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Evaluating Mobile Application as Assistive Technology to Improve Students with Learning Disabilities for Communication, Personal Care and Physical Function

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Abstract. This study addresses the challenges faced by Malaysian students with learning disabilities, emphasizing the critical role of assistive technology (AT), particularly Augmentative and Alternative Communication (AAC) within mobile applications. Focusing on the Smart-App, the research explores its efficacy in supporting students in learning and establishing routines for activities of daily living (ADLs). Four preschool students aged five to six attending a specialized institution, with the use of direct observation and an adapted checklist methodology to assess their personal care, physical function, and communication aspects. Smart-App's shows significant impact on communication, enhancing two-way communication through visual schedules and AAC features. In personal care, the app facilitated ADLs, such as handwashing and tooth brushing, emphasizing a sequential click-through approach. Additionally, the oral hygiene module served as an effective pedagogical tool. In terms of physical function, Smart-App contributed to toilet training and identified challenges in specific physical activities. The study contributes substantively to the discourse on AT in education, underscoring the potential of Smart-App as a valuable tool for enhancing ADLs and fostering independence among students with learning disabilities.

Keywords: learning disabilities; activities daily living; assistive technology; mobile application

1. Introduction

A wide range of learning disabilities, including Down syndrome, ADHD, autism, intellectual disabilities, dyslexia, dyscalculia, dysgraphia, and others, have been identified by the Malaysian Ministry of Education in recent years as these conditions affect students in preschool to higher education level (Ministry

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of Education, 2023). The primary hurdle encountered by students with learning disabilities revolve around their struggle to achieve independence, particularly during their early developmental stages (Pesau et al., 2020). Issues with effective communication and interaction further intensify their difficulties in accessing resources and completing daily living tasks independently (Nordin & Rabi, 2020). In general sense, basic activities of daily living (ADLs), which is pivotal for self-care and community participation, undergo significant development during the preschool years, typically at the age of two and four (Burgess et al., 2020). However, for students with learning disabilities, mastering essential ADLs like handwashing and tooth brushing poses notable challenges due to personal difficulties in grasping step-by-step processes and spatial relationships (Pesau et al., 2020; Vuohijoki et al., 2023). Written or oral instructions may present additional obstacles, emphasizing the need for targeted interventions to facilitate their development (Nordin & Rabi, 2020). With these disabilities posing a challenge towards life skills development of these students, measures should be taken in order to fix this problem.

Through recognizing the significance of technology in tackling the obstacles faced by students with learning disabilities, assistive technology (AT) emerges as a promising avenue. Defined broadly as physical technology, software, practices, or ideas for innovation (Rogers, 1983), technology has shown remarkable potential in enhancing the educational experience for these students (Atanga et al., 2020; Zilz & Pang, 2021). AT interventions, such as those highlighted in a systematic review by Fernández-Batanero et al. (2022) have successfully increased inclusion and accessibility despite current existing barriers. Furthermore, studies by Nur Anis Suhaila & Mohd Nordin (2022) demonstrate the positive impact of AT on personal care tasks, fostering their independence and well-being. Having a significant role in the process of facilitating effective communication and interaction, the importance of assistive technology (AT) is emphasized by Kaimara et al. (2021). Despite the increasing knowledge base on the effectiveness of AT, there remains a notable gap in understanding the features incorporated within applications and their efficacy in promoting assistive technology for students with learning impairment. With the aim to address this gap by focusing on Augmentative and Alternative Communication (AAC) within a mobile application as AT, this study specifically investigates how it can support students with learning disabilities in learning and establishing routines for ADLs. In the context of this study, four preschool students at the age of five and six years old according to Ministry of Education were being observed as the participants in terms of students with learning disabilities (2023).

The upbringing circumstances and cultural background in Malaysia has significantly influenced the process of teaching and learning for students with learning disabilities. The accessibility and efficacy of educational interventions in Malaysia are determined, at least partially by the country's educational framework as well as its cultural attitudes towards disabilities. Attitudes and behaviours towards people with disability can be influenced by cultural beliefs; these in turn impact what individuals with disabilities face at home, as well as

within their social circle or community. The awareness and acceptance of the necessity for inclusive education in Malaysia have been on the rise as is evident from some of its national policies and programs that are designed to support children with learning disabilities (Nordin & Rabi, 2020). However, there are still limitations in many rural areas regard to resources and specialty services.

Environmental factors (such as the availability of technology and infrastructural support) contribute significantly to assistive technologies being implemented or not. While rural schools may face numerous challenges, urban schools may have access to more sophisticated technology and teacher training. This statement, therefore, can serve to elucidate critical environmental and cultural contexts necessary for the development of appropriate assistive technology solutions that are useful by Malaysian students with learning disabilities.

This study, by concentrating on Smart-App for ADL activities and designed with actual cultural context of Malaysia environment aims to provide an applicable adaptable solution that catered towards a wider area in the country. By examining how Smart-App can be used in this context, the research provides insight into how assistive technologies might best be integrated within a range of educational contexts.

2. Literature Review

The utilization of Human Activity Assistive Technology (HAAT) Model, introduced by Albert et al. (2016), revolutionizes the approach to assistive technology in occupational therapy. HAAT adopts a comprehensive perspective, taking into account the dynamic interactions between an individual's functional abilities, activity requirements, contextual context, and assistive technology attributes. This self-centered model prioritizes individual needs and preferences, fostering collaborative decision-making among stakeholders. HAAT's key features include recognizing the interdependence of these elements, acknowledging the dynamic nature of individual needs and environments, and empowering individuals to actively participate in the assistive technology selection process. It promotes ongoing assessments and adaptations to ensure the continual efficacy of assistive technology in facilitating meaningful engagement in various activities.

2.1 Assistive Technology

Assistive technology can be used in a variety of ways, such as providing alternative input methods (e.g., speech recognition software) or output devices (e.g., magnifiers). For example, assistive technology can be used to create custom cue cards that list the steps needed to complete a task so that students with learning impairments do not have to read the instructions multiple times for them to understand the instruction. Another effective assistive technology component that gives students with learning difficulties a clear path to adhere to when completing personal care obligations is step-by-step instructions (O'Neill et al., 2020). These instructions can be presented in a variety of formats (Atanga et al., 2020; Zilz & Pang, 2021), such as text, images, or videos. Cue cards are another effective component of assistive technology that can help students with learning disabilities with personal care. These cards typically contain visual cues

or reminders for specific tasks and help students remember the sequence of steps. By providing visual cues, the cards compensate for possible working memory deficits or attention difficulties that students may experience. In addition, the clue cards can be adapted to individual needs by taking into account specific preferences, sensory sensitivities, or particular challenges of the student. This has been described as the augmented and alternative communication (Zaharudin et al., 2023). Augmented and alternative communication (AAC) encompasses a repertoire of methodologies, approaches, and instruments employed to amplify or substitute verbal expression for individuals encountering challenges in communication, exemplified by students with learning impairments.

The core principles of AAC underscore the universal right to communication, irrespective of abilities (Lui et al., 2022; Rocío Blanco et al., 2024). AAC is an effective instrument that facilitates communication and offers people the freedom to express themselves through a variety of means, such as gestures, speech-generating technology, and more. AAC interventions place a strong emphasis on functionality and are designed to support people in achieving everyday communication goals, such as expressing needs and participating in social activities (Zaharudin et al., 2023). Beyond communication skills, a holistic approach is employed as it encompasses cognitive, social, and emotional growth. The pivotal role of collaboration is highlighted, as AAC effectiveness thrives on a team approach involving the individual itself, their family, caregivers, and professionals. In other words, AAC can be presented within the assistive technology (Zaharudin et al., 2023).

Typically, in normal physical environment of the classroom for students with learning disabilities, it is usually equipped with technology or intervention to support the learning process of these students. One such intervention is assistive technology (AT), which helps students with disabilities learn in ways that are most effective for them (Fernández-Batanero et al., 2022; Starks & Reich, 2023; Svensson et al., 2021). Despite limitations such a lack of information and accessibility, AT has successfully boosted accessibility and inclusion for students with impairments, based on a comprehensive systematic study by Fernández-Batanero et al. (2022). Assistive technology can also be used to assist students with disabilities in accessing information and indirecty impact their well-being in a positive manner (Nur Anis Suhaila & Nordin, 2022). Additionally, the escalating availability of mobile devices has created opportunities for user engagement with mobile applications (Chelkowski et al., 2019). Students with impairments who can use mobile applications as assistive technologies are among the many recipients of this breakthrough in technology. These apps serve as crucial for providing access to knowledge, encouraging communication, and developing organisational skills in students with impairments (Chelkowski et al., 2019; Stathopoulou et al., 2020). There is still a significant knowledge gap about the features included in applications and how well they work to support AT for students with learning difficulties, even in spite of the increasing amount of research on the topic. Therefore, in order to fill the gap in the existing literature, this study will concentrate on the following objectives, (i) evaluating

the effectiveness of AAC features within a mobile application in enhancing communication skills among students with learning disabilities, (ii) assessing the impact of mobile application in supporting physical function, specifically in toilet training and related activities for students with learning disabilities, and (iii) examine the role of Smart-App in supporting physical function specifically in toilet training and related activities for students with learning disabilities. In the context of this study, a mobile application namely Smart-App has been chosen in investigating how it can assist students with learning disabilities in learning and establishing routines for ADLs.

2.2 Smart-App

Within the boundaries of this study, researchers concentrate on evaluating students with learning difficulties using the Smart-App application, which is at present in prototype development. Smart-App, designed to facilitate activities of daily living, stands out as a multifaceted mobile application addressing personal care, physical function, and communication needs. A distinctive feature of Smart-App is its capacity to streamline various functionalities, eliminating the need for students to toggle between disparate applications, thereby enhancing convenience for both students and teachers. The Smart-App's position as a cutting-edge communication tool that has been painstakingly designed to meet the specific needs of students with learning difficulties is very significantIts primary objective revolves around enhancing comprehension of verbal communication tied to daily routines and fostering effective communication between students and teachers.

With an emphasis on enhancing ADLs for students with learning difficulties, Smart-Apps offers students visual clues and assists so they are capable of conveying their needs, wants, and feelings. The module employs task analysis (Figure 1) which break down complex activities into manageable, achievable steps. Following the successful execution of the task, a motivational image expressing commendation will appear, signifying the completion of all requisite steps. Notably, the personalized care module embedded in the Smart-App website imparts essential self-care skills, such as hand washing, tooth brushing, and bathing (Figure 2). Through a sequential click-through approach, students can enhance their learning experiences, simplifying the execution of these activities. This breakdown of complex tasks not only fosters independence but also contributes to the development of executive functions and sequential thinking skills among students facing learning difficulties. Moreover, the toileting module within Smart-App centers on promoting independence in physical function, specifically within toileting practices (Figure 3). Utilizing visual cues and task analysis techniques, this module serves as a reminder for students regarding the various steps associated with toileting, including but not limited to flushing the toilet. The attributes of this app align with the recommendation made by Rocío Blanco et al. (2024), which concentrated on developing apps that have various modifications to make it compatible with those who have learning difficulties.

Figure 1: Example of steps-by-steps attainable procedures

Figure 2: Activities cues

Figure 3: Toileting practices

With embedded features within the mobile application, it helps teacher to communicate with the students as both of the parties are able to point to the cue and create a functional communication (Rocío Blanco et al., 2024). In the light of the foregoing, this studies focus is on evaluating the efficacy of Smart-App's usability in facilitating communication, personal care, and physical functioning, based on the embedded AAC features within and thereby contributing substantively to the discourse on assistive technologies in education. This is consistent with the findings of Ok and Rao (2019), who demonstrate that AT which reinforces skills and routines can be beneficial for students with impairments in learning.

2.3 Theories

Zone of Proximal Development (ZPD) is a phrase that was initially introduced by Vygotsky in 1978 to describe a range of tasks that an individual may complete with some assistance but cannot perform on their own. Through the scope of this study, the Smart-App's integrated scaffolds offer AAC features that facilitate students' successful communication and accomplishment of ADLs. For instance, the app's visual schedules and pictorial signals assist kids in learning routines that are simpler for those around them to follow—such as those with more severe special needs or no speech—which may eventually lead to ZPD. Students go from needing heavy support with the app to lower levels as they grow more adept in using it. This sequence captures the changing quality of the zone and emphasizes how it is important to provide responsive support for learning and development.

Furthermore, according to Meyer, Rose, and Gordon (2014), who established Universal Design for Learning (UDL) concept, learning environments have to be adaptable enough to accommodate the demands of any student. In order to accommodate all students with their diverse needs, UDL focuses largely on delivering multiple forms of representation, expression, and interaction. In accordance with this concept, assistive technology must be malleable in order to fulfil the various demand of learners who have learning difficulties. Smart-App is an example of it as it provides support for customized app that could be designed to fit individual student's requirements and operate

on the principles of UDL. With multiple modalities (e.g visual, auditory and textual instruction) the app leverages mean of representation to provide different ways for students (learning preferences) to access information. The app also has multiple modes of expression, as it allows for visuals and AAC support (using voice-in-output capabilities). Smart-App accomplishes this by keeping students engaged through interactive and exciting content, all with multiple means of engagement that prolongs the time they are excited in applying new concepts. Teachers are able to tailor the features of the app to the specific requirements of students separately thanks to this customisation feature, which is in line with UDL's goal of creating inclusive learning environments that benefit all students. Smart-App helps students with learning challenges right away and can help them become independent in the future by using UDL concepts.

A thorough framework for comprehending the efficient usage of assistive technology (AT) to boost the capacities and independence of people with disabilities is also provided by this study's scaffolding from the Human Activity Assistive Technology (HAAT) Model, created by Albert Cook and colleagues. The HAAT model is centered around four key components: the human (individual), the activity (task), the assistive technology, and the context (environment and cultural factors). Each component interacts dynamically to influence the overall effectiveness of assistive technology interventions. This study evaluates the extent to which the Smart-App facilitates students with learning difficulties by utilising the HAAT paradigm. By examining the interactions between the human, activity, assistive technology, and context components, the study provides a holistic understanding of how Smart-App can enhance communication, personal care, and physical function among students.

Henceforth, HAAT model has been used as the scaffold for this study (Figure 4). This study's Human component focuses on preschoolers with learning disabilities who have any particular difficulties with personal care, communication, and physical function. The Smart-App is tailored to address these challenges by providing visual schedules, step-by-step instructions, and AAC features. Moreover, in the Activity component, this study evaluates three main activities: communication, personal care, and physical function. Each activity is essential for the students' daily living and independence. For example, communication activities include using visual schedules and picture aids to express needs, while personal care activities involve tasks such as handwashing and tooth brushing, and physical function activities include tasks related to toileting. Additionally, The Smart-App serves as the assistive technology component in this study. It provides a range of features designed to support the students in performing ADLs. These features include visual aids, auditory prompts, and interactive modules that guide students through various tasks. The application's layout conforms to the guidelines of the Universal Design for Learning (UDL) framework, providing a variety of representational, expressive, and interactive mediums to meet the demands of a wide range of learners. Each of these elements was wrapped up and taken into account within the educational and cultural framework of Malaysia. The adoption and efficacy of

assistive technology are heavily influenced by variables like technological accessibility, infrastructure support, and societal perceptions of disability. Recognising these elements, the study seeks to shed light on how the Smart-App could be successfully incorporated into the Malaysian learning environment.

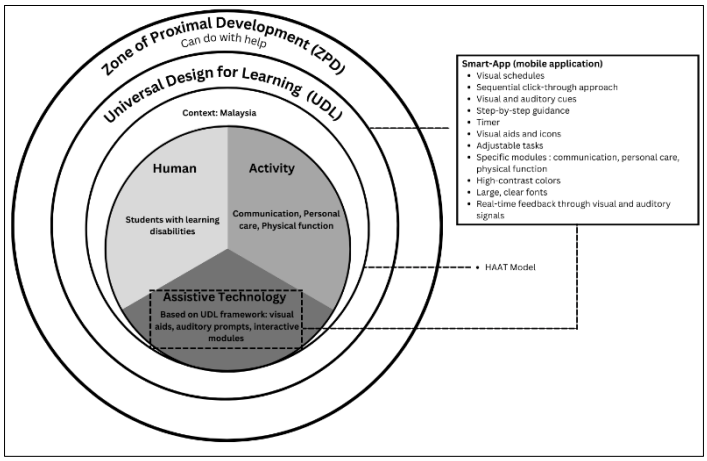

Figure 4: Conceptual framework used in this study

This study uses the HAAT model to systematically explore interactions between human, activity, assistive technology and context components. Furthermore, all variables involved in Smart-App have been assessed to provide a holistic evaluation ensuring that nothing could affect the efficacy of this application. The study's findings add to the expanding corpus of information about new and emerging technologies used in different educational settings that aid students with learning difficulties.

3. Methodology

3.1 Sample and sampling method

To assemble the study's sample, purposeful sampling was employed. Purposive sampling is used to zero in on certain, distinct concern or circumstances (Cohen et al., 2018). This approach enables a thorough analysis of the efficacy of a mobile application intended to assist these students with their activities of daily living (ADLs). The researcher decided to solely concentrate on students who have learning impairments and the teachers who interact closely with them as carers, therefore purpose sampling was the tool of choice. In the context of this studies, the sample consisted of four students between the ages of five and six of whom three are male and one female that fits the definition of students with learning impairments (Ministry of Education, 2023) in one of the private local preschool that caters to students with special needs. The students were placed under the carer of two class teachers. In these studies, the participants are named Students A1, A2, A3, and A4. They attended playgroup program for four hours, five days a week. The chosen centre was specifically targeted due to its nature that focus on students with learning disabilities and familiarity of the students with AT, such as iPads for classroom management. Besides, the efficacy of the Smart-App intervention has not been studied yet within this setting.

3.2 Informed consent

Informed consent was obtained from guardians of each participant. The consent process involved explaining the study's purpose, procedures and the use of collected data solely for research purposes. Guardians were assured of the confidentiality and anonymity of the data

3.3 Data collection Procedure

Given the young age of the participants and their limited grasp of verbal communication, data collection was primarily conducted through direct observation by the researcher in the natural environment during the researcher observed and recorded their interactions with the Smart-App. The observations were conducted in the natural classroom environment over a period of four weeks. To ensure a standardized approach to data collection, a checklist methodology was employed. The checklist employed in this study consisted of multiple sections, namely personal care, physical function, and communication, and was adapted based on the Independent Living Skill (ILS) checklist (Wallace et al., 2000). Each section contained a specific number of items, with the personal care section comprising six items, the physical function section containing four items, and the communication section including four items. Besides, field notes were also taken upon observation checklist Table 1 listed out the checklist observation item utilized in this research.

Table 1: Observation Checklist

Dimensions	Checklist
Personal Care	A1. Wash hands (water on/ off, soap) A2. Use a variety of towel dispenser/blowers A3. Use tissue to wipe and blow nose A4. Combing/brushing hair A5. Brushing teeth A6. Wash/wipe own body parts
Physical Function	B1. Bend and pull-down pants B2: Stand on one foot t wear pants B3. Press to flush toilet B4. Climb up and down from toilet bowl
Communication	C1. Can follow a daily routine visual schedule C2. Identify what comes first or next C3. Communicate needs using picture aids C4. Regulate behaviour with the help of behaviour visual cards

The researcher conducted observations during various activities involving the use of Smart-App. Detailed field notes were taken to supplement the checklist data. Each observation session focused on capturing the students' interaction with the app, their ability to follow the step-by-step instructions provided by the app, and their responses to visual and auditory cues. The analysis involved comparing the observed behaviors and task completion rates before and after the introduction of the app. The researcher closely observed how the students utilised the app, how effortless it was for them to do the tasks assigned, and whether or not teachers had to step in to provide assistance.

3.4 Data analysis

The data collected through the checklist and field notes were systematically analysed to identify patterns and measure the effectiveness of the Smart-App in supporting the students' ADLs. The analysis involved comparing the observed behaviours and task completion rates before and after the instruction of the app. Additionally, the researcher evaluated the students' ability to generalize learned skills to similar tasks without the app's assistance.

4. Results and Discussion

4.1 Effectiveness of Smart-App to support student with learning disabilities in communication.

Aligned with Anderson and Putman (2020) and Lui et al. (2022) study, the effectiveness of Smart-App in communication has been observed with regard to the use of augmentative and alternative communication (AAC). In the context of a classroom, visual schedules function as communication tools that provide students with a comprehensive overview of their daily routine and associated activities. There were notable behavioural changes during the transition from a physical visual schedule to a digital visual schedule at Smart-App. Previously, the physical schedule was prominently displayed on the classroom whiteboard, providing students with easy access and the ability to refer to it as needed. The switch to a digitized visual schedule in Smart-App meant that the physical visual schedule was no longer visible to students. Student A3 struggled with the absence of the physical visual timetable in the early stages of the observation as student A3 has been used to its presence. Hence, this show and support Shepley et al. (2018) remarks that in order to introduce a new approach such as using AT in class either for activities or class management, a gradual exposure will help the students with learning disabilities to get familiar with the whole approach. This is also emphasized by Davis and Garfield (2021) that gradual familiarization with the digital format is recommended to facilitate adaptation and optimal use of the application. Student A3 repeatedly expressed a sudden desire to "go home", which sometimes escalated into a tantrum. It was observed that teachers immediately presented the visual schedule via Smart-App in response to the scenario. Even though there were some communication challenges with student A3 at the beginning, as student A3 get familiar with the app, together with student A1, A2 and A4, they demonstrated that they were able to recognize the visual schedule icon on Smart-App. Hence the finding in this shared the similar light with Lui et al. (2022), Rocío Blanco et al. (2024) and Zaharudin et al. (2023) that a mobile application embedded with AAC can establish communication for individuals with significant communication challenges.

It was also observed that students A1, A2, A3, and A4 were able to effectively identify ongoing and upcoming activities through the use of visual schedules in Smart-App. However, student A3 occasionally required the teacher's assistance when confronted with the prompt on Smart-App, "Would you like to continue the schedule from where you left off?". It was noted that student A3 showed a tendency to immediately select the "start over" option without asking the teacher for confirmation. This ultimately led to the repetition of activities that had already been completed that day. Therefore, this suggests that in the context

of assessment tasks, the inclusion of extensive wording prompt should be circumvented. Ok and Rao (2019) posit that an extended prompt poses a difficulty for students with learning impairments as they are unable to decipher and comprehend extensive language structures. The cognitive load imposed by prolonged prompts can exacerbate the cognitive challenges faced by such students, impeding their ability to extract and process relevant information essential for a thoughtful response.

The facilitation of two-way communication between carer and students were significantly enhanced through the implementation of AAC via Smart-App. The auditory feedback features incorporated into the Smart-App as AT that imparts voice labels to designated images, thereby showcasing a noteworthy impact on expressive communication, language acquisition, and word enrichment. This AAC goes beyond mere convenience, as it resonates profoundly with the multifaceted needs of users, underscoring its pivotal role in fostering communicative competencies. This finding aligns with the research by Lui et al. (2022), Rocío Blanco et al. (2024), and Zaharudin et al. (2023), demonstrating that mobile applications embedded with AAC can establish effective communication for individuals with significant communication challenges. By providing vocalized cues for selected images, the Smart-App not only facilitates language development but also cultivates a nuanced understanding of vocabulary nuances. This is exhibited through observations of students A1, A2, A3, and A4, as they are able to convey their needs by utilizing the visual aids seamlessly incorporated into Smart-App. This innovative approach allowed students to make selections from a range of images, each precisely depicting their desires or requirements. In response to the teacher's inquiry, "What do you want?" a simple click on the chosen image triggered an audio prompt articulating the representation of the image, thereby enabling students to verbally articulate their desired objects or needs. Furthermore, the students' competence to easily identify symbols representing their personal schedules on the Smart-App on their own constitutes an important milestone. This capability not only enhances their sense of autonomy but also underscores the empowerment derived from AAC within AT. Table 2 presents the findings of the data analysis discussed in the preceding sections.

Table 2: Observation Checklist of Communication

Communication	Student A1	Student A2	Student A3	Student A4
Can follow a daily routine using visual schedule	o	o	o	o
Identify what comes first or next	o	o	o	o
Communicate needs using picture aids	o	o	o	o
Regulate behavior with the help of behavior visual cards	o	o	o	o

Reference: O: Exhibit; X: Did not exhibit.

This efficacy aligns with the findings of Ok and Rao (2019), who observed that AAC in AT serves as a catalyst for student engagement in classroom activities. Furthermore, Ke et al. (2022) underscored the capacity of AAC to empower teachers in managing the demands of students that may be excessively challenging or confusing. This resonates with the assertions of Bouck and Long (2021), Rocío Blanco et al. (2024) and Shepley et al. (2018), supporting this study's findings that the application of AAC within Smart-App, functioning as a form of AT, significantly contributes to teachers' ability to escalate ADLs for students with learning disabilities.

4.2 Effectiveness of Smart-App to support student with learning disabilities in personal care.

It was found by Wallace et al. (2000) that students with learning disabilities are more susceptible to infections due to poor hand hygiene, primarily because their disabilities often prevent them from understanding and following the complex steps of proper hand washing. This is also consistent with the findings of (Edemekong et al., 2022), that emphasized the importance of promoting ADLs in personal hygiene and enabling students with learning disabilities to execute them effectively through appropriate training.

Henceforth, in the context of this study, effectiveness of the Smart-App as AT in facilitating the acquisition of ADLs among students with learning difficulties, specifically in the execution of multistep activities such as hand washing was observed. The teacher strategically synchronized the presentation of hand washing steps on the app with the students' hands-on practice, fostering a synergistic learning experience. Noteworthy observations (as in Table 3) emerged as students A1, A2, A3 and A4 exhibited a commendable ability to recall and implement the hand washing steps through the SMART-APP interface such as turning the tap, wetting the hands, applying soap, rinsing off and turning off the tap.

Their adherence to most elements on the personal hygiene checklist was commendable, although a nuanced limitation arose in the utilization of paper towels for hand drying and nose blowing. A similar pattern manifested with students A1 and A2, attesting to the consistent effectiveness of the Smart-App in these contexts. The attainable multistep identified in the study conducted by Anderson and Putman (2020) ultimately establishes autonomy for students with learning disabilities in executing ADLs, obviating the necessity to rely on AT. Besides, employing a timer for each step not only served to maintain an efficient pace but also ensured that students allocated an appropriate amount of time to each task, preventing overemphasis on certain steps like rinsing or soap application (Shepley et al., 2018). Hence, students able to complete their ADL activities in a timely manner.

Table 3: Observation Checklist of Personal Care

Personal Care	Student A1	Student A2	Student A3	Student A4
Wash hands (water on/ off, soap)	o	o	o	o
Use a variety of towel dispensers/ blowers	o	o	o	o
Use tissue to wipe and blow nose	x	x	o	o
Combing/ brushing hair	x	x	x	x
Brush teeth	o	o	o	o
Wash/ wipe own body parts	x	x	x	x

Furthermore, the Smart-App exhibited prowess in imparting oral hygiene knowledge, serving as an effective pedagogical tool for teachers. The toothbrushing steps embedded in the Smart-App were leveraged as instructional materials, enabling educators to elucidate the intricacies of proper tooth brushing techniques which include wetting the toothbrush, putting the toothpaste on brush, and brushing the teeth. During the sessions, students engaged with the toothbrushing steps on the app, followed by assessments of their ability to execute these steps in a sequential and accurate manner. The outcomes of these assessments underscored the students' capacity to comprehend and retain the toothbrushing steps, as demonstrated through their proficient execution with minimal verbal prompts from the teacher. This may have been influenced by the experience in previous activities of hand washing. Smart-App's role in facilitating the acquisition of ADLs among students with learning disabilities was evident in its ability to teach multistep activities such as handwashing and tooth brushing. A synergistic educational setting was created by coordinating the app's presentation of handwashing prompts with students' hands-on experience. Because it is apparent that the Smart-App can be utilised to guide students for proper personal hygiene function, the study's results are comparable to those of Anderson and Putman (2020) regarding small, feasible steps and Shepley et al. (2018) regarding the benefits of including timer within the AT. The results presented here support the use of assistive technologies in fostering proper sanitation and promoting self-reliance among students with learning disabilities and cultivating the practices as habitual routine.

4.3 Effectiveness of Smart-App to support student with learning disabilities in physical function.

The usage Smart-App in enhancing the toileting skills of students with learning disabilities, particularly in the realm of physical function is also observed. While the notion of utilizing mobile devices, such as Smart-Apps, during toileting may seem unconventional, it is essential to recognize that this practice is purposefully integrated into the app to cultivate and reinforce disciplined toileting habits among students. Notably, (as in Table 4) student A1, A2, and A3 demonstrated the ability to autonomously communicate their need to use the toilet, while A4, who was still reliant on diapers, encountered challenges in expressing the same.

Table 4: Observation Checklist of Physical Function

Physical Function	Student A1	Student A2	Student A3	Student A4
Bend and pull down pants	o	o	o	o
Stand on a foot to wear pants	o	o	o	o
Press to flush toilet	o	o	o	o
Climb up and down from toilet bowl	x	x	x	x

Upon consultation with the teacher, a collective decision was made to initiate toilet training for student A4. This training involved the incorporation of Smart-App with the teacher scheduling predetermined toileting intervals set at 45 minutes. The initial implementation, however, revealed instances of involuntary urination during the scheduled intervals, coupled with an apparent unawareness of wetting the pants and difficulties in urinating upon reaching the toilet. This prompted a strategic adjustment, reducing the toileting intervals to 30 minutes and encouraging the student to prolong their toilet stay, fostering a conducive environment for successful urination. Furthermore, despite the proficiency of all students in removing their pants, as indicated in the observation checklist, challenges arose when they were tasked with standing on one foot while donning their pants. Noteworthy was their exhibited instability, manifested through wobbling feet, and a preference for sitting on the floor during this activity. This particular observation served as a crucial revelation for teachers and researcher, shedding light on the specific challenges faced by the students in the context of physical function.

5. Limitations and Recommendations

This study serves with the following limitations. The study only includes four students between the ages of five and six. The findings' applicability to a larger group of students with learning impairments may be limited by the small sample size. Hence, to improve the robustness of the findings, the study would definitely benefit from a bigger and more varied sample.

Besides, this study primarily focuses on short-term outcomes, such as the students' ability to follow instructions and routines. Long-term effects on the students' academic performance, social development, and overall well-being are not explored. It is recommended that future research could investigate the effectiveness of the Smart-App in supporting students with learning difficulties in a longitudinal study. This would help to determine the sustainability of the impact of SMART-APP over time. Future research could extend the potential of Smart-App in supporting other ADLs to support students with learning difficulties in other areas such as social skills, emotional regulation and organisation. By expanding the functionalities of Smart-App, it will help to address a broader range of student needs. It should also be further investigated whether certain subgroups of students with learning difficulties benefit more from Smart-App when factors such as cognitive ability, language skills and motor skills are taken into account.

Other than that, the Smart-App is in its prototype phase. The efficacy of assistive technologies may evolve as they progress from prototype to a fully developed version. Based on the findings of this study on the effectiveness of Smart-App in supporting students with learning disabilities with ADLs, it is suggested that Smart-App could integrate a monitoring system to track and document student progress in physical functioning. This monitoring function would include data on successful toilet use, accidents, and progress over time. At the same time, this feature would allow teachers and counsellors to monitor student progress and make informed decisions about intervention strategies (Burgess et al., 2020; Chelkowski et al., 2019; Starks & Reich, 2023). Moreover, the Smart-App could also explore the potential of incorporating multimodal communication methods, such as voice recording or video modelling, to enhance its effectiveness. The Smart-App could thereby provide students with a more thorough and engaging learning experience as a result (Kaimara et al., 2021). Additionally, Smart-App also could be benefitted with the integration of learning management system features which would allow teachers, parents, and therapists to collaborate and share information regarding the progress of students' ADLs. This collaborative approach not only fosters cooperation among these stakeholders but also ensures the continued relevance and sustainability of the Smart-App over time.

6. Research Implications

The results derived from this study exhibit considerable ramifications for the special education sector and the progression of assistive technologies. By illustrating Smart-App's capacity to improve communication, personal care, and physical functioning among students with learning disabilities, various critical implications materialize.

Concerning educational practices, the favorable impact of Smart-App on students' ability to undertake Activities of Daily Living (ADLs) implies that assistive technology can be successfully woven into the educational curriculum for learners with learning disabilities. Educators should contemplate embedding comparable applications into their pedagogical methodologies to aid in the honing of crucial life skills. This study's success accentuates the necessity of thorough training schemes for educators regarding assistive technologies (AT) usage. Professional development undertakings should center on acquainting teachers with multiple AT tools, their utilities, and optimal practices for classroom application. Moreover, the study accentuates the significance of individualized approaches in education. The adaptable features of Smart-App, tailor-made to suit each student's unique requirements, propose that similar technologies be contemplated when devising Individualized Education Plans (IEPs) for learning-disabled students.

From an administrative and policy viewpoint, Smart-App’s proven benefits argue for augmented financial investment and resource provision for the innovation and acquisition of assistive technologies in educational institutions. Policymakers ought to prioritize funds allocation towards AT to ensure all learning-disabled students gain access to such indispensable tools. The findings likewise bolster the progression of inclusive education policies mandating the

availability and employment of assistive technologies in classrooms. Adequately equipping schools with relevant AT can remarkably boost the educational experiences and outcomes for disabled students.

Pertaining to future research endeavors, despite this study concentrating on immediate outcomes, the requirement for longitudinal research to scrutinize the enduring influence of assistive technologies like Smart-App on students' scholastic success, social development, and overall welfare prevailed. Future investigations should evaluate the prolonged effect of AT utilization on the learners' progression over time. Expanding research parameters to encapsulate a wider and more varied cohort of students with differing types and severities of learning disabilities will aid in generalizing the outcomes. Similarly, through assessing Smart-App's efficiency across varying educational terrains, such as public schools and special education facilities, will grant a more comprehensive insight into its applicability.

Taking into account the study's results, developers of assistive technologies should deliberate on augmenting the attributes of applications such as Smart-App. Integrating multimodal communication methods, such as voice recording or video modelling, alongside learning management system features, can further elevate these tools' functionality and efficacy. The study also underscores the value of collaboration among educators, parents, and therapists. Future research should probe the effects of collaborative strategies on assistive technology implementation and success. Understanding how joint efforts can maximize AT use in supporting student learning and development remains pivotal.

7. Conclusion

In summary, the study substantiates the HAAT Model's relevance in application of assistive technology, providing a theoretical foundation for understanding the interconnected elements influencing the experiences of students with learning disabilities. This study provides insightful revelations into the potential of mobile applications as assistive technologies for learning-disabled students. The implications for educational practices, policy considerations, and further research accentuate the necessity for ongoing investment and innovation in this niche. Through addressing the distinct needs of learning-disabled students, assistive technologies like Smart-App can fundamentally cultivate independence and enhance life quality.

Recognizing the pivotal role of AT, the research focuses on the innovative mobile application Smart-App, which incorporates AAC features. The study exhibits the effectiveness of Smart-App in enhancing communication, personal care, and physical functioning for students with learning impairments. Notably, the integration of AAC within Smart-App contributes to improved communication, with visual schedules and auditory feedback facilitating meaningful interactions. The apps AAC features facilitated improved two-way communication between students and their teachers. Through visual schedules and auditory feedback, students were able to better understand and follow daily routines. The data collected indicated that all four students showed significant

improvement in their ability to follow a daily routine, identify sequential activities, and communicate their needs using picture aids. The Smart-App's visual and auditory cues helped students understand and remember the steps involved in toileting. The checklist results showed that students A1, A2, and A3 could bend and pull down their pants, stand on one foot to wear pants, and press the flush toilet button with the assistance of the app. However, climbing up and down from the toilet bowl remained challenging for all students. These findings suggest that while Smart-App effectively supports certain aspects of physical function, further refinement is needed to address more complex physical tasks. Smart-App proves instrumental in supporting personal care tasks, such as handwashing and tooth brushing, through step-by-step guidance and timer features. In the realm of physical function, the app aids toileting skills, emphasizing the need for tailored interventions and periodic adjustments based on individual capabilities. The adapted checklist data revealed that all four students were able to complete the handwashing routine and brush their teeth with minimal assistance after using the app. However, some challenges were noted in tasks like using towel dispensers and combing hair, which suggests areas for further enhancement of the app's features.

The findings underscore the potential of Smart-App as a comprehensive and user-friendly tool, addressing the unique needs of students with learning disabilities and contributing substantively to the discourse on assistive technologies in education.

The study aligns with the Human Activity Assistive Technology (HAAT) Model, emphasizing a person-centered approach in addressing challenges faced by students with learning disabilities. The dynamic interplay between individuals, activities, contexts, and assistive technology (Smart-App) is evident, reflecting the HAAT Model's core principles. Key HAAT features, such as interdependence and dynamism, resonate with the study's focus on enhancing communication, personal care, and physical functioning. The collaborative decision-making process involving teachers and students mirrors the model's emphasis on teamwork. The study's exploration of AAC within Smart-App aligns with HAAT's holistic approach, promoting overall development.

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