



International Journal of Learning, Teaching and Educational Research
Vol. 22, No. 11, pp. 116-129, November 2023
<https://doi.org/10.26803/ijlter.22.11.7>
Received Aug 17, 2023; Revised Oct 21, 2023; Accepted Oct 28, 2023

Exploring the Augmented and Alternative Communication (AAC) for Promoting Independence in Daily Skills of Students with Learning Disabilities

Rozniza Zaharudin , Nurul Ashikin Izhar*  and Deekha Lai Hwa 
School of Educational Studies, Universiti Sains Malaysia
11800 Penang, Malaysia

Abstract. Augmented and alternative communication (AAC) mobile apps are increasingly being used to support students with learning disabilities in developing their communication and daily skills. Mobile AAC apps offer portability, user-friendliness and customisation that enables students with learning disabilities to communicate by using symbols, pictures and words for clear expression. This study investigated the experiences of two teachers with AAC mobile apps in promoting daily skills among students with learning disabilities. Semi-structured interviews were conducted with the teachers, exploring their perspectives on the effectiveness of specific AAC mobile app features. The interview questions were adapted from the Mobile Application Rating Scale (MARs). The findings revealed that AAC mobile apps featuring these features were particularly effective in assisting students with learning disabilities in developing their daily skills. The teachers highlighted the benefits of AAC mobile apps in enhancing communication, promoting independence and facilitating the acquisition of essential daily skills. This study contributes valuable insights into the practical application of AAC mobile apps in educational settings and emphasise the significance of customisable features to cater for the individual needs of students with learning disabilities. Additionally, the study highlights the need for further research to explore the long-term impact of AAC mobile apps on the communication and daily skills development of students with learning disabilities. The findings of this study have the potential to inform the development and implementation of innovative AAC mobile app-based interventions for students with learning disabilities to help these students to achieve their full potential and become independent.

Keywords: augmented and alternative communication; user experience; mobile apps; students with learning disabilities; toddlers

* Corresponding author: Nurul Ashikin Izhar, shikinizhar@gmail.com

1. Introduction

Augmented and alternative communication (AAC) refers to a set of strategies, techniques, and tools used to enhance or replace spoken language for individuals with communication difficulties such as student with learning disabilities (Chan et al., 2020; Shin et al., 2020; Vuohijoki et al., 2023). AAC can include various techniques such as sign language, picture exchange systems, speech-generating devices, and mobile applications that facilitate communication and improve social skills (Chan et al., 2020). AAC can be used by people of all ages, including students with learning disabilities. AAC interventions are tailored to the students' abilities and needs, promoting their participation in social interactions and improving their overall quality of life. AAC can be integrated into mobile apps through the use of various features and functionalities (Chelkowski et al., 2019). As the AAC features can be integrated into more easily accessible and portables devices, it makes them a convenient way for students with learning disabilities to communicate (Wantini et al., 2019). They typically include features that make them easier to use than traditional forms of communication, such as voice commands and large text screens (Shin et al., 2020; Svensson et al., 2021). Additionally, many of them offer features that help students communicate their needs and wants more effectively than traditional forms of communication (Wantini et al., 2019). In other words, by using the symbols, pictures and words, an AAC mobile app is one of the ways to help students with learning disabilities that have difficulty in communicating.

Although there is a growing body of research on the use of mobile apps to support students with learning disabilities, there is a lack of research on the integration of AAC features in these apps and their effectiveness in helping students become more independent in their daily activities. For example, Chelkowski et al. (2019) studied the use of mobile apps in students with learning disabilities, but their study did not focus specifically on the AAC features within the apps. Atanga et al. (2020) focused on teachers' knowledge in using technology for students with learning disabilities, and Stathopoulou et al. (2020) explored how mobile apps can be used to foster social skills of students with learning disabilities by storytelling. Svensson et al. (2021) examined the effectiveness of technology in helping students with severe reading disabilities, but their study did not focus specifically on AAC apps.

This paper presents the perspectives of the user experience (UX) of teachers in the effectiveness of AAC apps in fostering independence in students with learning disabilities on their activities of daily living (ADL). The purpose of this research is to explore how teachers perceive the effectiveness of AAC mobile apps in helping students with learning disabilities become more independent in their daily activities. In order to do so, this research tries to determine how teachers perceive the effectiveness of AAC mobile apps in fostering independence in students with learning disabilities. This research is important as by better understanding the perspectives of teachers, they would be able to create and use AAC mobile apps effectively in helping students achieve their full potential.

2. Literature Reviews

One way that AAC apps can help students with learning disabilities is through the use of voice commands. These apps allow users to input text by speaking commands, such as “*show me my calendar*” or “*add an event*”. This type of functionality makes it easier for students to communicate their needs and receive information quickly and easily (Vuohijoki et al., 2023). This picture exchange communication system allows students to communicate their needs and express their desires to teachers. Besides, many of AAC apps have easy-to-use navigation menus (Mohamad et al., 2020) and large text screens (Atanga et al., 2020). These features make it easier for students with disabilities to interact with the app and access the information they need. For example, many of them offer voice transcription capabilities and message scheduling functions. This allows students to easily communicate their needs and wants in a way that is easy for others to understand (Shin et al., 2020).

Underscoring the advantage of AAC, this type of technique which is then incorporated into technology is a valuable aid for teachers to support students with learning disabilities in ADL. These apps can be used to communicate a variety of needs and wants, including requesting assistance, accessing information and communicating preferences (Lazo-Amado et al., 2022; Shin et al., 2020; Vuohijoki et al., 2023). AAC empowers students with learning disabilities to become more independent communicators. It reduces their reliance on others and gives them the tools to express themselves in various environments and situations. In addition, it helps these students to become more self-reliant and confident in their abilities (Atanga et al., 2020; Chelkowski et al., 2019; World Health Organization & UNICEF, 2015).

However, before they can be used in classrooms, they must be evaluated for effectiveness. Teachers are the immediate stakeholders that monitor the daily activities of students with learning disabilities when they are at school. It is important to get teachers’ perspectives on their experiences in using AAC apps for managing students with learning disabilities because teachers play a crucial role in implementing and supporting the use of AAC in the classroom (Chelkowski et al., 2019; Grimsby, 2020; Starks & Reich, 2023). This type of evaluation will help to ensure that the app is effective and meets the needs of students with disabilities. Additionally, evaluations can identify any areas in which the app could be improved, so that future updates are made accordingly. Evaluations of AAC apps should consider how they can help teachers manage their students’ behaviour in the classroom and support their educational goals (Jaya et al., 2021; Zulkifli & Mohamed, 2019). Visual (Rahman et al., 2020) and voice commands (Namoun et al., 2023) are two features that can be very useful in helping teachers to manage their students’ behaviour (Hermanto & Pamungkas, 2023). For example, a voice command could be used to play a specific sound file when the student is required to stand up or sit-down during class (Namoun et al., 2023). This would help to ensure that the student knows what is expected of them and would help to reduce the chances of them engaging in disruptive behaviour. Additionally, visual commands could be used to ensure that students understand what is required of them (Rahman et al., 2020). For example, visual commands

could help students who are learning how to brush their teeth in remembering the steps. The app can be used to show to the student pictures of each step, or it can be used to play a game that helps the student practise brushing their teeth. Hence, an understanding of teachers' experience using the apps is crucial as they can help tailor the app to meet the needs of their individual students (Rashid & Wong, 2023).

AAC mobile apps

In the context of this research, an AAC mobile application has been used to address ADL with a specific emphasis on two primary domains: personal care and physical functionality. The personal care domain encompasses three key ADLs: handwashing, bathing and tooth brushing, while the physical functionality domain involves toileting skills. The selection of the mobile application was based on its provision of comprehensive, step-by-step procedures for each activity, supplemented by visual aids in the form of pictures. Students can interact with the application by selecting the corresponding picture that corresponds to the step they have completed, as depicted in Figure 1.



Figure 1: Completion of a step

Upon the successful completion of a task, a visual representation in the form of an image will manifest, as depicted in Figure 2. The motivational image featuring words of praise serves to accentuate the reinforcement of favourable conduct exhibited by the students.



Figure 2: Task completion

The inclusion of visual schedules within AAC applications provides educators and students with learning disabilities the means to effectively monitor their ADL as depicted in Figure 3.



Figure 3: Interface of visual schedule

The apps offer additional functionalities such as a timer, which aids educators in influencing student behaviour through various stages of activities. Furthermore, within the same interface, there is a text-to-speech feature that audibly articulates the names of activities as depicted on the visual schedules.

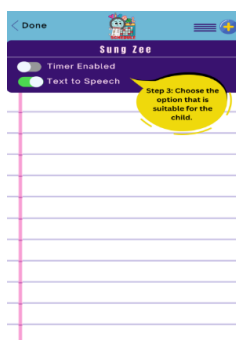


Figure 4: Timer and text-to-speech features

3. Method

This research used a qualitative approach to assess the efficacy of AAC applications in facilitating the learning process of students with learning disabilities, from the perspective of teachers who use these apps. Specifically, the data was gathered through interviews, as it aligns with the qualitative nature of this study. Two teachers namely *Teacher 1* and *Teacher 2*, with more than two years' working experience were selected as participants, as they both served as caretakers for students with learning disabilities at the research site. The semi-structured interview questions were derived from the Mobile Application Rating Scale (MARS), developed by Stoyanov et al. (2015). The MARS consist of four dimensions: engagement, functionality, aesthetics and information. The interviews commenced with general inquiries concerning demographic information, such as age and teaching experience. Subsequently, each participant

responded to a uniform set of questions pertaining to their perceptions of using AAC apps and their effectiveness in supporting daily activities for students with learning disabilities. Data collection involved the use of voice recording and verbatim transcription techniques. The collected data were then refined through the elimination of extraneous, irrelevant and repetitive statements, resulting in the organisation of the remaining data according to predetermined themes. Content analysis was used to directly examine the interview results and to present the findings in accordance with the research question's thematic framework.

4. Results and Discussion

4.1. Teachers' experience in using AAC apps to support students with learning disabilities in ADL in the dimensions of engagement

The evaluation of AAC applications was conducted by assessing the teachers' experience in using these applications to aid students with learning disabilities. Both teachers reached a consensus that the students displayed positive behaviour while using the applications. According to *Teacher 1*, the students exhibited a liking for the apps due to the novelty they offered, expressing excitement at seeing their own images and finding the graphics engaging. *Teacher 2* also observed this enthusiasm, noting that her students were eager when initially introduced to the apps and actively interacted with the images therein. This favourable response indicates that the inclusion of visual elements in the applications effectively stimulated student interest and engagement (Berni & Borgianni, 2021; Hermanto & Pamungkas, 2023; Kaimara et al., 2021; Rahman et al., 2020). Additionally, *Teacher 1* emphasised the benefits of visual scheduling features, stating that they reduced the time she spent managing and organising schedules. She remarked, "Yes, the app is interesting to use, and it saved up my time in arranging the physical visual schedule. Previously I had to spend about 10 to 15 minutes daily in organising students' visual schedule, but now I don't have to do it anymore. The app helped me the most in the visual schedule. I'm not sure about what strategy does the app use." Similarly, *Teacher 2* conveyed her experience of time saved and reduced workload resulting from the use of these applications, stating, "For me, the app is time-saving as it helps in reducing my workload." These accounts collectively demonstrate that AAC apps serve as a time-saving tool for teachers, enabling them to allocate more attention to critical matters related to supporting students with learning disabilities. The reference to teachers' workload underscores the challenges they face in handling administrative tasks alongside their responsibilities of teaching and supporting students with learning disabilities (Shin et al., 2020; Starks & Reich, 2023).

Besides, *Teacher 2* expressed her viewpoint regarding the employed approach employed by the applications and its capacity to render the AAC app captivating. According to her, "I think the app is interesting to use for both student and teacher. The strategy used by the app possibly is technology and animation. We all know that students love to watch YouTube, so I think they like the animation of the app as compared to usual bland presentation of a task. Sometimes my students even go and get the iPad for me when it's 'change picture time'". This evidence substantiates the notion that visual aids serve as a crucial factor in captivating the attention of students with learning disabilities, thereby fostering their active participation in planned instructional endeavours (Chan et al., 2020; Hermanto & Pamungkas, 2023; Kaimara et al., 2021). The use of visual aids, particularly in the form of a visual schedule,

enhances the allure of educational activities, leading to an augmented level of student engagement and ultimately reinforcing the efficacy of pedagogical approaches employed by teachers (Hermanto & Pamungkas, 2023; Kaimara et al., 2021).

Furthermore, both teachers emphasised the inherent characteristics of AAC apps that enabled them to generate personalised visual timetables, incorporate images and include voice recordings, thereby providing a versatile framework to adapt schedules and task sequences to individual needs (Chelkowski et al., 2019; Simon et al., 2022). *Teacher 1* claimed that *“The app provides necessary settings such as I can create each student own schedule and insert picture. We could also record our voice.”* In addition, the features that allow teachers to customise the schedule also create flexibility for teachers to change details from time to time which make the apps a versatile tool for managing students with learning disabilities as claimed by *Teacher 2*, *“The app is very flexible as I can create our own visual schedule and arranging the task.”*

Based on teachers’ perspectives on their experiences, it has been determined that AAC applications possess the capability to effectively involve teachers and students with learning disabilities in using them as tools for communication strategies. Noteworthy attributes such as customisable schedules (Zilz & Pang, 2021), voice recording functionality (Namoun et al., 2023), animated and visual elements (Hermanto & Pamungkas, 2023; Rahman et al., 2020) have been acknowledged as valuable features that ought to be taken into account by developers of AAC applications when designing assistive technologies aimed at assisting students with learning disabilities.

4.2. Teachers’ experience in using AAC apps to support students with learning disabilities in ADL in the dimensions of functionality

Teachers’ experience in the functionality of AAC apps were evaluated based on the difficulties of students with learning disabilities to use the apps in terms of the representation of menu labels and icon. In terms of functionality of labels and icons, the study observed that students quickly grasped the meaning and purpose behind each icon, leading to a reduction in the learning curve for using the app effectively. *Teacher 1* claimed that students needed some guidance on how it worked but then they were quickly to adapt. According to *Teacher 1*, *“Initially my students need guidance for few days to understand the usage of the app, and I think that it’s quite fast for them as sometimes they took longer time to learn a concept. For the icons, it is clear and appropriately represent the function.”* This, in turn, promotes a sense of independence and empowerment among students, as they can express themselves more easily and efficiently through the AAC app (Shin et al., 2020). Similarly, *Teacher 2* also claimed that *“The content and the icons of the app are straightforward and clear, thus I think that it is easy for students with learning disabilities to learn how to use the app.”* This finding reflected that the labels and icons developed in the AAC apps are well-designed and work as intended (Shin et al., 2020). The effectiveness of the labels and icons in AAC apps was consistent across a diverse range of students, including those with varying cognitive abilities and motor skills. This also shows that the labels and icons work well as visual cues as

students are easily able to adapt and interact with the app (Chelkowski et al., 2019).

Additionally, teachers' experiences in navigating when switching between screens in the apps were also evaluated. *Teacher 1* found that the navigation process was easy, and students could independently learn use it. She said, "By daily practising, students can navigate through the app independently." Similar responses were received from *Teacher 2* as she observed that her students were able to comprehend the connection between clicking their profile picture and the visual schedule prompt. According to *Teacher 2*, "For my student, I will usually open the app interface for them, the students just must click on their profile pictures, and it will direct them to the content. They are able to understand the relation of clicking their picture and appearance of visual schedule, or back to the main interface." It was observed that the app's interface had a consistent layout, which contributed to a smooth transition when switching between screens. This consistency played a crucial role in enhancing the overall user experience, as teachers could easily locate and use the necessary tools without wasting time on unnecessary searches.

Thus, the results of the study indicate that AAC apps effectively fulfil their intended purpose and can be effectively used by students with learning disabilities. The labels and icons within these applications serve as visual cues, facilitating the navigation process for students. Moreover, these visual cues aid in the comprehension of the applications' content, as they present information in a clear and accessible manner to the students with learning disabilities (Kaimara et al., 2021).

4.3. Teachers' experience in using AAC apps to support students with learning disabilities in ADL in the dimensions of aesthetics

Teachers' experiences were explored under the dimension of aesthetics. The aesthetics value was evaluated in terms of the arrangement and size of icons. Teachers were asked on the appropriateness of arrangement and size of icons on screen towards supporting students with learning disabilities. Notably, a unanimous consensus was reached by the participating teachers, who collectively opined that the current configuration of icons adequately fulfils its intended functionality. According to *Teacher 1*, "Most of the icons are combination of picture and word which enable students to identify the function of the app and at the same time learns the word. I think the arrangement of the icons are neat and the size of the icons are suitable for the students too. My students love the icon of completion that praised them after each task too." This study's findings demonstrate that an orderly configuration and optimal dimensions of icons significantly enhance the positive user experience of AAC apps. When icons are intuitively organised and grouped based on their functions and categories, students can navigate the app more efficiently, leading to increased communication effectiveness (Atanga et al., 2020; Starks & Reich, 2023). The inclusion of prompt-based visual stimuli has proven to be effective in motivating students to engage with these applications, consequently facilitating the processes of teaching, learning, and care (Hermanto & Pamungkas, 2023). This reinforcement not only motivates students to use the app more frequently but also encourages them to explore various features, ultimately enhancing their communication skills and overall user experience (Berni &

Borgianni, 2021). These results corroborate the observations made by *Teacher 2* as she said, *"I'm satisfied with the arrangement and its size. I think that the icon and the words shown in the app is big and readable. The icon in the app also reflects each of the function such as wash hand's function is reflected in the picture and word."* Nevertheless, *Teacher 2* raised her concern regarding the extent of the prompt's length, expressing concerns for students with learning disabilities who may encounter challenges in comprehending and processing extended prompt structures. She claimed that *"My student still struggles to read few long phrases in the confirmation pop-up dialogue in the app."* This research suggests that alterations are necessary in the design of AAC apps with regard to the length of prompt instructions. It is essential to take into account the cognitive capacities of students, specifically their ability to comprehend and process lengthy prompt instructions. To mitigate the challenges faced by students with learning disabilities in communication, potential remedies could involve incorporating shorter and more straightforward phrases or providing supplementary aids, such as audio prompts or visual cues. These adaptations are likely to enhance the accessibility and effectiveness of AAC apps for individuals with learning difficulties (Nordin & Rabi, 2020; Shin et al., 2020).

4.4. Teachers' experience in using AAC apps to support students with learning disabilities in ADL in the dimensions of information

Teachers' experiences in the communication of AAC apps were evaluated based on their ability to convey information to student with learning disabilities. In this dimension, the features of visual schedule, visual cues and step-by-step procedures in ADL within AAC apps were evaluated. Both teachers showed high positive respond on this feature in smoothing their support to the students. The visual schedules helped *Teacher 1* to communicate with students on their daily routine as she said, *"The visual schedule enable teacher to communicate with students about their daily routine and improve their awareness towards the things that happened in a day. I noticed that my students have poor working memory, so the visual schedule also serve as a reminder for the students to be in which class during the activities."* The use of visual schedules in AAC apps has not only improved communication but also contributed to better time management and organisation for both teachers and students (Kaimara et al., 2021; Rahman et al., 2020; Shin et al., 2020). With clear and easily accessible schedules, students can anticipate and prepare for their daily activities, leading to reduced anxiety and behavioural issues in the classroom (Ncube & Sedibe, 2022). Another significant benefit of incorporating visual schedules in AAC apps is the fostering of greater independence among students with learning disabilities (Stathopoulou et al., 2020). As they become more familiar with the symbols and routines, students can gradually take charge of their daily activities and become active participants in their learning journey.

Meanwhile both *Teacher 1* and *Teacher 2* were delighted with the visual cues features in understanding more on their students' needs on which *Teacher 1* commented that, *"As I mentioned just now, my students have poor working memory which sometimes they struggle to recall the name of objects that they want. The function support students to express themselves and teacher able to understand their language too."* This was supported by *Teacher 2* as two of her students only communicated in Mandarin and it was quite hard for the teachers to have two-way communication

with them. Teacher 2 said, *“The communication function of the app helps me to understand my students and reduce their frustration too. Both of my students have language and communication issues, which one of them has language barrier as he speaks in Mandarin most of the time and I couldn’t understand what he tried to express, and another student’s pronunciation is not clear, and I must guess what the students need. With the app, I able to add In the pictures of objects in the centre and students able to use the picture to express his needs.”* The inclusion of visuals enhances the communication process, making it easier for teachers and students to understand each other despite potential language differences or difficulties (Berni & Borgianni, 2021; Kaimara et al., 2021). Visuals, such as images, symbols or pictograms, play a crucial role in augmenting verbal communication or replacing speech altogether for individuals with communication challenges (Hermanto & Pamungkas, 2023). These elements serve as a universal language that transcends linguistic barriers, enabling a more inclusive and accessible learning environment (Berni & Borgianni, 2021).

As the AAC apps in this study focus on promoting ADL in students with learning disabilities, hence the step-by-step procedures has been included to prompt students’ independence on ADL. Step-by-step is a small achievable procedural involving certain function and Teacher 1 claimed that, *“My students learn the proper steps of washing hands, brush teeth and bath using the app. The task is broken down into small achievable steps which enable my students to follow through the steps and weren’t overload with information”* and further supported by Teacher 2, *“I used the app to teach my students the steps of washing hands and brushing teeth. Usually, I will hold the iPad and guide students step-by-step in washing their hands, a tick will appear upon completion of a task and students were prompted to next step. I wished that after a period, students will master the skill and I will be able to fade off the use of app and generalise the skill at every setting, not limited to the centre only.”* This shows teachers’ focus on students’ independence to follow a proper hygienic process. The apps serve as valuable teaching tools that can be customised to meet each student’s specific needs, ensuring that they receive personalised instruction and guidance (Berni & Borgianni, 2021). By breaking down complex tasks into manageable steps, the AAC apps help students understand the sequential nature of ADL and enable them to follow along at their own pace.

4.5. Pedagogical implications and limitations

In the context of this study, it has been shown that AAC mobile apps can be effective in assisting students with learning disabilities in developing their communication and daily skills. Specific features such as visual schedules, visual cues, voice prompts, prompt and timer features, as well as step-by-step procedures can be especially beneficial for students with learning disabilities. Teachers can use the visual schedules to help students stay organised and understand their daily routine. The visual cues and voice prompts help to support students in completing tasks and assignments. Furthermore, teachers could also use the prompt and timer features to help students stay on track and manage their time effectively. The step-by-step procedures can then be used by teachers to teach the students to complete the task in more achievable ways.

AAC mobile apps are also portable, user-friendly and customisable, making them a versatile tool for supporting students with learning disabilities in a variety of settings. This includes the classroom, at home and in the community. Teachers and students alike appreciate the novelty, excitement and engaging graphics of AAC mobile apps. This can help to motivate students and make learning more fun and enjoyable. Nevertheless, it is important to note that the AAC features and skills in the apps used in the context of this study only be used to cater handwashing, bathing and tooth brushing, and toileting skills. Therefore, the AAC features for other ADLs may need to have modifications as there is no one-size-fits-all solution. Future research should explore the use of AAC mobile apps to support students with learning disabilities in developing a wider range of ADLs, such as dressing, eating and meal preparation. Furthermore, this study only explored the perspectives of teachers on their experiences in one early childhood education institution. To enhance the development of the AAC mobile apps, more teachers' perspectives are needed to identify the features and functionality and refining the apps that focusing on the needs of young children with learning disabilities.

5. Conclusion

In this research, it was found that visual schedule, visual cues, voice prompts, prompt and timer features were highly effective in assisting students with learning disabilities in completing tasks. Teachers had positive experiences and reactions when using AAC mobile apps, with students displaying positive behaviour due to the novelty, excitement and engaging graphics. Visual scheduling features reduce time spent managing and organising schedules, and this feature of the app was particularly useful for both students and teachers. AAC mobile apps allow for personalised visual timetables, images and voice recordings, making them a versatile tool for managing students with learning disabilities. The labels and icons in AAC mobile apps are well-designed and effective, promoting independence and empowerment. The app's consistent layout and aesthetics value make it effective for supporting students with learning disabilities. However, teachers raised concerns about the length of prompt instructions and suggested potential remedies like incorporating shorter, more straightforward phrases or providing supplementary aids like audio prompts or visual cues. Step-by-step procedures in AAC apps promote ADL, demonstrating teachers' commitment to students' independence and hygienic practices. By providing students with the tools and support they need to be successful, teachers can help them to reach their full potential.

Acknowledgement

The author would like to thank everyone who participated in this research and contributed whether directly or indirectly in the process of collecting data and providing insights.

Declaration

During the preparation of this work the authors used Quillbot and InstaText in order to improve the language and readability of the articles. After using these

tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the article.

Funding

This research is supported by a grant from Universiti Sains Malaysia (304/PGURU/6315517).

6. References

- Atanga, C., Jones, B. A., Krueger, L. E., & Lu, S. (2020). Teachers of students with learning disabilities: Assistive Technology knowledge, perceptions, interests, and barriers. *Journal of Special Education Technology*, 35(4), 236–248. <https://doi.org/10.1177/0162643419864858>
- Berni, A., & Borgianni, Y. (2021). From the definition of user experience to a framework to classify its applications in design. *Proceedings of the Design Society*, 1, 1627–1636. <https://doi.org/10.1017/pds.2021.424>
- Chan, R. Y. Y., Sato-Shimokawara, E., Bai, X., Yukiharu, M., Kuo, S. W., & Chung, A. (2020). A context-aware augmentative and alternative communication system for school children with intellectual disabilities. *IEEE Systems Journal*, 14(1), 208–219. <https://doi.org/10.1109/JSYST.2019.2911671>
- Chelkowski, L., Yan, Z., & Asaro-Saddler, K. (2019). The use of mobile devices with students with disabilities: a literature review. *Preventing School Failure*, 63(3), 277–295. <https://doi.org/10.1080/1045988X.2019.1591336>
- Grimsby, R. (2020). “Anything Is Better than Nothing!” Inservice Teacher Preparation for Teaching Students with Disabilities. *Journal of Music Teacher Education*, 29(3), 77–90. <https://doi.org/10.1177/1057083719893116>
- Hermanto, H., & Pamungkas, B. (2023). Teacher strategies for providing access to learning for students with special needs in elementary schools. *International Journal of Learning, Teaching and Educational Research*, 22(4), 345–361. <https://doi.org/10.26803/ijlter.22.4.20>
- Jaya, S., Zaharudin, R., Hashim, S. N. A., Ithnin, M. A., Zaid, S. M., Mapjabil, J., & Nordin, M. N. (2021). Employing design and development research (DDR) approach in designing next generation learning spaces (NGLS) in teachers’ pedagogy and technology tools. *Review of International Geographical Education Online*, 11(7), 1237–1246. <https://doi.org/10.48047/rigeo.11.07.116>
- Kaimara, P., Oikonomou, A. C., Deliyannis, I., Papadopoulou, A., Miliotis, G., Fokides, E., & Floros, A. (2021). Waking up in the morning (WUIM): A transmedia project for daily living skills training. *Technology and Disability*, 33(2), 137–161. <https://doi.org/10.3233/TAD-200326>
- Lazo-Amado, M., Cueva-Ruiz, L., & Andrade-Arenas, L. (2022). Designing a Mobile Application using Augmented Reality: The Case of Children with Learning Disabilities. *International Journal of Advanced Computer Science and Applications (IJACSA)*, 13(6). <https://dx.doi.org/10.14569/IJACSA.2022.01306101>
- Mohamad, S. N. M., Nor Azmidy I., Imam, B. M. K., & Che Ku Nuraini, C. K. M. (2020). Designing a Mobile Game Application for Student with Learning Disabilities. *JOIV: International Journal on Informatics Visualization*, 4(3). <http://dx.doi.org/10.30630/joiv.4.3.404>
- Namoun, A., Humayun, M. A., BenRhouma, O., Hussein, B. R., Tufail, A., Alshantqi, A., & Nawaz, W. (2023). Service selection using an ensemble meta-learning classifier for students with disabilities. *Multimodal Technologies and Interaction*, 7(5). <https://doi.org/10.3390/mti7050042>

- Ncube, M., & Sedibe, M. (2022). Exploring challenges to inclusion of children with intellectual disabilities in early childhood development in Mutoko District, Zimbabwe. *International Journal of Learning, Teaching and Educational Research*, 21(10), 195–211. <https://doi.org/10.26803/ijlter.21.10.10>
- Nordin, N. S., & Rabi, N. M. (2020). Identifying the social communication deficits among students with learning disabilities in primary school. *International Journal of Academic Research in Business and Social Sciences*, 10(3). <https://doi.org/10.6007/ijarbss/v10-i3/7073>
- Rahman, N. A., Mailok, R., & Husain, N. M. (2020). Mobile augmented reality learning application for students with learning disabilities. *International Journal of Academic Research in Business and Social Sciences*, 10(2). <https://doi.org/10.6007/ijarbss/v10-i2/6896>
- Rashid, S. M. M., & Wong, M. T. (2023). Challenges of implementing the individualized education plan (IEP) for special needs children with learning disabilities: Systematic literature review (SLR). *International Journal of Learning, Teaching and Educational Research*, 22(1), 15–34. <https://doi.org/10.26803/ijlter.22.1.2>
- Shin, D., Song, J., Song, S., Park, J., Lee, J., & Jun, S. (2020, April 21). TalkingBoogie: Collaborative mobile AAC system for non-verbal children with developmental disabilities and their caregivers. *Conference on Human Factors in Computing Systems - Proceedings*. <https://doi.org/10.1145/3313831.3376154>
- Simon, M., Wilkes-Gillan, S., Ryan Chen, Y. W., Cordier, R., Cantrill, A., Parsons, L., & Phua, J. J. (2022). Toilet training interventions for children with autism spectrum disorder: A systematic review. *Research in Autism Spectrum Disorders* (Vol. 99). <https://doi.org/10.1016/j.rasd.2022.102049>
- Starks, A. C., & Reich, S. M. (2023). “What about special ed?”: Barriers and enablers for teaching with technology in special education. *Computers and Education*, 193. <https://doi.org/10.1016/j.compedu.2022.104665>
- Stathopoulou, A., Loukeris, D., Karabatzaki, Z., Politi, E., Salapata, Y., & Drigas, A. (2020). Evaluation of mobile apps effectiveness in children with autism social training via digital social stories. *International Journal of Interactive Mobile Technologies (IJIM)*, 14(03), 4. <https://doi.org/10.3991/ijim.v14i03.10281>
- Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., & Mani, M. (2015). Mobile app rating scale: A new tool for assessing the quality of health mobile apps. *JMIR MHealth and UHealth*, 3(1). <https://doi.org/10.2196/mhealth.3422>
- Svensson, I., Nordström, T., Lindeblad, E., Gustafson, S., Björn, M., Sand, C., Almgren/Bäck, G., & Nilsson, S. (2021). Effects of assistive technology for students with reading and writing disabilities. *Disability and Rehabilitation: Assistive Technology*, 16(2), 196–208. <https://doi.org/10.1080/17483107.2019.1646821>
- Vuohijoki, T., Ihalainen, T., & Virkki, J. (2023). Smart clothing and furniture for supporting participation-co-creation concepts for daily living. *SN Applied Sciences*, 5(4). <https://doi.org/10.1007/s42452-023-05315-w>
- Wantini, Sutrisno, Casmini, & Suyatno. (2019). Therapy of social-emotional development on autism spectrum disorder diagnosed child in inclusive early childhood education and development Yogyakarta, Indonesia. *International Journal of Learning, Teaching and Educational Research*, 18(7), 33–50. <https://doi.org/10.26803/ijlter.18.7.3>
- World Health Organization, & UNICEF. (2015). *Assistive technology for children with disabilities: creating opportunities for education, inclusion and participation: a discussion paper*. <https://www.unicef.org/media/126246/file/Assistive-Tech-Web.pdf>

- Zilz, W., & Pang, Y. (2021). Application of assistive technology in inclusive classrooms. *Disability and Rehabilitation: Assistive Technology* 16(7), 684–686. <https://doi.org/10.1080/17483107.2019.1695963>
- Zulkifli, A. S., & Mohamed, S. (2019). The knowledge level of special education teachers in managing the behaviour of special need students [Tahap Pengetahuan Guru dalam Mengurus Tingkah Laku Murid Berkeperluan Khas (MBK)]. *Jurnal Wacana Sarjana*, 3(4), 1–7. <https://spaj.ukm.my/jws/index.php/jws/article/view/289>