matched peers (Anderson et al, 2006).

Most schools will have an early identification system or support for students like *Response to Intervention* (RTI). In this approach, the process begins with a universal screening of each child in the general education classroom. Some examples of ways the disability can manifest itself in the classroom are included in Table. 1. If some of these struggles are occurring, an intervention team discusses specialized plans for the learner to provide them with interventions at increasing levels of intensity to improve their rate of learning. Progress and data are closely monitored to assess the learning rate and academic level of performance of the individual student. If a student continues to struggle with these supports, then they will be referred to the child study team for discussion around specific assessments that may be requested. Involving teachers throughout this process helps to address the child more holistically, rather than one generalized need. Once a determination is made and permission is obtained, data is collected and reviewed, the team will determine federal eligibility defined in IDEA (P.L. 105-17). Part B of the document states that a child is only eligible for services if the impairment "adversely impacts educational performance (ASHA, n.d.)."

To further assist in understanding the variety and depth of communication disorders and the scope of practice for the speech therapist, the American Speech-Language-Hearing Association (ASHA) created the Big Nine classification system. These are not grouped in a specific order and include; articulation, cognitive aspects of communication, communication modalities, fluency, hearing, receptive and expressive language, social aspects of

communications, swallowing, and voice and resonance.

The following table looks at the *ASHA Big Nine* in terms of the school-based setting, describes specific characteristics that may occur, and describes the adverse impact of different disorders on classroom learning.

Table 1. ASHA Big Nine, Connection to Characteristics and the Classroom Impacts

ASHA Big Nine	Characteristics	Adverse Impact in Classroom Learning at Schools
Articulation **how speech sounds are made using the mouth, lips, and tongue. Main focus on errors in production of individual speech sounds**	A child needs to be able to produce the "s" sound to say "star" instead of "tar."	*Functional impact in the classroom: (Hitchcock et al., 2015)* Difficulty being understood in the classroom. At risk of being teased or bullied
Cognitive Aspects of Communication **includes attention, sequencing, problem-solving, executive functioning**	Executive Function: Scheduling, planning. Problem Solving: Breaking an assignment down to steps.	*Functional impact in the classroom: (Pfiffner, Barkley et al., 2006)* Executive function issues can cause a student to be disorganized and turn in assignments late. Problem solving deficits can cause a student to have difficulties scoping research projects, and choosing facts to support arguments.
Communication Modalities **includes oral, manual, augmentative and**	Aided: Communication boards with symbols, Augmentative	*Functional impact in the classroom: (Walker & Chung, 2022)* Curriculum may need to be adapted.

alternative communication techniques, and assistive technologies)	Alternative Communication (AAC) software and devices.	Teachers and paraeducators need to be trained to use the aided or unaided systems.
	Unaided: sign language, facial expression, gestures, body position	Peer relationships may be difficult to form.
		Difficulty participating in classroom discussions.
		Literacy instruction requires specialized teacher training and experience.
Fluency **forward flowing speech**	Repetitions of sounds, syllables, words, and phrases; prolongations; and blocks.	*Functional impact in the classroom: (Adriaensens et al., 2017)*
		Reluctance to raise hand and participate in class discussions.
	Can be accompanied by visible tension in the face, speaking avoidance, struggle behaviors, and secondary behaviors such as eye blinking.	Difficulty working in small groups.
		Social emotional issues such as fear and lack of confidence.
		Increased risk of bullying.
Hearing **Hearing loss is a partial or total inability to hear in one ear (unilateral) or**	Students with hearing loss using hearing aids, cochlear implants, and FM	*Functional impact in the classroom: (ASHA, n.d.)* Hearing loss can delay a child

both ears (bilateral).	systems; also, students who are trying to hear in noisy classrooms and/or classrooms with poor acoustics.	developing speech and language and prevent a student from discerning comments/questions from peers during "whole class" discussions. Hearing loss can mimic learning disability and cause social isolation.
Receptive and Expressive Language Receptive Language: **How the individual** <u>**understands**</u> **language** Expressive Language: **How the individual** <u>**expresses themselves**</u> **with language**	Receptive Language: Following two-step directions such as "Put down your pencils and open your book." Expressive Language: Telling a story or answering questions in complete, grammatically accurate sentences.	*Functional impact in the classroom: (Ziegenfusz et al., 2022)* Receptive language deficits can cause difficulties with reading, understanding directions for assignments. Expressive language deficits can cause difficulties with putting thoughts into sentences in a way that makes sense (e.g., contributions to class discussions and written assignments can lack coherence or meaning).
Social Aspects of Communication **challenging behavior, ineffective social skills**	Pragmatic skills: Difficulty maintaining reciprocal conversations, making eye contact, reading social cues and body language. Inappropriate use of language.	*Functional impact in the classroom: (McClemont et al., 2021)* Difficulty with group assignments. Increased risk of rejection by peers and bullying.

Swallowing **oral, pharyngeal, esophageal, and related functions**	Children on feeding tubes, children learning how to self-feed and swallow after being on a feeding tube, medically fragile children, children with multiple disabilities, children with eating disorders.	*Functional impact in the classroom: (Arvedson & Homer, 2006)* Poor nutrition can impact academic performance. Psychosocial issues resulting from feeding tubes or eating disorders can isolate a student and impact peer relationships in the classroom.
Voice **How the vocal folds and breath are used to make sounds.** Resonance **The voice quality that results from the balance of sound vibrations in the throat, mouth and nose.**	Voice can be too loud or soft, or high- or low-pitched. With resonance issues, their voices can have a muffled or nasal quality. Caused by functional, organic or neurologic processes.	*Functional impact in the classroom: (Ruddy & Sapienza, 2004)* Example: Children can hurt their voices by too much yelling on the playground. Voice and resonance issues decrease student ability to communicate in the classroom and increase the risk of bullying.

Classroom Connection & Technology

Children with communication needs and disorders work with teachers and speech-language pathologists (SLPs) across diverse educational settings including early intervention, general education, and special education classrooms to increase their communication skills so they can access the educational curriculum (Byrnes, 2000). Depending on the need and severity of the individual child, they may require support through *Response to Intervention* or an Individualized Education Program (IEP). By providing this approach or plan, children are required specialized adaptations to help them communicate in the classroom and access the curriculum.

Some of these specialized adaptations often include assistive technology. Assistive technology, in general, is any piece of equipment, or product system that is used to increase, maintain, or improve the functional capabilities of a child with a disability (IDEA, 2019). Some examples of assistive technology include augmentative and alternative communication (AAC) devices, educational technology such as dictating tools, pre-recorded textbooks, writing software with predictive capability and/or mobile apps (Gilakjani et al., 2013).

There are many benefits when using mobile apps in the classroom. Depending on the mobile app that is utilized, they have been shown to increase communication (Dias & Victor, 2022; Du et al., 2022; Holyfield et al., 2018) and language learning (Light et al., 2019). They have also been shown to support and facilitate social interaction including collaboration (Dias & Victor, 2022; Du et al., 2022; Light et al., 2019). At the same time, when using apps, there has also been evidence that they can encourage independent learning (Dias & Victor, 2022). When students are able to work independently, this can assist the teacher in differentiating individual students' strengths and needs more easily because they have the ability to share resources with the individual student and the students can also share among each other. The individual support that many apps provide can help increase engagement (Du et al., 2022; Lubniewski & Kiraly, 2020). Teachers and clinicians are motivated to use apps as a dynamic way of teaching and targeting various goals (Dias & Victor, 2022; Du et al., 2022).

Currently, there are over 2 million mobile apps that teachers have access to download on iOS or Google Play (Ceci, 2022). Teachers and SLPs choose an app for a variety of reasons (e.g., recommendation from a colleague, student interest, specific design features, connection to the curriculum, instructional features; Du et al., 2023; Lubniewski et al., 2018). Depending on the hardware device where the mobile app is operating, many devices have sensors, cameras, microphones, touchscreens, voiceover and voice agent feedback (Dias & Victor, 2022; Crescente et al., 2011). Due to the flexibility and support provided, it makes it a popular choice for teaching and learning especially when supporting a diverse student population.

To use mobile apps, the teacher may need to be trained and taught how to effectively implement a mobile app to achieve a specified goal in the student's program (Andzik et al., 2019; Du et al., n.d.). Oftentimes, the teacher will also need to train the paraprofessional and the family in using the educational and assistive technology. This can be an issue because typically teacher preparation programs have traditionally had a low emphasis on technology

integration (Kimmons, Miller, Amador, Desjardins & Hall, 2015). This creates a large barrier because there is a lack of knowledge and skills for successful implementation of assistive technology and educational technology in the classroom (Dell, Newton, & Petroff, 2021; Dias & Victor, 2022).

The iRPD Framework and the Present Study

One of the ways to support teachers' technological knowledge and skills is to partner with an SLP whose practice includes the integration and development of technology tools such as mobile apps. When the teacher and the SLP collaborate, each plays an important role in the successful implementation and development of the technology tool in the student's education program. Using a design-based research methodology, the Research, Practice, and Design for iPad Apps (iRPD) framework is one of the first models to engage stakeholders in a three-way collaborative process to collaboratively produce apps for educational purposes (Kucirkova, 2017, Figure 1). The iRPD framework is governed by five guiding principles: triple collaboration, shared epistemology, interconnected social factors, awareness of app affordances, and child-centered pedagogy. The three key stakeholders of iRPD, also referred to as the ''iPRD trio'', include practitioners, researchers and mobile app designers. The iRPD trio works in triple collaboration through shared epistemology to develop an awareness of affordances of the mobile apps.

The iRPD framework expands upon the traditional child-centered user-design approach by visualizing equal involvement across all three stakeholders (e.g., practitioners, researchers, and mobile app designers) and addresses how an interprofessional research team could collaborate to design and evaluate mobile apps for education. To establish this triple collaboration with a shared epistemology, it is important to ensure that all stakeholders ''share a set of values and an understanding of the scope of the project'' (Kucirkova, 2017). In other words, practitioners, researchers, and designers should collaboratively consider how to provide an internally consistent user experience and coherent message to articulate differences across domain knowledge during app production. Additionally, the research team works together to resolve any conflicts and barriers posed by interconnected factors (e.g., sociocultural, economic, ethical, and political) by including children as active partners in the research cycle.

This framework is particularly inspirational for the present study because it not only constructs the collaborative relationship across three stakeholders but also emphasizes the importance of a shared epistemology across stakeholders that informs and powers the design process. Building upon this model, the present study seeks to synthesize qualitative interviews with SLPs as well as non-SLP designers/developers and researchers who design and use apps for pediatric speech-language therapy. Results from this study enable the iRPD model to be further developed and expanded to explore the roles and responsibilities of stakeholders during the app design and implementation process. These findings provide cross-profession education for teachers who will be working with children with communication needs and SLPs in diverse educational settings and contexts. Based on the iRPD framework, this study was designed to answer the following questions:

1. When using and developing mobile apps for pediatric speech and language learning, what student needs, challenges, and recommendations are discussed by practicing speech-language pathologists and app designers/developers?

2. What technology tools, in addition to mobile apps, do speech-language pathologists use to support speech and language goals?

3. Using the iRPD framework, how can teacher practitioners collaborate with multiple stakeholders to design and develop mobile apps that address the learning needs of students with communication needs?
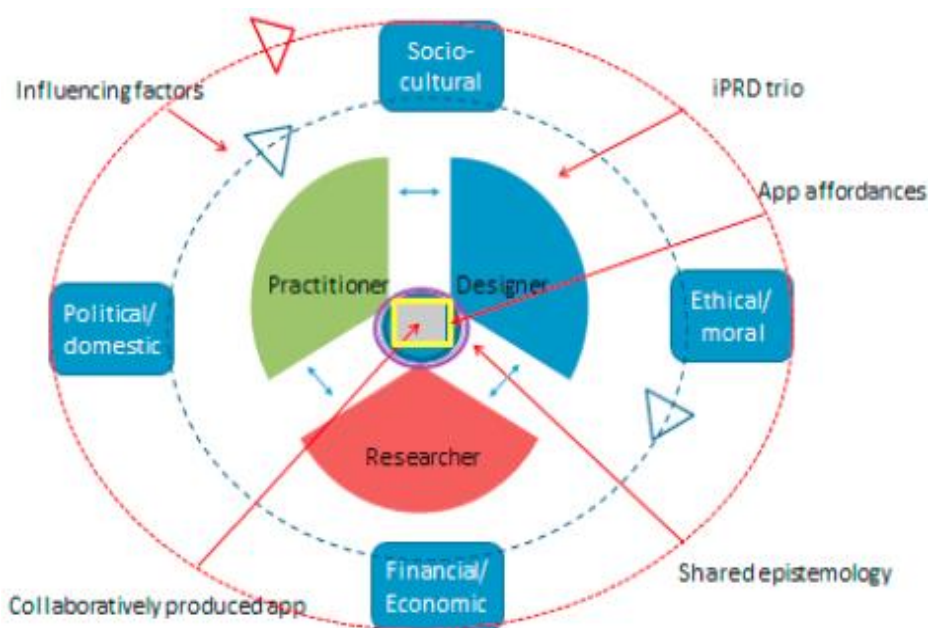

Figure 1. The Research, Practice, and Design for iPad Apps (iRPD) framework by Natalia Kucirkova

Method

A total of 50 participants (Appendix A: Participant Demographics) were recruited via email using snowball sampling strategies from the third author's personal network and word-of-mouth referrals, as well as recruitment through technology-related presentations at professional conferences. To collect a comprehensive perspective about the process from mobile app design and development, to implementation and use, semi-structured interview sessions (ranged from 45 to 70 minutes) were collected and analyzed via qualitative coding based on the Consolidated Framework for Implementation Science (CFIR), a theoretical framework developed by Damschroder et al. (2009). The semi-structured interview questions were constructed based on two domains ("intervention characteristics" and "characteristics of individuals") out of the five domains of CFIR in order to examine individual characteristics of SLPs and characteristics of mobile apps. Additionally, the interview questions investigate mobile apps used as intervention tools by analyzing five specific subdomains of "intervention characteristics": sources, relative advantage, design quality and packaging, cost, and adaptability. To further understand contributing factors related to app design and adoption, four influential factors; (1) financial, (2) social-cultural, (3) political, and (4) ethical/moral factors from the Research, Practice and Design for iPad Apps (iRPD) framework (Kucirkova, 2017) were integrated into the qualitative coding process to unpack the collaborative process to produce/use iPad apps for educational purposes.

Amongst these 50 participants were 23 "SLP App Users" (P1 to P23) who reported using apps across various clinical contexts in public and private school settings, university clinics, children's hospitals, and a cerebral palsy center, via in-person and teletherapy. The other 14 participants "SLP App Designers" (P24 to P37) were not only SLP app users but also have been involved in app designing. These SLP App Users and SLP App Designers came from different states in the United States, with three international SLPs that came from China, Malaysia, and Sweden. The remaining 13 participants "Designers" (P37-P50) were individuals from various backgrounds (e.g., parents of children with disabilities, Ph.D. students, producers) without a clinical background as SLPs but were involved in the development process for apps used by SLPs.

Interviews were analyzed using template analysis (Brooks & King, 2012; Crabtree & Miller, 1992; Crabtree & Miller, 2022) and thematic analysis (King, 2004) and then summarized in

clinician user personas (Jansen et al., 2021; LeRouge et al., 2013, Appendix C), a technique used in the field of human-computer interaction. Each transcript was coded independently by two coders. Then, using member checking, 5% of the total text within each transcript was compared for differences and resolved by the larger research team (Creswell and Miller, 2000) until a consensus was reached. A total of seven emerging themes were identified, including mobile app use techniques, clinical practice, therapy activities, therapy techniques, influential factors, perceptions and attitudes about mobile apps, and app design and development recommendations (Appendix B).

To answer the research questions of this study, we highlighted findings from SLP practitioner designers and practitioners (P1-P37) by focusing on themes developed from the codes. For question 1, deeper analysis was conducted on codes and themes under client characteristics (i.e., age group, type of disability/disorder, levels of ability), clinical practice (i.e., clinical challenges), support systems (i.e., perception and attitudes), and recommendations (i.e., unmet clinical needs). For question 2, further analysis was conducted on the codes under clinical practice (i.e., therapy activities, therapy materials), app characteristics (i.e., app names and genres) and tools. For question 3, the codes that were used were clinician and developer characteristics (i.e., clinical setting, clinician/developer experience), app characteristics (i.e., app names and genres, app use techniques, design and development, app features), recommendations (i.e., app design, system design, unmet needs), and marketing (i.e., distribution channel and methods, advertising/public relations/promotion, marketing research).

Results

Client Characteristics

The clients that the participants have provided services for have been from birth (P2), preschool (P2, P8, P11, P14, P19, P26, P29), elementary (P2, P6, P8, P11, P12, P14, P15, P29) middle school (P2, P6, P11, P12, P15), high school (P11), and adult (P2, P6, P8, P12, P19). Some clients were bilingual (P14, P26, P29). There is a variety of diagnosed disabilities among the clients that included a speech or language impairment, autism spectrum disorder (P2, P6, P8, P14, P19, P26), cerebral palsy (P6), cognitive impairment (P2, P6, P11, P26), deafness (P2), Down syndrome (P2, P6, P14, P26), specific learning disability (P11, P12, P14), mental disorders (P6), motor impairments (P2), and Parkinson's (P26). The range of

severity of the disability was from mild, moderate, severe, profound, and nonverbal. The clients included those who had individualized education plans (IEPs) and 504 plans for the general education curriculum, those in general education identified for special education services, those in a pull-out setting within the school (e.g., special education, speech pathologist setting), and those in private schools for students with disabilities.

Educational Setting & Goals

For the participants 1-37 that identified themselves as a speech language pathologist (i.e., clinician or an SLP designer/developer), the main setting that was identified where the speech language services were being administered was within the school (P8, P14, P15). Many participants did not identify whether this was a public school or private school; however, within the school setting some participants further identified that the services were provided within the classroom (P2, P6, P11, P12, P19, P26). Two participants did not identify a specific setting within the school (P29, P31). Within the classroom setting, the participants identified a variety of levels of support including small student-teacher ratio, co-taught settings, and as a resource to provide additional support (e.g., paraprofessional, therapy assistant (P26). During these sessions a variety of therapy goals were being addressed including: language (expressive/receptive, P26, P29), vocabulary (P19), semantics (P19), social skills (P14, P19), articulation (P19), syntax/grammar (P29), and narrative development (P14).
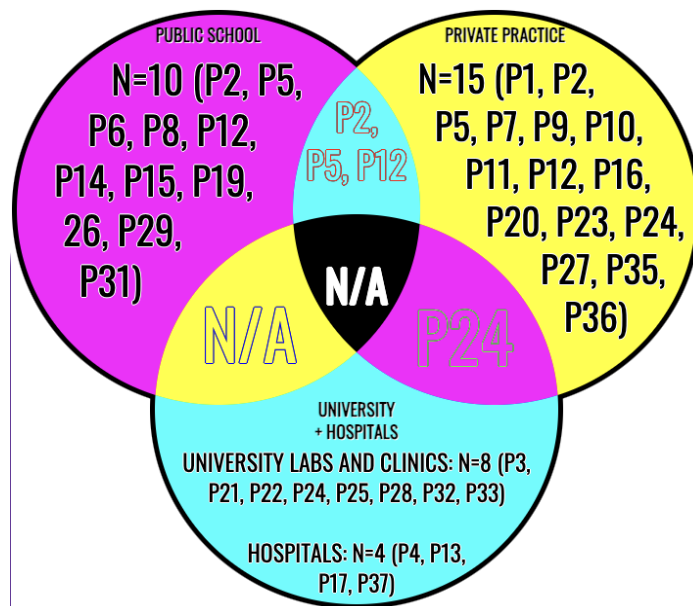

Figure 2. Work Settings for SLP Participants (P1-P37)

Practitioner Challenges & Recommendations

Participants highlighted specific areas of need, and their perceptions and attitudes about technology, including the use of apps. Overall, six themes were identified that focused on dispositional, pedagogical, identified support from administrators and families, resources and professional development, student needs, and technology factors (e.g., design and development, usability).

Dispositional

The participants shared dispositional qualities that they perceived were needed when implementing technology with students. The identified qualities were open-minded (P29) and consistent (P14). One participant also shared that teachers are receptive to SLP ideas because they are considered "leaders regarding tech" (P6), and as an SLP they felt that they wanted a "smart partnership" with the teacher to collaborate about the technology. To be a leader in tech, a few participants shared that there needs to be "more guidelines for apps and having some evidence-based research that can pull from those resources (P2, P26)." They wanted guidelines for designing apps, but specific apps for "education (P2, P19)", "a specific population (P25)", or "for children with disabilities (P26)". There was a clear desire for more structure when designing, selecting, implementing, and assessing apps for students.

Pedagogical

Due to the goal-driven nature of speech therapy and special education services, participants stated that app selection and use needed to support goals and objectives (P8, P11, P12, P19, P29). Technology is used "for a reason (P12)." There was a desire that "technology should be in the classroom, but must be tied to the purpose of the activity (P19)" and "don't use it for the games aspect of it unless the game is part of an application that works on articulation or language (P11)." Some participants also stated that they chose an app to promote and support positive behavior (P11, P15) or as a reward for a student during a therapy session (P19). Overall, the participants stated that having clear goals and objectives that connect to the student's strengths and/or needs was critical when using the technology.

Depending on the app or technology that is chosen, some clients may be distracted. This can

create behavioral difficulties if the SLP or teacher is working in a group setting because they may not have the full attention of all the students (P8, P11, P12). It's important to use "clinical judgment needed to take into account motivation, reinforcement, interaction between students on a given day (P26)." One way to address this is to make sure to differentiate the types of apps that are used (P29), select apps that include a human element like reciprocal communication (P6), or apps that are able to augment reality (P15). Some participants shared that depending on the app that was selected they spent "too much time in therapy answering questions about the apps (P2)." There was also advice that even though there may be a form of data collection or assessment within an app, "make your own tracking system with google sheets and documents (P15)."

Support from Administration & Families

Participants identified needs from administrators and families (P8, P14, P19, P26, P29). They identified that they wanted more accountability from the stakeholders (e.g., families, paraeducators, teachers, administrators) who are using the child's specifically programmed AAC app (P19) and that they wanted "assistance" from administration (P19). Some participants felt that families needed more information about the benefits of apps (P26) because of the debates about negative effects of technology with children (P29). Participants felt the need to be able to communicate with families so that there is consistency with the use of the technology (P14, P29), they can create connections for the students who may be struggling (P8), and they can promote language development (P29).

Resources and Professional Development

The support from administration and families is critical as well as identifying communities and organizations that support technology (P19, P26). It "would be nice to have some type of group to connect about technology, maybe a technology SIG through ASHA or some other organization (P26)." Another SLP discussed the benefits of being involved in the *SLP Peeps community* on *Twitter* and said, "It was an incredible growing experience. As the only SLP in my community, I'm literally the only one in town. I didn't have anyone that I could bounce questions off of that actually understood what I did (P8)."

There was a desire to have additional professional development so that they would "be able

to adopt or know an AAC system well enough to find specific vocabulary and model it with something in real life (P19). P41 also shared that to find useful apps they would "search on iTunes or the internet" and "typically I end up on some speech blog or website, and then I find more apps there." A number of participants identified that there aren't specific resources or places where to find information about apps, so some participants began blogging and speaking at conferences to educate fellow teachers and speech therapists (P30, P31, P32).

Challenges for Student

Another theme from the data was specific to students. Some participants shared that for specific populations of students (e.g., autism, motor impairments, cognitive deficits), navigating apps can be challenging (P2). They may not have immediate success because they aren't moving quickly from level to level (P2). One participant suggested that the app have a specific focus area, "in autism maybe positive feedback and visual attention (P15)" to increase the success with using the app. There were concerns stated about the attachment to the screen (P2) and some even went on to say that students could become "technology addicts (P6)." Due to the overuse of screen time, "children don't know how to interact with others (P8)" Ensuring that apps are "not for entertainment purposes but for therapeutic purposes (P11)" is critical in their success. Another concern was that the app could be "overstimulating (P14)" and that while "technology can be more engaging (P19)", educators should pick "something that will be more toned down to keep engagement appropriate (P11)." The participants recommended that apps should be designed to be more inclusive of student's vocabulary (P2) and additional apps should be designed to focus on cause-effect to support understanding, new learning, and memory (P15).

Impact of Technology for Clinicians

In general, the participants discussed overall drawbacks and benefits of technology. Participants identified that they had issues with connectivity and that some apps moved at a slower speed (P2, P11, P26). Some apps had mandatory updates (P14) that took time and needed to be completed frequently. The participants wanted fewer options (P14) but ones that were more customizable (P2) with fewer stimulating sounds and images (P14, P26). The participants felt that the iPad allowed for more consistency and standardization (P26); however, across apps, the participants wanted the voice output to be standard dialects. Even

with all the design and development needs, there was still an advantage of that the use of technology "can be more timely or up-to-date and have more variety (P26)."

The participants also identified the ease and convenience of using technology. One example was "giving an assessment, where especially with the two iPads, where the examiner has things at their fingertips (P26)." To assist in supporting teachers with the use of technology, data was collected to identify specific technology and tools based on different types of non-digital vs. digital therapy tools along with diverse software and hardware (Table 2), and a mapping of popular app genres with sample apps based on the ASHA Big Nine domains (Table 3).

Table 2. Different Types of Non-Digital vs. Digital Therapy Tools

Hardware Devices	iPad, iPhone, Samsung Tablet, Microsoft Surface Pro, CD-ROM, SMART board, Tobii Dynavox AAC device
Non-Digital Materials	Flash Cards (e.g., articulation, sequencing, PECS, paper, flashcards, category pictures, PTS flashcards), worksheets and books (Mad Libs), board games (e.g., board, tic-tac-toe), paper and markers, Rolodex, toys and manipulatives.
Online Database	School district database, IEP goal banks, app database, online vocabulary glossary, subscription of Smarty Symbols
Software Applications	Android & iOS App Store (for checking ratings and cost), video conferencing (e.g., Skype, Zoom, Facetime), mobile Apps (e.g., Youtube, Google Reader, Super Duper therapy apps, Toca Boca game apps), PDF reader, iBooks, Google Drive, PowerPoint
Websites	Assessment platforms (e.g., Pearson Q-Interactive), Pinterest, Facebook (e.g., groups, community, downloads on pages), ASHA Forums, blogs that have reviews on apps (e.g., Yappguru.com*), Teachers Pay Teachers, Craigslist

*YappGuru.com is no longer in operation.

Technology Tools & Key Features

Amongst all the mobile apps used by SLPs, several key features were identified for different genres of apps across several content areas (e.g., speech, language, or social skills). Example apps for each app genre category along with ASHA Big 9 categories and implications for teachers are included in Table 3. For example, participants mentioned the most critical feature of articulation and speech apps include drill-based activities for repeated practice and the ability to record audio or voiceover for feedback on students' production; for language and articulation apps, it is important to ensure that activities are scaffolded. For example, for an articulation activity, they first proceed with a syllable, to a word, then to a phrase, to sentence, to structured conversation, to unstructured conversation level activities. For social skills apps, problem-solving scenarios based on real-life situations were reported to be highly desired. In addition, participants highlighted various gamification and data management features and app design techniques that could be beneficial for app designers and developers. These included gamification features such as utilizing level design (e.g., the ability to unlock one level to get to another level) and enabling multiple users to play together for better social interaction, interaction features that highlight preferred visual and functional design preferences (e.g., using colorful and fun graphic design, enabling pauses within in-app progress), and data management requests (e.g., integrating the ability to track therapy goals and progress).

Table 3. Sample Apps for Across Different App Genres Based on ASHA Big 9 Areas

App Genre	Implication for Teachers	ASHA Big 9/SLP Utility	App Names	App Description
AAC Apps	Teachers should be prepared and/or dedicate time to implement the use of AAC in the classroom,	Communication Modalities Receptive & Expressive Language	Go Talk Now AAC <Developed by Attainment Company>	Individuals can communicate through actions, recorded or text-to-speech messages, and images.
		Communication Modalities	LAMP Words for Life <Developed by	Gives individuals a variety of pre-stored words used

	support programming of the AAC systems (e.g., adding vocabulary, creating new pages).	Receptive & Expressive Language	Prentke Romich Company>	to expand into sentences to express wants/needs.
		Communication Modalities Receptive & Expressive Language	Proloquo2Go <Developed by AssistiveWare>	This app is customizable and used to help assist individuals in expressing wants/needs.
		Communication Modalities Receptive & Expressive Language	Snap Scene <Developed by Tobii Dynavox LLC>	Offers the opportunity to take a photo and include a recording to communicate in real time.
Academic and Entertainm ent Apps	Teachers can use these apps to support academic goals as well as for classroom or behavior management.	Cognitive Aspects of Communication Receptive & Expressive Language	Organic chemistry app: Little Alchemy <Developed by Jakub Koziol>	Aims to teach children how to mix simple elements in a fun and interactive way.
		Receptive & Expressive Language Social Aspects of Communication	YouTube Kids (e.g., Peppa Pig, Paw Patrol, PJ Masks, Bubble Gum Bee, Bubble Guppies) <Developed by YouTube>	Interactive videos that teach children basic concepts (colors, shapes, letters, numbers), language, and social skills.
Assistive Technolog y	Teachers should collaborate	Cognitive Aspects of Communication	ClaroSpeak Plus <Developed by Claro Software	Text is highlighted and read to the individual while

Apps	with the SLP and occupational therapist to support students' needs within the classroom.	Communication Modalities Receptive & Expressive Language	Limited>	also offering word predictions to assist in writing.
Game Apps	Teachers need to be mindful of ads that may "pop up" during the app use to determine if it is appropriate to use with a specific student.	Cognitive Aspects of Communication Receptive & Expressive Language Social Aspects of Communication	Angry Birds Reloaded <Developed by Rovio Entertainment Corporation>	Aim angry birds utilizing a slingshot to destroy different obstacles and unlock new levels.
		Receptive & Expressive Language Social Aspects of Communication	Candy Cards app <Developed by AppStar Studio>	Virtual way to draw cards during a game of Candy Land.
		Cognitive Aspects of Communication Receptive & Expressive Language	My Play Apps (My Play Home-language, My Play School-language, cognition, My Play Store-language, cognition) <Developed by PlayHome	Allows individuals to manipulate certain environments (house, school, store) in detail.

			Software Ltd>	
		Social Aspects of Communication	Reward games - Daniel Tiger's Grr-ific <Developed by PBS KIDS>	Gives children the opportunity to learn about emotions in a fun and interactive way.
		Cognitive Aspects of Communication Receptive & Expressive Language	Toca Boca App <Developed by Toca Boca AB>	Children can experience and manipulate a variety of different environments (neighborhood, school, office, stable, and farm).
Simulation Apps	By using these apps, it promotes critical and evaluative thinking. Usually simulation apps are more ambiguous or open-ended and they increase student engagement.	Cognitive Aspects of Communication Receptive & Expressive Language	Cut the Rope- fine motor, control swiping. <Developed by ZeptoLab UK Limited>	Cut a rope in a variety of different ways to feed a monster and unlock new levels and hidden prizes.
		Hearing Receptive & Expressive Language	Finger Drums- expressive language, math, receptive language, literacy, music, and rhythm. Work on answering questions, asking questions.	Provides three drum kits where you can play along to pre-recorded songs or songs in your music library.

			<Developed by On Beat Limited>	
		Receptive & Expressive Language Social Aspects of communication	Pocket Pond-feed, pet and watch koi fish in a pond. <Developed by TriggerWave LLC>	A koi pond where you can feed, pet and watch koi fish.
		Cognitive Aspects of Communication	Pop the Bubbles-cause and effect, when you touch something, something happens immediately. <Developed by Yonatan Erez>	Shoot bubbles in a variety of combinations to complete levels.
Speech-Language Apps	Teachers need to understand that an app is two dimensional and some students with perceptual disabilities may struggle with transferring the information. It's important to use	Articulation Receptive & Expressive Language	Boo Articulation Helper <Developed by Thomas Ljungblad> Articulation Station <Developed by Little Bee Speech>	Teaches children consonant sounds and offers activities in the word, phrase, sentences, and story levels.
		Receptive & Expressive Language	Language app - Super Duper Pronouns <Developed by Super Duper Publications>	App aims to improve overall language skills in children.

	multimedia learning to promote learning.	Articulation Cognitive Aspects of Communication Receptive & Expressive Language	Smarty Ears apps <Developed by Smarty Ears>	Offers therapy resources for individuals with basic concept skills, receptive and expressive language, articulation, sequencing, and auditory memory difficulties.
		Cognitive Aspects of Communication Receptive & Expressive Language Skills	Between the Lines <Developed by Romain Lebouc>	Trains the brain to read a simple phrase and infer the hidden meaning.
		Articulation	Speech Blubs <Developed by Blub Blub Inc.>	Voice-controlled app used to help children learn new sounds and words.
		Cognitive Aspects of Communication Receptive & Expressive Language	Tactus therapy apps <Developed by Tactus Therapy Solutions Ltd.>	Offers therapy resources for individuals with reading, writing, naming, comprehension, and conversational difficulties.
Utility Apps	Teachers should frequently review the	Hearing Voice and Resonance	Decibel X:db Sound Level Meter	Sound level meter. Assist teachers in identifying harmful levels of classroom

utility apps that have been downloaded and uninstall the ones that are not being used to create more space.		<Developed by SkyPaw Co. Ltd>	noise, help students learn to control vocal volume.
	Expressive Language	iDoodle <Developed by Vson Technology Co., Ltd.>	Give individuals the opportunity to draw freely; creates opportunities for expressive language (e.g. describing, answering -wh questions, etc.)

Profile of the SLP Clinician Designer

The profile of an SLP clinician designer is multi-faceted. In addition to clinical expertise that informs the app, clinician designers have visual design skills running the gamut from sketching on paper and handing off control to designers, or starting with digital sketches and working back to paper. They also have product management skills (e.g., specifying features and functions, conducting usability tests on end-users to get feedback on app design, communicating with developers, driving the development process, and revising the app as needed based on stakeholder feedback). In addition to product management, SLP clinician designers are product marketers. In our data, SLP clinician designers perform or participated in product design (P9, P15, P24, P21, P26, P37), usability testing (P24, P26, P30, P37), and marketing and promotion (P9, P24, P34). SLPs collaborate with different stakeholders during the dynamic process of app creation (P34, P37). SLP designers report that good communication with developers is critical, as is knowing the limits of their own expertise within that IRPD trio. "I'm not a software engineer and so sometimes I don't realize what is hard to program and what's not (P21)." "Having open communication…not being rigid" is important to successful app creation (P26).

The common factor that SLP-designers bring to the table is insight and motivation based on clinical experience (P9, P24, P25, P26, P27, P28, P37). Some SLP designers are motivated to create apps for specific disorders (P24, P28, P37), and other SLP designers are motivated by

the challenge of improving clinical service delivery by infusing interactivity and fun into the therapy process (P24, P37). For example, an SLP designer created a dance party app to motivate students doing articulation therapy, which is typically very repetitive (P24). Another group of SLP designers is motivated to create tools and assessments that fill a gap. "I realized that there should be an app that works at the sound level" (P37). SLP clinician designers use their clinical experience in the ideation and design process, "I wanted to create functionality that resembles what I do in therapy (P37)" and often draw on the input of other stakeholders including teachers and parents (P34).

Testing and Revising Apps

SLP clinician-designers test apps with the end-user (e.g., the student) in sessions meant to simulate actual use (P12, P24, P37). The value of the iRPD trio in the test development process is that it serves as an iterative loop for product design. Usability testing by the practitioner can trigger a different design direction or confirm a design decision. "Usability testing confirmed my suspicion that the older the child was, the more they expected some kind of gameplay where you get a score or win something. That wasn't my [original] intention with the app (P37)." SLP designers also do usability research among colleagues who are teachers and speech therapists, "I always find myself asking: does this make sense to you? And I mean that from a user experience point of view … do they [the students] know where they need to tap first? (P24)."

Marketing Apps

SLP clinician-designers had an entrepreneurial mindset to engage in the variety of activities needed to market and promote an app; for example, developing "go to market" strategies such as identifying target markets, and determining pricing (P32). SLP clinician designers reach out to bloggers and app influencers (P41), and promote apps through digital means including social media (Twitter, Facebook) (P9), special mailing lists, creating promotions such as contests and giveaways (P9), speaking at conferences (P34), and using professional networks to get word out (P5, P11, P12, P48). "Word of mouth is a very real thing. If you create something and it brings a client success, the client's parents or clinician is going to talk about that (P24)." Some designers leverage the experience of media professionals such as TV executives or branding professionals (P27). App store reviews are mentioned as a key driver

for app downloads ('I think the main thing is ratings. Those are very important in the app world (P9)."

Professional Development and Support

SLP clinician designers are working "out of the box" professionally on many fronts: with new technology, new stakeholders (developers, coders, researchers, marketers), and new roles and responsibilities. SLP clinician designers spoke about being lonely in this new enterprise (P37) and needing support from a community of SLP developers (P28). SLP designers also spoke of the need for communities where developers and clinicians can come together and share ideas "a forum…where both a developer and SLP speech therapists could come together and talk. That might be interesting (P37)." Other SLP designers voice a need for professional associations such as American Speech and Hearing Association to provide standards and publish research (P34) about app functions, features, and design and the benefits of technology use in speech therapy. Proximity to a gaming/developer community or a university is also helpful for clinician designers, to reach out for ideas and possible developer-collaborators (P37).

App Features

SLP clinician designers included a myriad of features in their apps based on insights or ideas from their clinical practices, including interaction features, settings, and methods of delivering instruction. For example, in assessment, it is critical to give each individual being tested consistent instructions, or else the results can be skewed. An assessment app was designed to give the student pre-recorded directions via the iPad speaker, to eliminate the possibility of different testers giving variations of the directions, or unconsciously emphasizing words or phrases (P25). An SLP clinician who wanted to keep her clients motivated designed enticing and unpredictable interactions throughout the app, "You can push different images …there's just a little noise, or an act happens and kids have to figure out where they are, it's not always on the same spot (P30)." Another SLP clinician designer spoke about the need for levels of prompting so an app could be used with students with different levels of functioning, or so that the app could keep pace with the student's skill progress (P28). A story app included audio files reading the story, and on screen, a scroll of text highlighting the story as it was read, so a pre-reader could follow along (P30). An

articulation app displayed the speech sound, gave the student auditory feedback, allowed students to record themselves saying the sound, and allowed them to rate themselves when they produced the sound (P34).

App Use Techniques

SLP clinicians designed techniques for using their apps based on clinical practices, such as an articulation app that taught speech sounds based on simple consonant-vowel combinations that are easy for beginners (e.g., Boo, Bee, Baa). The student drags the consonant and vowel together and the SLP using the app can have them articulate the words slowly or multiple times, triggering continuous, multiple repetitions that optimize learning and motor speech planning (P37). The same app has a visualization of the vocal cords moving when the sound is voiced vs silent. Another app-use technique facilitated skill generalization. The app included a record feature which allowed children to record themselves practicing outside of a speech therapy session. Then "When they come back, the first thing I do in therapy is review their recordings (P34)."

Discussion

There is an important connection that the SLP and teacher share; similar populations of students who need skill development in order to communicate and use language successfully in the classroom. In this paper we have interchangeably used the term clinicians, SLP clinicians, clinical practitioners, and speech language pathologists. As we move forward, we will use the term "practitioners" to refer to speech language pathologists, teachers, and special educators as a whole in order to reconceptualize the teacher's role from a passive technology user to as an active participant.

Considering the Challenges and Recommendations of SLPs

The SLP practitioners and designers in our study believed that those who were implementing and designing apps had qualities that supported the process, like being open-minded and consistent. A teacher can reflect on the qualities they believe that they have and identify if these are similar. If they do not have these qualities, they can still be successful, it just may impact the implementation of using the mobile app because it may take the student longer to

learn the app due to the consistency of the administration of the app. It is important to note that they saw SLP's as leaders in technology, and practitioners should be mindful of their expertise in mobile apps that support speech and language learning goals. By connecting and collaborating with SLP's in the school, practitioners can be more successful at integrating speech and language apps in their teaching (Du et al., 2023).

When using apps during teaching, SLP practitioners noted that it is important to think about the student and to use professional judgment when selecting and implementing an app. Some students may become highly engaged with the technology and they may have a difficult time transitioning to another activity. Or another student may be distracted looking through the different word choices to select one to communicate with the teacher or classmate. Another example is when a student is requested to use the app, they shut down and refuse. It is important for practitioners to think ahead and create a plan to mitigate the potential behavioral issues that may occur with using a mobile app.

One way to address potential behavioral concerns is to partner with the family. A consistent theme in the data was the presence of a fourth stakeholder in addition to the clinician, the teacher, and the student -- the parents. Parents can be the hidden success factor in speech and language learning, so practitioners need to be mindful about providing directions for the families. Parents need to be able to look at an app and know how to use it. The SLP practitioners also noted that parents frequently purchased their own copies of apps to support their child's learning at home. To build on their continuum of care, practitioners can use apps to send activities or homework "home" to partner with families in a dynamic way.

Families need to be supported with training. Additionally, practitioners need to be cognizant of professional development opportunities that support learning technology since it is the practitioner's responsibility to remain up-to-date on evidence-based apps and teaching strategies. Technology is continually emerging, and apps are frequently updating and changing, so it is important that practitioners identify communities and organizations that research new developments in technology and their application to teaching and language learning. ASHA (American Speech Language and Hearing Association) and the Council for Exceptional Children are two organizations that provide multiple opportunities to engage in the most recent technology (e.g., blogs, updated policy, international conferences). Having information on the most up-to-date technology and teaching strategies will give the

practitioner the knowledge to support a variety of students with diverse learning needs.

The data collected in the interview study also provided reports on how there are challenges with utilizing apps among certain populations, such as those with autism or motor impairments. For example, for a student with autism, the SLP practitioner shared that it was overstimulating and that her client stimmed by clicking the same icon and repeating the same word each time they used the app. It was also noted that some apps don't work for the students who have severe motor impairments who may use eye gaze or switch scanning to communicate and interact with apps. As a practitioner, it's important to consider the strengths and needs of your student as well as the features of the technology to choose a mobile app that best supports their learning.

There is also the challenge of monitoring students when they are using an app that contains advertisements in order to avoid the child seeing inappropriate ad content or inadvertently purchasing something being advertised. There was one report of an SLP discussing how they had to be very careful that the student didn't tap on something and try to purchase anything. Free mobile apps are cost beneficial; however, the main drawback of utilizing free apps are the advertisements. Practitioners need to check district or school policy around mobile apps and technology. Verify yourself that app-level blocking features are enabled to stop ads and pop-ups during use. Free mobile apps also may contain inappropriate ad content such as violence and sexual content. Practitioners will want to preview free mobile apps prior to use to ensure that the content is appropriate. If you decide to use a free mobile app, understand that you will need to sit side by side with the student to protect them from inappropriate content.

Multiple school-based SLPs reported encountering challenges with accessing different forms of technology (i.e., iPads, computers, color printers),which reduced the uptake of technology in the school environment. There were reports of difficulty in using AAC technology as a tool to communicate with others across the school setting and how younger children may need extra assistance and time in learning how to use new technology. It is important for practitioners to select and implement technology so that students are able to interact naturally. This does take time not only for the practitioner to plan effectively but also consideration needs to be taken around the student's schedules which can lead to a limit in planning how to incorporate technology (e.g., taking videos).

In our data we saw multiple SLPs discuss concerns regarding automatic updates. For example, some SLPs mentioned how software updates can seriously disrupt teaching by overwriting or deleting valuable student progress data and history. There have been numerous incidents when an app is updated, whether it be iOS or Android, and access or data is lost due to the app update. It is important for practitioners to consider creating, maintaining and storing the information that they need outside of the app to avoid losing established student data.

iRPD Trio

In this research study, we explored how to reconceptualize the iRPD trio, in this case, SLP practitioners, mobile app designers, and technology researchers and the role of the teacher. Learning from the challenges experienced by SLP practitioners, multiple areas of support could be made available from the other two stakeholders, app designers and technology researchers (Du et al., 2023). Each stakeholder has specific roles and perceptions in selecting, implementing, designing, and developing mobile apps that are important to consider.

Practitioners

Teachers and SLPs wear multiple, often interchangeable hats when implementing technology tools to support learning and communication goals. In their role as practitioners, teachers integrate technology seamlessly into the curriculum, using tools and utilities such as Google Earth, e-learning platforms such as Brainpop, and permitting students to produce blogs, podcasts and videos for assignments (Light & Polin, 2010; Ventayen et al., 2018). In their role as practitioners, SLPs are fluidly integrating apps into therapy sessions (Du & Tekinbas, 2020) including language apps and articulation apps. SLPs also use technology tools such as digital video and audio recordings of students in speech sessions for feedback to students, or Youtube videos to demonstrate concepts. Often SLPs and teachers trade hats when implementing technology, such as SLPs working to update AAC devices with specific vocabulary to support academic goals, and teachers working to give opportunities for the child to use the new words on the device in the classroom (Rotheram-Fuller & Dixon, 2023).

Some teachers are not receptive towards implementing technology due to factors such as cost, training, and usability issues (Flanagan, Bouck, & Richardson, 2013). To address this

challenge, teachers need to advocate with administration, request professional development, and explore blogs for databases that collect information about useful apps (e.g., CIDDL, Edutopia). SLPs also need to provide in-service training, and set realistic expectations about how much they can adapt the teacher's curriculum materials and delivery methods. Additionally, developers need to be mindful of learning curves and classroom constraints to make the technology simple to implement for teachers.

SLP Practitioner Designers

As active practitioners with knowledge of the needs of the student and the strengths and weaknesses of the technology, SLPs and teachers also have the knowledge to participate in a user-centered design approach, called participatory design (Elizarova & Dowd, 2017). With the direct experience gained from using the technology with students in the classroom, teachers have valuable insight and feedback for developers that can improve the product. They can share how the app is performing in relation to a specific student goal, or ways that they use the app to collect data. In addition to feedback on the implementation of technology, teachers have insight on how the app or the tool is being received by the student. With that knowledge they are also in the position to represent the student's voice in the product design. For example, if a student is struggling to identify a specific picture with a word, the teacher can suggest other options to visually depict the image that may be more effective.

Non-SLP Designers and Developers

The findings from the multi-stakeholder interviews indicated that non-SLP app designers and developers can contribute valuable skills that can assist teachers and SLPs in facilitating effective technology-enhanced therapy sessions within classrooms. One key skill they can offer is the scalability of therapy apps across different technology configurations and languages. During our interview study, our non-SLP app developer participants mentioned how they provided technical support and quick releases of different versions of the same app that were compatible with various device configurations to make it accessible for students in the classroom and at home. This stakeholder group also has the skills to translate apps from one language to another so that they can reach multiple language communities. They can also leverage their technical skills to create more personalized apps by updating the in-app characters and voice tone used based on research, feedback, and cultural constraints of

potential users. Participants discussed how the involvement of non-SLP developers throughout the design process could be helpful in proactively integrating translation theory-driven therapy techniques into application features, game mechanics, or app storylines.

App developers would greatly benefit from close support from teacher and SLP practitioners in the creation of effective and engaging technology-driven lesson plans for students in classrooms. As part of the iterative design process, app designers and developers often benefit from evaluating the apps in a classroom setting to understand which application features are effective and which may need improvement. This application testing is also important to ensure that the app is meeting the therapy goals set forth initially.

Teacher and SLP practitioners can assist usability testing by providing access to app testers and classrooms and providing expert input based on prior experience of working with students in a classroom setting and working with similar apps. Teachers can explicitly discuss their thoughts on which types of application features worked and did not work well for specific therapy goals. Teachers can also provide concrete input on what additional features can be added to track student interaction with the app that could later be used to assess student improvement for a specific communication goal. Other strengths that teachers and SLPs can bring to the table include therapy materials, funding to conduct usability testing, specialized external support including icon collection. Overall, our interview data illustrates the unique role non-SLP developers can play in designing and developing scalable therapy apps for classrooms that accommodate students of different language groups and populations.

Researchers

The dynamic collaboration between research, development, and practice is pivotal in designing effective interventions (Olswang & Goldstein, 2017) as well as effective apps and technologies. The researcher ensures the app or tool has scientific rigor; the practitioner contributes expertise about the communication patterns and needs of specific populations, or specific educational practices. Practitioners are also mindful of the implementation and administrative issues likely to impact the use of the app or tool and can give the developer valuable insights in how to engineer the technology so that it fits seamlessly in the educational setting.

Conclusion

Understanding the student user is foundational in the process of selecting, implementing and designing an app. The more various facets of the student's needs and experiences are considered, the more likely the mobile app will be successful. With the holistic understanding of the student in mind, knowing specific mobile apps and their features is critical in the selection of choosing them to meet a specific goal or objective. We can learn from the speech language pathologists not only how to implement apps but also how to design apps that support language learning especially students with communication needs. This is mirrored in the iRPD model where they can be a practitioner and focused on their teaching practice and collaboration among key stakeholders especially speech language pathologists. They are also seen as a researcher, collecting student data and adapting their teaching based on the data.

Finally, they can be designers and make impacts to the field especially when it comes to developing technology to assist language learning. The key to this model is being able to identify how to work with different stakeholders and the unique assets that they, as teachers, bring as they move throughout the iRPD framework as practitioners, researchers and designers so that the students can have an internally consistent user experience. In the future a closer look at the non-practitioner developer data is beneficial to educate teacher practitioners on basic technology competency to become better collaborators and more independent designer partners.

Recommendations
Implementing Apps

It is important to consider different stakeholder needs when implementing apps to use with students. Based on the data from the stakeholders in this study and the foundations of the iRPD framework (i.e., shared epistemology, interconnected social factors, awareness of app affordances, child-centered pedagogy), we compiled a list of six areas to consider when implementing apps.

1. Collaborate and Create a Smart Partnership

The first step is collaborating, whether you are a teacher, special educator, speech language

pathologist. Sharing ideas and getting on the same page is critical. Teachers and special educators share a unique lens of the classroom and the day-to-day impacts that language and technology play within the classroom. It is also critical to collaborate with speech language pathologists because they hold a unique epistemology that can provide the teacher with a greater understanding of language and specific strategies and technology to support students and their teaching. Having a "smart partnership" where practitioners think "smarter not harder" is the key! Collaborating to exchange ideas, implement new technology, collect data, analyze the results is all a part of the partnership. The members can determine and assign each role and meet to continue working towards a common goal. Each partnership is unique and roles may vary depending on what is decided among the collaborators in the partnership.

2. Conduct a Holistic Review of the Student

Each student is unique and has different factors that impact their learning. It's important to learn their strengths and needs with the language and communication but also with the technology. An advanced organizer like a SWOT worksheet that identifies strengths, weaknesses, opportunities, and threats can help guide the practitioner in collecting information about the student. The SWOT analysis can be given individually to multiple people to gather data on a specific student, or it can be used in a meeting with a variety of stakeholders where they discuss each section to gain more knowledge about the student. During this process you want to involve the family and possibly the student if it is age appropriate. In collecting information about the student there may be some social factors (e.g., multilingual, diagnosed disability, school setting, type of service delivery) that influences the type of tool and where you will begin using the technology. For example, if a child is multilingual, is the app or technology offered in other languages? Or if the student is placed in an inclusive setting for part of the day and a self-contained setting for ELA (English Language Arts), it may be more appropriate to begin teaching the technology in a smaller setting where interaction can be supported and monitored more frequently. By gathering the information about each facet of the student, the practitioner can create more individualized choices in technology for the student and teach them in a child-centered way.

3. Connect to Goals and Objectives

Technology and the tools that are selected need to connect to academic content standards or

the specific goals and objectives that have been identified for the student. This may seem like a basic concept; however, there has been a direct connection to academic success and improvement in areas beyond the classroom. If the student has an identified disability in his or her IEP, there may also be technology considerations to be mindful of when implementing technology. For example, a student with autism may be distracted by an app that has flashing graphics and loud noises, or a student with cortical visual impairment (CVI) may require high-contrast visual design. If you choose to include the student in the process of setting and tracking the goals, it can help them learn important life skills like planning, organizing, and time management while also building communication skills, self-awareness, and confidence.

4. Explicitly Teach the Technology

Make sure that you have used the technology before. Test run it, conduct activities and practice utilizing the technology or the app like you plan to use with the student. Review and evaluate the special features and make appropriate selections based on the holistic review of the student and their goals and objectives. Then, think about exactly where, when, for how long you want to first introduce the device or app. You don't want to assume that younger children are digital natives and are able to quickly learn the technology.

5. Integrate the Technology among Settings

Once it is determined that this is the technology tool or app that is going to be implemented you'll want to provide professional development for others who interact with the student. This phase is where you can build on the partnership that you developed in step 1 of this process. Practitioners will collaborate with that team to identify key stakeholders for the training. This is particularly important for families and maybe even training multiple members if possible so that there is a larger support network for the student. Once the training has occurred among the key stakeholders, the team will also discuss gathering data for the generalization and maintenance of the tool for the student.

6. Continually Evaluate

Data collection needs to occur in each setting. This can be informal like observations, anecdotal records, and discussions with the student, family or other practitioners. It can also

be formal where you are directly observing the student or providing a survey to gather more concrete data that may not be able to be observed. The goal of continual evaluation in multiple forms is to monitor the effectiveness of the technology intervention and adjust to make changes if needed. There needs to be evidence that the intervention is effective. Sometimes the app or technology tool will have a data collection system; however, the participants suggested having the practitioner create their own tracking system to ensure the individual goals and objectives are being met. An additional tip that was shared, that is above and beyond, yet still critical advice from our participants was to connect to a tech community. They discussed the benefits of state, federal, and professional websites like National Council of Teachers of English (i.e., Connected Community website or blog), International Literacy Association, Council for Exceptional Children or American Speech-Language-Hearing Association). These websites can provide up-to-date policy changes, position statements, and lesson resources to support language learning.

Designing Mobile Apps

It is possible to design mobile apps as a practitioner. Based on our research, we've compiled a list of recommendations with some supporting templates to further assist you in developing apps based on your insights and experience.

1. *Identify Gaps*

As you use your instructional materials, make note of any gaps in the materials and tools that you are using. A gap can be an opportunity to create a mobile app that will fill an important need. Before investing too much time, do thorough market research by searching for apps that might be solving the same or similar problems. You can search the iOS App Store and Google Play store, in addition to conducting web searches using keywords that describe your app idea, for example, "math facts AND mobile app." Specialized databases such as the *Educational App Store* might be helpful during this step.

2. *Draw Upon your Knowledge and Experience and Generate App Ideas*

Practitioners have valuable domain knowledge and experience that can be used as app creation ideas. Draw upon your knowledge and your teaching experience to generate app

ideas that will connect with your students. Some examples in our study included an SLP practitioner who saw a need for a categorization app to supplement her non-digital materials, and an SLP researcher who developed an app that made use of biofeedback technology being developed in her lab.

3. Identify Key Stakeholders in Your Setting and Collaborate

Identify and collaborate with stakeholders in your setting who can give input on app design and implementation, such as SLPs, paraeducators, parents, and special education teachers. Other stakeholders could include technology gatekeepers at the school, TOSAs (teachers on special assignments), and administrators who authorize curricula and purchases. Later, these stakeholders can also help you test and refine your app during development.

4. Collect and Analyze the Data

With different stakeholders identified in the previous step, the practitioner can conduct structured interviews on mobile app usage and design (e.g., asking the same predetermined questions to all stakeholders, in the same order). You will gather different data based on stakeholders' role and perspective, and this information will give you actionable insight for app implementation, app development and sales and marketing. For example, you could learn from a TOSA (Teacher on Special Assignment) who is assisting with English Language Learning that your school district is looking for apps that address a specific instructional area. To help structure the data collection and analysis process, we included the codebook (Appendix B) that we used in our research study. The codebook can provide ideas and themes that can assist you with your app design and development. There are quotes provided in the example that can be used as a guide as you analyze the interviews. Additionally, the codebook includes areas of influential factors that will affect and constrain your app, including financial, economic, political, social/cultural, and ethical/moral that you will want to consider as your design and develop your app.

5. Organize your Ideas

Use the *Persona Template* (Appendix C) to organize your ideas, such as app features and functions, student needs and characteristics, teaching goals and strategies, influential factors,

and stakeholder perspectives. Personas are a user-centered design tool that help designers consider the worldview of specific users (e.g., their professional backgrounds and challenges, their perceptions and attitudes, and their needs and desires). Personas can help focus the digital designer on the concerns of specific users in a holistic way. The *Persona Template* in Appendix C was directly designed from the codebook in Appendix B. It is a summary of the primary codes in the codebook, as well as the subcodes nested under the primary codes.

6. Connect to a Community

Many of the SLP designers in our data spoke of how lonely it can be to design apps, since app design is an entrepreneurial activity taking place outside of a practitioner's main job and professional community. These practitioner designers filled their need for support by reaching out to communities of app designers and other practitioners for ideas and encouragement. You can connect with like-minded practitioner designers yourself via social media (e.g., a Facebook group such as "Teachers With Apps"), technology blogs (e.g., https://www.helloteacherlady.com/blog), or industry groups such as International Technology and Engineering Educators Association. Informal, self-organizing conversations ("subreddits") of developers and aspiring developers can also be found on Reddit (i.e., www.reddit.com). Here are a few subreddits you can follow to start learning from others: r/AskProgramming, r/LearnProgramming, and r/Coding.

7. Develop your Team

Refer to the iRPD framework in Figure 1 to organize the app development process and all its key considerations, the team members and their interactions. Reach out to developers and researchers with your ideas. These individuals will need to have a highly collaborative mindset to be able to work dynamically with other team members, as illustrated in the iRPD framework.

8. Design, Test and Retest your Mobile App

Actively involve stakeholders in the research cycle, including the student. Take data on the prototype app and share information while you are in the design phase of the mobile app. Try ideas, test, and iterate.

9. Provide Feedback and Consider the Feedback of Others

Create an internally consistent user experience by considering feedback from your stakeholders and development partners. When each stakeholder perspective is considered and balanced with the others, the synergy assists in creating apps that reflect the needs of the student, the teacher, and the environment. Also, think through the feedback features of the app (Banihashem et al., 2022). What feedback do you want the app to give? What feedback do you want the teachers or SLPs to give? For example, the app could give the child feedback for a correct answer with an interactive sound or visual. In some cases, the practitioner will need to give the feedback themselves. For example, currently an app cannot judge if a speech sound is correctly produced so a practitioner must assess the speech sound and provide the feedback (in the future with artifical intelligence this may change). In some cases the practitioner and student will work together using the app and feedback will occur with the teacher as a guide to facilitate learning and feedback using the app. Using the articulation example above, the practitioner can reinforce the correct sound production of an "r" sound, and tell the student, "Give yourself a point." When the student "gives themselves a point" the app can provide feedback like sounds or visuals.

Getting Started

These prompts can be used to assist in improving your practice to support language learning.
1. Reflect on personal collaboration with SLP and make concrete goals on how to improve the collaboration or shared practices.
2. Explore a variety of apps utilized by SLPs (see Table 3) to support language learning and identify at least 1 to try to implement within your practice.
3. Analyze the dynamic interaction between stakeholders in the iRPD framework in your setting. Identify some opportunities and challenges of collaborating to create mobile apps.
4. Identify a developer (see Table 3) and reach out to him or her. Discuss ways that you can collaborate and support each other in your unique roles.

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Appendix A. Demographic Information of 37 SLP App Users and Designers and 13 Non-SLP App Designers and Developers

Participant ID	Work Setting	Location	Areas of Specialty
P1	Private Practice	OR, USA	General
P2	Public School	CA, USA	AAC
P3	University Clinic	WA, USA	AAC
P4	Children's Hospital	PA, USA	AAC
P5	Private Practice	MA, USA	Instructional Tech
P6	Public School	TX, USA	General
P7	Private Practice	AZ, USA	General
P8	Public School	TX, USA	General
P9	Private/Telepractice	CO, USA	General
P10	Cerebral Palsy Center	Malaysia, USA	General
P11	Public School/Telepractice	WI, USA	Telepractice
P12	Public School	OR, USA	General
P13	Hospital/Telepractice	NM, USA	Assessment

P14	Public School	CA, USA	General
P15	Public School	AZ, USA	General
P16	Private Practice	China	General
P17	Children's Hospital	OK, USA	General
P18	Home Health	TX, USA	General
P19	Public School	NY, USA	AAC
P20	Private Practice	CA, USA	Behavioral Intervention
P21	University Clinic	CA, USA	AAC
P22	University Clinic	OH, USA	Pedagogy and Games
P23	Private Practice	CA, USA	Telepractice
P24	University/Private Practice	NJ, USA	Fluency & Games
P25	University Research Lab	IN, USA	AAC
P26	Public School/Telepractice	OR, USA	Prosody
P27	Private Practice	TX, USA	Assessment (Bilingual)
P28	University Clinic	ND, USA	Articulation & Language

P29	Public School/App Company Owner	TX, USA	Articulation & Language
P30	Senior Product Management	WA, USA	Assessment
P31	Public School	CA, USA	Articulation & Language
P32	Research Lab (Telepractice)	NY, USA	Biofeedback
P33	University Research	TX, USA	Assessment (Bilingual)
P34	SLP/Graphic designers	UT, USA	Articulation & Language
P35	Private Practice	CA, USA	Auditory Processing
P36	Private Practice	MA, USA	Social Groups
P37	Hospital SLP/iOS Developer	Sweden	Articulation & Games
P38	Play Designer Children's Game Company	Sweden	Children's Games
P39	PhD Student Researcher	CA, USA	Speech Recognition Game
P40	Interactive Producer	Canada	Speech Recognition Game
P41	Parents with Disabled Children	WA, USA	Children's Games
P42	Web developer/Parent w/ Disabled Child	UT, USA	AAC

P43	Parents with Disabled Children	CA, USA	Speech Recognition Game
P44	iOS developer	Israel	Children's Games
P45	PhD Student Researcher	CA, USA	Speech Recognition Game
P46	PhD Student Researcher	TX, USA	Speech Recognition Game
P47	Director of Operations	NC, USA	Speech Therapy Apps
P48	Interactive Producer	Lithuania	Children's Games
P49	iOS developer	Sweden	Children's Games
P50	iOS developer	Sweden	Children's Games

*AAC = Augmentative Alternative Communication (AAC); P1 to P23: SLP App Users, P24 to P37: SLP App Designers, P38 to P50: Non-SLP App Designers and Developers

Appendix B. Interview Codebook with Codes, Themes, and Sample Quotes

Themes	Codes	Sample Quotes
Client Characteristics	**Age Group**, Type of Disability/Disorders, Levels of Ability	"Creating apps for kids, for little ones. The smallest from one year, for example, until the school age like preschool kids." (P44)
Clinician & Developer Characteristics	Clinical Setting, Clinician/Developer **Experience**, Non-clinical Roles	"I was always interested in technology, so I went and got a second master's in instruction tech, which I did online through a state college near here, Framingham State." (P5)
Clinical Practice	**Therapy Goals**, Therapy Environments, **Therapy Activities**, Therapy Materials, Therapy Techniques, Clinical Challenges, Case Management	"They think that they're just playing. Here I'm asking them questions like, "Where do you think the bee is going to be next?" I'm working on prepositions [laughter] and they're just coloring." (P28)
App Characteristics	App Names & Genres, App Use Techniques, **Design and Development**, App Features	"I couldn't find any app that did what I wanted it to do. I reached out to Barbara, and I said, "I have this idea, I want to do a categorization app. Here is what it would look like." She is like, "Absolutely, you make it up, and I will come up with how it looks." I spent the next, probably close to a year, in developing and researching how to teach categories, and why was it really important." (P28)

Therapy Tools	Non-digital Materials, **Online Platforms**, Software, Hardware, Database	"For fluency clients, we will go to websites, try to identify famous people who stutter, or watch videos of children who stutter just to help educate them and empower them." (P1)
Influential Factors	Sociocultural, Political, Ethical/Moral, **Financial**/ Economic, Motivating (to the clients)	"I probably wouldn't pay 30 dollars for a pronouns app you know what I mean. For a general sentence building app that I can use to make a bunch of different things I'd be more willing." (P6)
Support Systems	Stakeholders & Organizations, **Perception & Attitudes**	"I think the tech community, for the most part, really doesn't understand the education system, doesn't understand special education. And it's sometimes difficult to communicate with them." (P23)
Recommendation	**App Design**, System Design, Unmet Clinical Needs	"For some reason, [kids] just love to watch [game apps]. It would be really cool if there was an app component in there where they would have to say something to make him run or jump or whatever and using language in it." (P7)
Marketing	Distribution Channel and Methods, Advertising/Public Relations/Promotion, **Marketing Research**	"We realized here that we had to connect with people in different ways. So…I'm a member of groups on Facebook where teachers are, are talking about education and technology and iPads, special education and so on." (P50)

Appendix C. Blank Persona

CLIENT CHARACTERISTICS

Age	Types of Disability/Disorders	Levels of Ability
➢	➢	➢

CLINICIAN CHARACTERISTICS

Clinical Setting	Clinician Experience	Non-Clinical Roles
➢	➢	➢

CLINICAL PRACTICE

Therapy Goals	➢
Therapy Environments	➢
Therapy Activities	➢
Therapy Materials	➢
Therapy Techniques	➢
Clinical Challenges	➢
Case Management	➢

APP CHARACTERISTICS

App Names & Genres	App Use Techniques	Design & Development	App Features
❏	❏	❏	❏

TOOLS

Non-Digital	Online Platforms	Software	Hardware	Database
●	●	●	●	●

SUPPORT SYSTEMS

Individuals Stakeholders / Organizations	Perception & Attitudes
●	●

RECOMMENDATION

App Design	System Design	Unmet Clinical Needs
●	●	●

INFLUENTIAL FACTORS

Sociocultural	➔
Political	➔
Ethical/ Moral	➔
Financial/ Economic	➔
Motivating (to the clients)	➔

COMMERCIAL OPPORTUNITIES

Marketing	★

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