

A Low-Tech Assistive Tool for Inclusion of Persons with Hearing Impairments in Fiji

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1.0 Abstract

The rapid advancements in 21st-century technology have significantly driven the development of assistive tools, which serve as transformative aids for individuals with disabilities and emerging bilingual learners. Despite the growing recognition of technology's potential in education, equitable access to these interventions for individuals with special needs remains a pressing concern, particularly in developing countries. This study examines the challenges faced by persons who are deaf or hard of hearing in Fiji and introduces a low-tech assistive device specifically designed to address these barriers. Utilizing a two-phased survey methodology, the research explores the experiences and perceptions of individuals with hearing impairments regarding their inclusion in public spaces, government services, entertainment, and social media platforms. The second phase evaluates the efficacy of an ICT-based Sign Language Tool, developed to assist parents and educators in consistently learning and applying universal sign language. The findings reveal substantial obstacles faced by persons with hearing impairments in accessing public services, highlighting the need for tailored interventions. The study underscores the potential of simple, cost-effective, low-tech solutions to alleviate societal barriers and enhance inclusion. This baseline research lays the groundwork for the development and adaptation of targeted assistive technologies to support the inclusion of persons with disabilities in Fiji, with prospects for broader application across the South Pacific region.

2.0 Introduction

Assistive technologies have facilitated inclusion in the learning processes of students. Disability specialists strongly recommend the use of simulation programs and assistive technology devices for problem-solving and activity-based learning assistive technologies have gained popularity in improving the skills and knowledge of students in challenging subjects.

Specialised studies focusing on performance and behaviour of students with disabilities (Dryer, Henning, Tyson, & Shaw, 2016) indicate that the non-academic constructs of psychological well-being act as motivation to learn and quality of life (QOL) can deeply influence the academic achievement of students with a disability. However, this could vary depending on the type of disability the student lives with (Dryer et al., 2016). Overall, the emotional health and self-esteem have also noted to be high contributing factors to a student's academic life, particularly for students with disabilities (Wiest, Wong, & Kreil, 1998). Studies found that children who have lower literacy rates tend to be affected by it emotionally which becomes a barrier in educational success (Elies, Schabmann, & Schmidt, 2021). Although it is generally challenging, a number of ICT driven pedagogical tools have been developed (Sharma et al., 2018) to strengthen and support learning world-wide (Ali, 2019), including some highly effective ones in developed countries (Cha, Park, & Seo, 2020). One such inclusive intervention is the introduction of the South Pacific's first digital literacy tool which assists by identifying digital literacy gaps and addressing those gaps with a premeditation module (Reddy, Sharma, & Chaudhary, 2020). The tool measures the digital literacy competencies of individuals and then provides a remedial on the relevant literacies. Digital literacy has been identified as one of the fundamental skills needed in the Pacific islands (Reddy, Sharma, & Chaudhary, 2021). Within the south pacific countries, the tool has been used effectively by persons with certain disabilities. This shows the potential of such innovative and inclusive tools in addressing the consequent barriers leading to pedagogical issues which persons with disabilities may encounter, particularly if they had limited to no inclusion interventions in their early lives.

While the involvement of parents and teachers play a pivotal role in supporting students with disabilities (Rodríguez et al., 2017), the support of peers have also proven to be helpful especially in learning Mathematics and English subjects (Trigueros et al., 2019).

In Fiji organisations such as Fiji Disabled Peoples Federation, Pacific Disability Forum and other non-government organisations work closely with the Ministry of Education, and the Ministry of Social Welfare to protect the rights of the persons with disabilities and ensure that the provisions assigned to them have reached them. The participants in the surveys and focus group for this study are part of the Fiji National Council for Disabled Persons. Fiji National Council for Disabled Persons supports its members in areas of health, information and public awareness, legislation, housing/transport/environment (Accessibility), sports and recreation and the establishment of self-

help organization (Persons, 2020). Their outreach covers most communities, including special schools in all divisions of Fiji.

This study focuses on areas where inclusions remain a challenge, and aims to contribute to the comprehension of inclusion and remediation in Fiji by investing the following areas:

1. It surveys and analyses the current state of inclusion of the deaf and hard of hearing community in Fiji. It seeks to gather if they are included or considered when providing services in public places, the education sector, and workplace and government services.
2. It introduces a Sign Language Tool (Mala, 2019) as a form of an assistive device for teachers, students, parents and generally anyone who would like to learn the universal sign language.
3. It discusses inclusion and diversity in learning and working in STEM related subjects in Fiji, with the possibility of extending the study to the South Pacific Islands.

3.0 Background

According to a report by the World Bank (Bank, 2020) ("Disability Inclusion," 2020), 15% of the World's population have some form of disability. The same research shows that disabilities are more prevalent in the population of developing countries because of poverty, which increases the risk of disability through malnutrition, inadequate access to education and health care, unsafe working conditions, a polluted environment, and lack of access to safe water and sanitation. As per the statistics given by (Marchildon, 2018), 90% of the persons with disability live in developing countries as accessibility continues to be a barrier for people with disabilities when compared to the individuals living in the developed countries.

Disabilities can affect people in different ways, even when one person has the same type of disability as another person. There are many types of disabilities, such as those that affect a person's vision, hearing, thinking, learning, movement, mental health and communication. According to the Individuals with Disabilities Education Act (IDEA), there are 13 categories of disabilities (Lee, 2014) as illustrated in Table 1.

	<i>Disability/Impairment</i>	<i>Symptoms and Explanations</i>
1.	Specific learning disability (SLD)	These include Dyslexia, Dysgraphia, Dyscalculia, Auditory processing disorder and Nonverbal learning disability
2.	Other health impairment	These include conditions that may limit a child's strength, energy, or focus, such as Attention Deficit Hyperactivity Disorder, which impacts their need for attention and modifies their behavioural functions.
3.	Autism Spectrum Disorder (ASD)	This is a wide range of developmental disability which has numerous symptoms, which impacts a child's behaviour, particularly their social and communication skills. There
4.	Emotional disturbance	There are various mental health issues which may include depression, anxiety disorder, bipolar disorder, obsessive-compulsive disorder and schizophrenia. Some people may have two or more of these disorders affecting them concurrently.
5.	Speech and/or language impairment	This category covers difficulties with speech or language, such as stuttering or difficulties in pronunciations. It also includes language problems which make it difficult for kids to express themselves in class.
6.	Visual impairment	This includes both partial sight and blindness.
7.	Deafness	These are kids who are diagnosed as deaf. They have little to no sense of sounds/hearing.
8.	Hearing impairment	This refers to a hearing loss which can change over time. It is not the same thing as having trouble with auditory or language processing
9.	Deaf-blindness	Kids with a diagnosis of deaf-blindness have both severe hearing and vision loss. Therefore, their communication and other needs are so unique that programs for just the deaf or blind cannot address them.
10.	Orthopaedic impairment	This is a condition where the child lacks function or ability in their bodies. A typical example is a cerebral palsy.
11.	Intellectual disability	While kids with intellectual disabilities may have the below-average intellectual ability, they may also have poor communication, self-care, and social skills. One example of intellectual disability is Down Syndrome.
12.	Traumatic brain injury	These are brain injuries caused by an accident or some kind of physical force.
13.	Multiple disabilities	A child with multiple disabilities has more than one condition covered by IDEA. Having multiple issues creates educational needs that cannot be met in a program designed for anyone disability.

Table 1: Categories of impairments with their description.

(Source: The 13 Disability Categories under IDEA." Understood for All Inc)

For positive changes in developing countries, it is important to study the success stories and identify best practices to create a substantial benchmark for inclusion. The World Report on Disability was a 5-year project initiative between World Health Organization (WHO) and the World Bank was launched in 2011. It had immense contributions from leading academics such as late Professor Stephen Hawking and peer reviewers from over 74 countries (Bickenbach, 2011). Its main agenda was to research and analyse data of the partnering countries to facilitate the implementation of the United Nations Convention on the Rights of Persons with Disabilities (CRPD) (Bickenbach, 2011). This policy supplemented the existing policies and initiatives worldwide, which assists in comprehending as well as facilitating the provisions needed for inclusion, particularly in developing countries. It presented international best practices and benchmarks for current and future initiatives for inclusion (Organization, 2011). Fiji, one of the developing countries in the Pacific region, stands on 61 out of 194 countries with an average percentage of 8.6 per 100 persons in Estimates of disability prevalence (%) and years of health lost due to disability (YLD), by country (Organization, 2011). Over 40% of annual surgeries in Fiji is related to amputations (Zealand, 2019). However, the fact that Fijian hospitals execute a minimum of one amputation per eight hours (Reece, 2018), indicates that on average over 1000 disabilities will be created per year which will add to the existing population living with impairments. These staggering statistics show evidence of the need for more disability-related support in Fiji.

According to the 2017 Census report, Fiji's population was 884,887, out of which 13.7% persons are living with at least one functioning challenge, which constitutes to 113,595 persons aged 3 and above (Statistics, 2015). Out of the 15 provinces of Fiji, the highest numbers are reported in Rotuma, Serua and Lau provinces. However, the inclusion of persons with impairments will remain a challenge as the lack of resources curtails their ability to be included in educational institutes, consequently leading to scarce opportunities for inclusion in the workforce.

There could be several factors that inhibit the possibility of inclusion. Public awareness of inclusion opportunities, availability of trained service personnel and funding for research and development in this area could be some factors that may hinder the practice of inclusion. Other important factors may be the socio-economic status of families which may prevent them from seeking inclusive opportunities for their family members as services and devices may be expensive. Furthermore, there needs to be stringent policies which not only encourage inclusion in education (Ainscow, Farrell, & Tweddle, 2000) and the workforce, but also call for the development and use of devices which contribute in the ability to operationalise inclusion (Mavrou, 2011). Educational institutes could become part of the solution as they do further research and development of remediation tools and devices (Sharma et al., 2018).

For schools to become inclusive, they need to adapt adjustable methods of teaching and learning differently (Yasdar, Djafar, Elihami, & Faisal, 2020). Students have differently learning abilities, however it is no indication that one student may learn better than another as, however, if teachers could explore their styles, it may significantly contribute to effective learning (Willingham,

Hughes, & Dobolyi, 2015). To be successful in knowledge transfer, student engagement and assessment, assistive devices become highly effective tools to ensure inclusion of a student with impairments to learn in par with abled students (Ahmad, 2015).

The purpose of an assistive device for a student is to aid in their functional capability and improve their chances of success in accessing the general educational curriculum (Nordström, Nilsson, Gustafson, & Svensson, 2018) (Chambers, 2019) and associated support (J. P. Akpan & Beard, 2014). With the intervention of assistive technologies, students and individuals gain confidence and show significant improvements in independent thinking, increased autonomy and problem-solving (J. Akpan, Beard, & McGahey, 2014), which are vital attributes in learning and development of a student or individual with special needs. Assistive devices can also assist persons with mobility issues, and if made affordable and easy to carry (Riener, 2016). The artificial intelligence and augmented reality have brought about the birth of highly sophisticated devices such as those based on Brain-Computer Technologies for enhanced motor skills (Coyle, 2016). Moreover, robotics are widely used to assist persons with mild to severe challenges in movement and motor skills which are highly recommended for rehabilitation purposed as well (McDaid, Xing, & Xie, 2013). Children with severe physical impairments have found Gaze-based assistive technology useful for communication and activities (Borgestig, Sandqvist, Parsons, Falkmer, & Hemmingsson, 2016). Similarly, Tongue Drive Systems have recently been designed to assist students with disabilities to communicate using their tongue (Kumar, Sharma, Assaf, Sharma, & Naidu, 2019) with Android devices (Assaf et al., 2018).

Assistive technology devices can be categorised into three areas (Bouck, Savage, Meyer, Taber-Doughty, & Hunley, 2014):

1. No Tech - no special aids required such as pencil grips, highlighters, visual schedules
2. Light-Tech - easily available solutions, which teachers can adapt and implement for daily usage in classrooms such as braille devices and calculators
3. High-Tech - access to electronics and other computerised devices such as voice to text-text to voice converters (Beard, Carpenter, & Johnston, 2011).

According to the World Report on Disability, there are over 1 billion persons in the world who live with some form of disability, out of which 80 percent live in developing countries (Raporu, 2011). This equates to 15 percent of the world's population and 1.5 million persons from the Pacific islands.

In efforts to promote the inclusion of deaf and hard of hearing persons, the Pacific Disability Forum conducted a study through consultation of 161 persons with disabilities across the south pacific islands (Dr Elena Jenkin, 2019). The research findings indicated that the deaf community in the pacific islands faced barriers pertaining to access to education, sign language interpretation, membership into deaf communities and associations, the knowledge of sign language communication for their families, and access to employment and sustainable livelihoods. This indicated that there was a dire need to a) promote, develop and record sign language, b) promote inclusion and protection within treaty body reporting and policy alignment, and c) foster and expand early intervention and education services.

4.0 The Fijian Sign Language Self-Learning Uniform Tool

4.1 Background and Existing Issues

Fijian Sign Language (FJSL) had long been considered a ‘broken’ sign language as it was thought to be the equivalent of broken English (Nelson, Tawaketini, Spencer, & Goswell, 2009) . The local sign language had started to develop a character of its own based on the Australasian signs introduced in Fiji in the 1970’s.

Nevertheless, in 2007, the Fiji Association of the Deaf (FAD), together with AUSAID, NZAID and USP, took a bold step in local deaf community history through effectively collaboration for the development of a Fijian Sign Language Dictionary. This printed dictionary accommodated signs for both international and local concepts and was one of the major steps in standardizing the language in Fiji (Ministry of Commerce, 2019).

The objective for any sign language is to be easy adoptable and uniform for everyone. However, FAD, together with many users, have noted that the printed dictionary is not good enough for teaching and learning independently. It is a widely accepted phenomena that humans learn sign language at a much faster rate by observing dynamic signs being performed rather than from static images. The variations in signs due to different dialects are also a major issue when attempting to establish communication on a common platform. Moreover, teachers for hearing impaired students in remotely located special schools are always in need of tools to provide assistance (Boila, 2021).

Despite the FJSL printed dictionary being introduced in 2007, FAD reported a high demand to include current terminology and update the signs from present database. Another issue highlighted by FAD was the limitation in the number of FJSL interpreters, and that most are not available at all places within Fiji. Furthermore, other issues such as difficulty in teaching parents and other teachers in special schools, mismatches in signs, and various other learning and teaching related issues were reported. The 2007 FJSL printed dictionary has widely been used for over a decade

but is slowly becoming redundant in this age as the dependency on technology continues to increase given the latest advancements. Preference is given to tools incorporating the advantages that technology has to offer, and thus, a video dictionary was deemed to be the most suitable starting point to provide effective solutions to the outlined issues. In terms of improved assistance, a tool incorporating video and infographics would definitely be much easier to use compared to a printed dictionary and would concurrently be in compliance with current technology norms.

4.2 Objectives

Despite sign language not being a universal language yet, it is the most important communication tool within the deaf community. The FJSL tool aimed to standardize the local sign language to a much greater extent by creating a uniform solution. The tool, which can also be categorized as a video dictionary, is also meant to capture the numerous variations within the FJSL, owed to influences from other sign languages. This reduces ambiguity and encourages uniformity. Furthermore, the 2007 FJSL dictionary has become outdated, as new terminology has surfaced in day-to-day conversations in government, schools and other organizations. These words were not in usage more than a decade ago. Hence, this tool also aimed at introducing signs for new words through collaboration from senior FAD interpreters.

4.3 Design and Development

From the period of May 2019 to June 2019, multiple meetings were held by the USP development team with senior FAD interpreters to discuss the development of the tool. The 2007 FJSL printed dictionary was revisited, and each word was analysed again by the FAD team in terms of current relevance, changes to the signs, and the addition of variations. The FAD team was comprised of members from all major divisions of Fiji (Central, Western and Northern) to capture the collective input from all FJSL using regions in Fiji. This allowed the development team to be able to note down all the variations from different regions.

The team also listed important new words which needed to be included in the tool. The senior FAD interpreters collaboratively created the new signs for these new words, as the FJSL gestures for majority of new terminology were non-existent. A total of 128 new signs were created and incorporated into the tool.

From the periods of June 2019 to August 2019, the video recordings for the tool were taken. The recordings were done in the presence of the senior interpreters, who each took turns performing the signs for certain groups of words. The recordings were done in alphabetical order of the words and arranged just like a dictionary. The video editing, text and sound addition and general compilation of the tool was done between the periods of September 2019 to November 2019. The

tool was officially disseminated on 20th December 2019, under the presence of the Fijian Minister for Local Government, Housing and Community Development, Hon. Premila Kumar. This version of the tool contained a total of 1891 signs.



Figure 1 Handover of the FJSL Tool

4.4 Overview of the FJSL Tool

The tool is embedded on a portable USB drive, and it just utilized a simple plug and play feature. The user simply needs access to a PC or TV (with USB connection), plug in the USB and the tool automatically starts. A menu opens where users have the options to play all videos in order or select to play videos of words from a specific alphabet. The user can also individually select which words they want to view the signs for. In Fig. 1 and Fig. 2, stills from two videos are displayed to discuss the different aspects. The relevant parts of interface are also discussed. It should be noted that the FJSL is not only intended for the deaf and hard of hearing, but also for the public. These can include people who interact with deaf persons on regular instances such as children of deaf adults, parents of deaf children, people working in special education, sign language interpreters, disability organizations and many more. Therefore, an automated voice stating the word is also

automatically played after the interpreter performs the sign. This would be beneficial to the fully abled public wishing to learn FJSL.



Figure 2 FJSL Tool showing the word: little

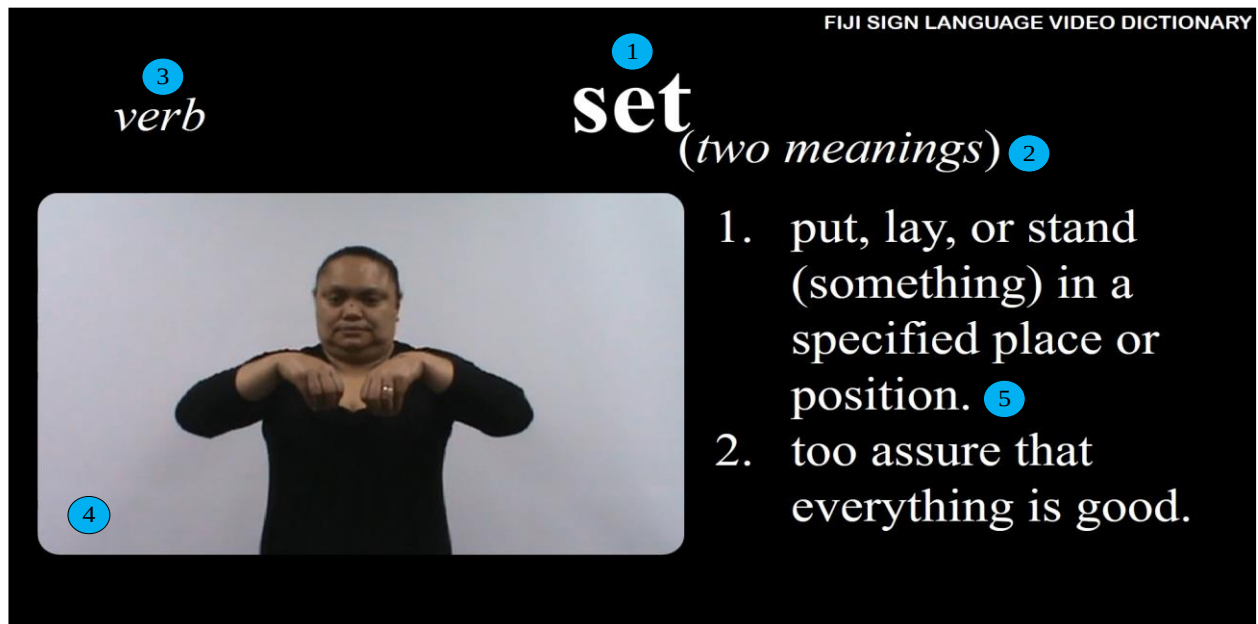


Figure 3 FJSL Tool showing the word: Set

4.5 Aspects

1. The English word – displayed in huge text font
2. Denotes number of variations of the sign (**Fig. 2**) or the number of meanings for the words (**Fig. 3**). There is a different sign for each variation or meaning and therefore, the interpreter performs all variations.
3. Provides the part of speech the word.
4. Video of the interpreter performing the sign. In the case of variations, the interpreter performs each variation, one after the other, clearly indicating the order.
5. The definition(s) of the word. For words with multiple meanings (such as **Fig. 2**), all the definitions are listed, and the relevant signs are shown by the interpreter, in the order the definitions/meanings are listed.
6. The same sign can be used for other words having a similar meaning i.e. one sign can be used for multiple words in the same context. These words are shown in capital under the definition.

4.6 Remarks

With the development of this tool, there now is a huge possibility for online training and provisions of teaching materials on FJSL. This tool can be used for easily training new FJSL interpreters everywhere in a short span. The solution is cost effective, and it is easy to produce multiple copies at virtually no cost. Additionally, this tool will drastically improve learning rates in children and adults, at the same time creating more awareness and understanding of FJSL. This tool is the first of its kind in Fiji to support people with hearing impairment. It is a known fact that developing innovative tools is a continuous task, as new words and signs emerge consistently. Therefore, in comparison to printed learning material, this tool is easy to update and is fully adaptable as it is easy to incorporate new signs (and create more versions) in future without a huge cost. Anyone can learn independently at no-cost from home and from schools using a computer or television. In the future, with possible funding, this tool can be upgraded to the form of a mobile app or even a website dedicated to teaching and learning FJSL.

This tool is not only relatively easy to use and cost-effective, but it also proves beneficial to the deaf community and the nation. Incorporation of such tools into learning platforms would create a sense of inclusivity for the persons with disabilities and allow deeper social bonds to be formed as a community.

5.0 Methodology

The research method used for this paper was a Survey and Interview methodology. According (Philips, 2017; Solakivia & Ojalaa,2017) (Solakivi & Ojala, 2017) a survey methodology is most suitable for cases where a problem needs to be defined, studied to what amount and in what context a problem exists and then the solution needs to be sought for future comparison and trends. Therefore, this two-phased survey was deployed to two sets of participants.

In the first phase, a first survey was conducted with 50 participants who had hearing impairments in Fiji. This survey collected information using a quasi-structured questionnaire on the demographic of the sample, level of hearing impairment and their perception of access to services around them. It aimed to explore how they are currently included if they have access to technical assistance if they know sign language and to understand barriers to inclusion of persons with hearing impairments. The results assist to establish if there is a need to further educate the South Pacific society about dealing with hearing impairments, getting a proper diagnosis and to introduce appropriate assistive technologies for the inclusion of persons with hearing impairments.

A second survey was conducted with 20 participants who had hearing impairments and had used the "The Sign Language tool" and collected information about their experience in using the tool and their suggestions on improving it. The participants had been given an assistive tool called the "Sign Language Tool", which aims to train persons with hearing impairments, teachers, parents (or anyone who would like to include the deaf and hard of the hearing community) in learning the Sign Language correctly. Results of this survey will assist the research team in improving the Sign Language Tool, as well as motivate the creation of more assistive devices for persons with impairments.

The second phase involved conducting semi structured interviews with a focus group of people which comprised of professionals working in several areas for the inclusion of persons with special needs. Their selection was based on their involvement in initiatives towards the inclusion of persons with disabilities in education or the workforce of Fiji. According to literature, the interviews are the oldest method of data collection in social sciences yet they tend to explain, better understand, and explore research subjects' opinions, behaviour, experiences and phenomenon (Young et al., 2017). For this research, a structured interview was used and the participants in this group were:

- i. Sign Language Interpreter
- ii. Founder- Deaf Consultancy Pacific
- iii. A Special School Teacher

For data analysis, the "Statistical Package for the Social Sciences" – SPSS software was used to construct the graphs, calculate the mean of accessibility to the services and to perform a correlation analysis. Usually, a Spearman correlation is often used to evaluate relationships between the items

(Reddy et al., 2020). For this study, the Spearman's correlation analysis was used to evaluate the relationship between the variables - Sign Language competency with the accessibility to services, programs, and events. Table 2 shows the variables that are used for the research with its corresponding description. All the phases of the research have been given ethics clearance from University of the South Pacific and have been further tested for reliability and validity before dissemination to the interviews and survey participants.

Variables	Description
A1	<i>Accessing the services of community restaurant</i>
A2	<i>Accessing the services of: home delivered meals</i>
A3	<i>Accessing the services of housebound shopping service</i>
A4	<i>Visiting (face to face): libraries</i>
A5	<i>Visiting (face to face): information centres</i>
A6	<i>Accessing: customer service</i>
A7	<i>Accessing: assistance</i>
A8	<i>Accessing: government websites</i>
A9	<i>Assessing: citizen-centric eServices</i>
A10	<i>Accessing: social media</i>
A11	<i>Accessing: websites</i>
A12	<i>Accessing government benefits: bus concessions</i>
A13	<i>Accessing government benefits: education concessions</i>
A14	<i>Attending: National events such as Eid on the Park/Diwali Mela/Fiji Day</i>

Table 2: The data set designed for the current research.

6.0 Results and discussion

Demographics

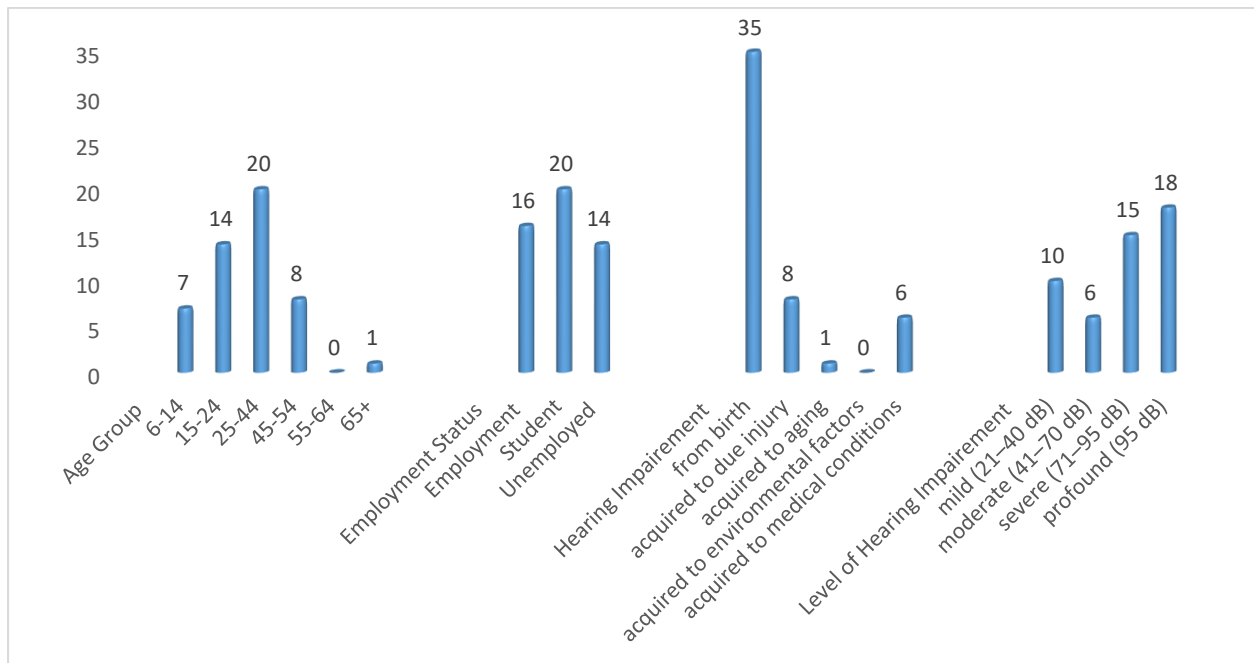


Figure 3: Demographics of the sample.

As shown in Figure 3, a total of 50 participants answered the survey of which 32% were employed, 40% were students and 28% were neither employed, nor students, but possibly taken care of members of their family. The participants are living with hearing impairments either from birth or acquired due to injury or medical conditions or the impairment was due to old age. The results show that 70% of the participants had hearing impairments from birth, 16% acquired the impairment from some kind of injury, 12% due to medical conditions while 2% contracted the impairment due to old age. For the current study the following measuring levels measured in decibels (dB) of hearing impairment were used for this study; mild (21-40dB), moderate (41-70dB), severe (71-95dB) and profound (95dB). The data gathered shown in Figure 1 revealed that 67.34% of the participants had severe – profound levels, 12.24% fell at a moderate level and 20.41% had a mild impairment.

Variable	Mean	SD	Variable	Mean	SD
A1	3.12	1.493	A8	3.18	1.466
A2	3.36	1.453	A9	3.04	1.414
A3	3.38	1.441	A10	3.58	1.513
A4	3.16	1.503	A11	3.42	1.486
A5	3.20	1.443	A12	2.12	1.365
A6	3.12	1.534	A13	2.88	1.409
A7	3.22	1.461	A14	3.40	1.429
Total Mean	3.15				
Chi-Square					

Table 3: Summary of the Mean and SD for the data set.

The 14 variables listed in Table 2 were used to evaluate the accessibility of programs, services and events to the participants. The responses were measured based on a rating from 1-5 with point 1 being the lowest accessibility and 5 being the highest. The results in Table 3 show that the accessibility for all the variables except A12 and A13 had a mean of 3 – 3.6. This means that the accessibility of services for programs and events was average. The variables A12 and A13 (accessibility to government services) were low- a rating of 2. Since the SD values are above 1, the responses from the students are distributed over a wide range meaning they had a different perception on the accessibility of different services (Rumsey, 2015).

Furthermore, a normality test was performed to decide the type of inferential statistics that can be carried out on the data set. The results of the normality test - Shapiro–Wilk test and Kolmogorov-Smirnov test showed that the data was not normally distributed. As such the chi-square test was performed to evaluate the relationship between the variables. The first test was performed on the participant's response on the accessibility of services of programs and events with participant's age.

H0: There is no significant association between age and participant response.

The results for the “Likelihood Ratio” instead of “Pearson Chi-Square” was taken as the expected count violated the rule of 20%. The value 0.089 > the p-value of 0.05 therefore we accept the H0. There is no association or no effect of age on the participant's response on the accessibility of services of programs and events.

Another chi-square test was performed using the data on “when the participant’s got the disability” with participant’s response on the accessibility of services of programs and events. Once again, the null hypothesis was:

H0: There is no significant association between age and participant response.

Since the expected count violated the rule of 20%, the value for “Likelihood Ratio” was taken. The value of 0.547 > the p-value of 0.05 therefore we accept the H0. There is no association or no effect of time the participant got the disability with the participant’s response on the accessibility of services of programs and events.

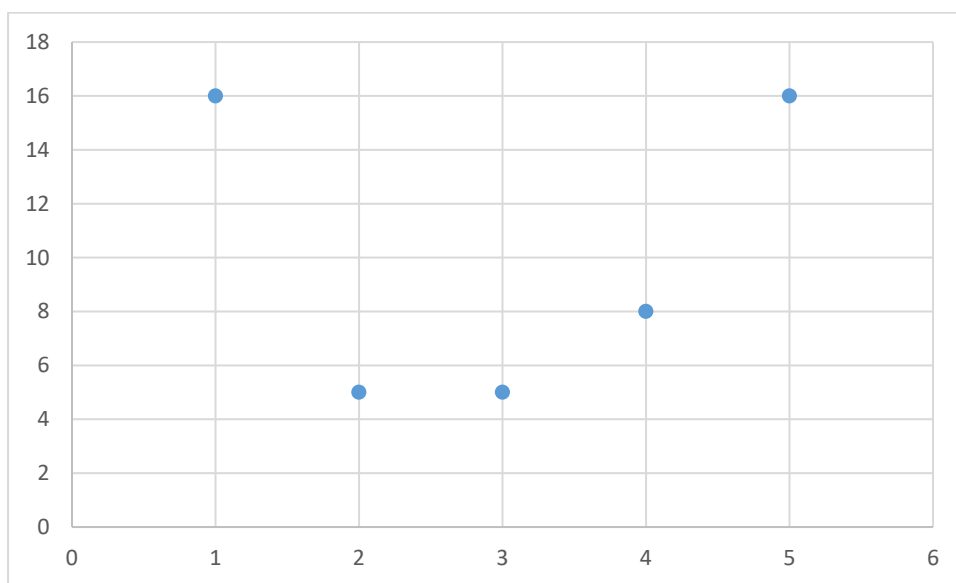


Figure 4: Competency of the participants in using the Sign Language Tool.

Figure 4 shows the Sign Language Competency of the participants with 1 being very little knowledge about signs, 3 being the participants having some knowledge to understand the signs and 5- the participants fully understanding the sign language. The results show that 30.61% the participants had high competency – 5, 16.33% had a competency of 4, 10.20% had a competency of 3, another 10.20% had a competency of 2 and 32.65% had a competency of 1. A total of 57.14% of the students fell in the range of 3-5.

			V1	V2
<i>Spearman's rho</i>	V1	<i>Correlation Coefficient</i>	1.000	.964**
		<i>Sig. (2-tailed)</i>	.	.000
		<i>N</i>	50	50
	V2	<i>Correlation Coefficient</i>	.964**	1.000
		<i>Sig. (2-tailed)</i>	.000	.
		<i>N</i>	50	50

Table 4: Correlation between the Sign Language Competency and Accessibility to services.

A correlation analysis was also performed to evaluate the relationship between Sign Language competency (V1) with the accessibility to services, programs, and events- variables A1, A2, A5, and A6 (V2). The results in Table 4 show that there was a strong correlation or strong relationship between Sign Language competencies with the accessibility to community services, services to home-delivered meals, visiting libraries and information centres. Also, according to (Rumsey, 2020), the Pearson correlation value of 0.70+ indicates a positive or strong linear relationship between the variables. The Sig value from the table is 0.00, which is <0.05 , this also proves that the sign language competency has a positive and strong impact on the behaviour of the participants on how they conveniently get access to resources in the society.

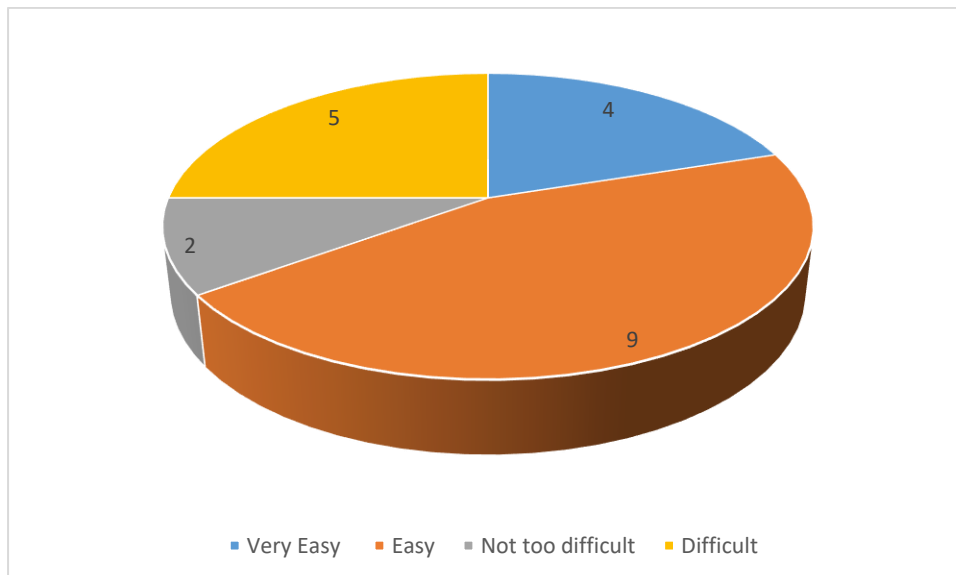


Figure 5: Participant response on the overall difficulty of the Sign Language Tool

The participants were also asked about the overall difficulty in using the Sign Language Tool. Figure 5 shows that 65% of the participants did not face any difficulty in using the tool and the various features the tool had whereas 35% of the participants have difficulty in using the tool and found the features of the tool were difficult to use. The authors of this paper believe that more training should have been provided to the participants before they used the tool.

The chi-square test was also performed to evaluate the association between participant's response on difficulty of the tool with age and employment status. The null hypothesis for the first test – with age was as follows:

H0: There is no significant association between age and participant response.

The results for the “Likelihood Ratio” as the expected count violated the rule of 20%. The value $0.010 < \text{the p-value of } 0.05$ therefore we reject the H0. Therefore, it can be stated that there is an association between age of the participant's and their response on the difficulty of the tool.

The second chi-square test was performed between the employment of the participants and their response on the difficulty of the tool. Once the rule of 20% for expected count was violated. The value for “Likelihood Ratio” was 0.041. Since $0.041 < \text{the p-value of } 0.05$, the H0 is rejected. As such there is an association between the employment status and the participant's response on the difficulty of the tool.

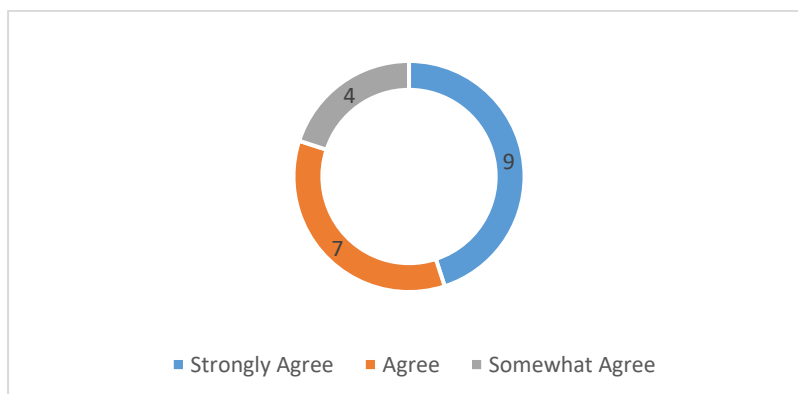


Figure 6: Participants response on Sign Language Tool as an effective learning tool.

For the Sign Language Tool as an effective learning tool, as shown in Figure 4, all the participants agreed that the tool was effective, however, the range of agreement differed- 45% of the participants strongly agreed, 35 % agreed and 20% of the participants somewhat agreed. The participants also suggested the following improvements for the tool; the addition of modules,

caption and more words, the use of more pictures, add vernacular language, increase the time frame for explanation and create an app for the learning tool.

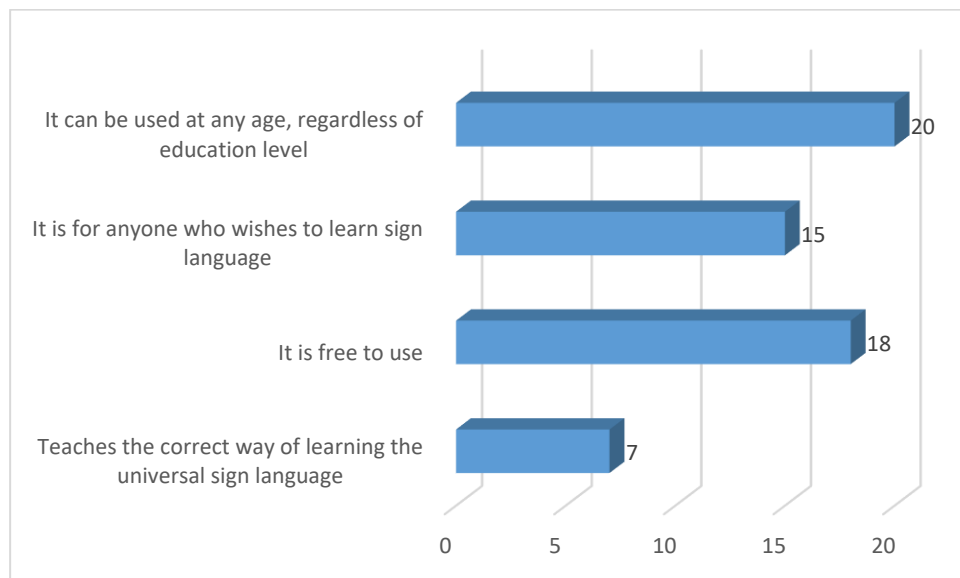


Figure 7: Advantages of the Sign Language Tool indicated by the participants.

Figure 7 shows the advantages of the Sign Language Tool perceived by the participants. Majority of the respondents supported the fact that the tool was free to use and could be used by any age group who wished to learn the sign language, the education level was not a pre-requisite to use the tool. According to literature, a Sign Language tool is developed to assist individuals hence any individual who wants to use the tool should be able to use it without any difficulty (Fitzpatrick et al., 2016; Hauser et al., 2016). The response to this study is in align with the aforementioned claims in the literature.

There were some suggestions from the participants on how the Sign Language Tool can be improved. Their suggestions include having more videos, adding more pictures with captions, making the tool more interactive and fun, and adding vernacular languages and dialects, adding captions or more words for better understanding and having the tool as an app. The research team has taken this feedback and are working towards it now.

8.2 Structured Interview with Focus groups

A structured interview was conducted over a special focus group comprising of professionals working in several areas for the inclusion of persons with special needs. The participants of the focus group have been instrumental in initiatives towards inclusion of persons with disabilities in the workforce and education. They discussed their perceptions on the lives of persons living with hearing impairments and the use of assistive technologies. The persons interviewed were:

- i. Sign Language Interpreter
- ii. Founder- Deaf Consultancy Pacific
- iii. Teacher- Nadi Special School

In summary, the interviewees indicate that the persons with hearing impairment in the society is increasing and assistance from the government and relevant stakeholders have enabled successful participation of these individuals in our community. However, there is still a need to improve the services that are provided to the persons with hearing impairments in schools such as; Schools to undergo a proper access audit and make reasonable adjustments to suit needs, teachers to know sign language, parents to be more involved in the educational needs of their children and people providing support services to have background knowledge about disability and deaf culture, provide home based programs and specialized apps to support learning. As far as the jobs of the persons with disability in Fiji is concerned, under the bill of rights, Fiji's constitution gives persons living with disabilities the right to employment. However, the interviewees have noticed that persons with disabilities still have difficulties to join organisation or find employment as organisations find it difficult to accommodate people with disabilities because they have special needs, and they require special treatment at work, for examples, they need a hearing aid they need special care from the organisation. Additionally, some graduates are employed however, they are paid below their qualification levels therefore, and the employers in Fiji need to change their existing attitudes towards the employment of persons with disabilities.

The challenges in learning that the person who disability face include literacy and numeracy because they are unable to hear the sound, it is hard for them to understand the actual sound and phonics of the words, so they cannot figure out what the word sounds like, so they have very low understanding of the concept of sounds. They also have difficulty in numeracy because numeracy deals with numbers, calculations, and measurements, so if they are intellectually impaired, they have very limited understanding of the concepts that are used in mathematics. Some of the suggestions from the interviewees to improve the numeracy and literacy include sign language interpreters, TV and video captions, text crawling, CART – Communication Access Realtime Translation, Audio Induction Loop systems, FM systems, loop systems, accessible telephones/videophones, visual alert systems, and apps for “speech to text”.

The newly designed and developed Sign Language Tool received positive feedback from the interviewees. They found the tool to be effective for learning and was easy to understand. However, they gave their recommendations on the improvements for the tool such as inclusion of pictures, more videos and suggestion to convert it into an app format. More details on the interview are provided in the Table 5 in the Appendix.

9.0 Conclusions

Assistive technologies (ATs) play a pivotal role in improving abilities of persons with disabilities whether it is inside the classroom or outside. While some ATs are specifically used to improve the functionalities of the disabled, others have the capability to perform as mainstream technologies to assist people to improve their learning and skills. For example, assistive technologies such as mobility aids, hearing aids, adaptive switches and utensils and cognitive aids are built to assist persons with disability. On the other hand, assistive technologies such as text-to-speech and verbal command functions of smartphones, tablet computers that provide live sign-language interpretation, education technologies that help in improving skills are used for individuals who need assistance in improving their skills and knowledge. The current research explores the use of assistive technology for persons with hearing impairments and suggests such interventions that can improve the state of inclusion in Fiji. The results of the current research reflect that the users of the assistive technologies need relevant skills to use any assistive technology to its full potential.

The study results show that 70% of the sample has hearing impairments from birth. From the sample, 57.14% have an average to very high levels of competency in Sign Language. There is a need to measure the sign language competencies because there is a strong relationship between knowing the sign language and an individual's ability to freely function in the civil society. The correlation analysis reflects that there is a strong correlation between the sign language competency and the convenience at which the participants got access to services in the civil society. The newly designed and developed Sign Language tool received positive feedback from the participants. The survey results show that the tool was effective for learning and easy to use and understand for any age group. The results further reaffirm the finding of the empirical research done in the early parts of the study which suggest that low-tech tools are highly adaptable in developing countries. The suggestions on improvement of the tool were as such: having more videos and pictures with captions, making the tool more interactive and fun, and adding vernacular languages and dialects and developing the tool as an app.

Since the Sign Language Tool showed an easy adaptation for persons living with impairments, similarly a simple assistive technology can be designed and developed targeting education in Fiji, with the possibility of extending it in the South Pacific. Additionally, the assistive technologies

that have been developed and used for education in other countries can be used as a reference with consultation with the Fiji disabled community. STEM subjects have a language of its own, so it is recommended for the tool to have different modules with each having its own difficulty levels. As suggested in this study, the tool can incorporate the use of videos, captions and creativity so that learning STEM is easier and fun. Developing a simple yet an effective tool for inclusion should a way forward to solve the persisting issue of the difficulties faced in learning STEM in Fiji.

In addition to close captioning, voice over incorporation is recommended to include the blind and those who face varying challenges associated with reading text or watching video tutorials. Organisations representing the greater civil society, education and employment ministries should integrate this tool as part of their early childhood curriculum, addressing our sustainable development goals.

Furthermore, it is highly recommended that any updates or enhancements of the FJTL include the local languages used in Fiji such as iTaukei (local indigenous language) Fiji Baat (Fiji Hindi), Fäeag Rotqam (Rotuman) with possible extension in the Pacific through adaptation of the local languages (Project, 2017).

10.0 Limitations of the study

This study focuses primarily on the inclusion needs of persons who are deaf and hard of hearing. The participants, both for both the surveys have some degree of hearing impairment. However, their views may not be a complete reflection of the view of all persons with hearing impairments in Fiji. The study captures information from only those participants who have fully consented to participate in this survey. It does not account for those persons with disabilities who have other disabilities in addition to hearing impairment. This could be a useful addition to future studies to assess the needful interventions for inclusion of those participants who have more than one impairment in addition to hearing impairment.

A follow up study will need to be conducted to see the efficacy of the Sign Language Tool after implementation of the updates which will be done based on the feedback of this study. As such, native dialects will also need to be closely assessed for accuracy and reliability.

Appendix

The responses of the interviewees are summarized below for concluding remarks and references.

Questions	Founder- Deaf Consultancy Pacific	Sign Language Interpreter	Teacher- Nadi Special School
<i>What are your general thoughts on the level of inclusion and participation of the deaf and hard of hearing in our communities?</i>	The level of inclusion and participation of the deaf and hard of hearing in our communities is increasing but there are some holistic areas we need to review and invest and develop to support the communication accessibility for the deaf people.	The accessible services provided by government and stakeholders have been immensely helpful and satisfactory. There have been different modes of accessing information and communication service for instance during the COVID 19 crisis, there were interpretations in the television news and deaf persons have been invited to be part of taskforce teams to contribute to discussions in how services could be Deaf friendly too.	In the past, it was difficult for deaf people to mix around in communities, but now we see more inclusion because of awareness work is done, and also there have been hearing devices made which makes it easier for deaf people to be included in the communities
<i>Some schools in Fiji welcome students with disabilities, as they now declare themselves as inclusive". However, it is still seen that a significant percentage of children with disabilities still do not attend school. How can this situation be improved further?</i>	Well, it begs the questions. The term "inclusive" is complicating too many relevant stakeholders. It depends on the availability of resources they have to ensure accessibility for all the students with disabilities. Some inclusive schools do not have full knowledge of disability-needs. They need to adjust to suit the needs of the students with disabilities effectively and efficiently, not the students with disabilities suiting to the needs of the existing school environment. E.g. when a school wants to have a "fully inclusive" learning environment for everyone, so it ensures "full participation" for deaf students. So, this means will the staff, teachers, hearing students (students without disabilities) must learn sign language to communicate effectively? Does it mean that deaf students will have 100% participation in all daily school activities or peer-level communication? This situation can be improved in many ways like • Implementing effective deaf-needs specific education policies • Resources like technologies to help fill the communication gap and make learning easier. • Sign language and Deaf culture to be one of the compulsory subjects in all-inclusive schools. • Deaf schools are best places not for only receiving bilingual education through the mediums of	It can be improved further by: • Schools to undergo a proper access audit and make reasonable adjustments to suit needs. • Teachers to know sign language. • Parents to be more involved in the educational needs of their children. • People providing support services to have background knowledge about Disability and Deaf culture.	We need to do more awareness in communities and provide support to families e.g. transportation and easy access to school for children with special needs. We can also have a home visitation program or home-based teaching for children who can't come to school due to severe disabilities. Online teaching and a mobile app can be handy as well.

	communication, sign language and written English. • More information can be found on the World Federation of the Deaf		
<i>Under the bill of rights, Fiji's constitution gives persons living with disabilities the right to employment. Therefore, employers are also responsible for creating provisions for inclusion of persons with disabilities. With all such empowerment, do you think Fiji's job market inclusive for persons who are deaf and hard of hearing? Are persons with disabilities have enough job opportunities? How do you think it can improve?</i>	Yes, Fiji's constitution and the UNCRPD clearly states that persons with disabilities have the right to employment, but the main issue is the attitude of the employers that leads to invisible acceptances of persons with disabilities as part of inclusive job recruitments. No, I don't think so Fiji's job market is full inclusive yet for persons who are deaf and hard of hearing even though the Fijian Government are making great Employment Taxation Scheme (ETS) for both employers and employees. Most of the employers are not practising the affirmative actions (which ensures the equal representations of people with diverse identities from different minority groups).	Deaf persons are still given token employment. We have university graduates still out of jobs and if given one, it is often a position that is lower than their qualifications. Most of our graduates teach at the Special schools and not in mainstream employment as they would wish. Employers need to change their mindsets about employing Deaf persons and they should work together with the government in providing equal opportunities on merit for everyone.	We do have the rights, but we have to follow our responsibilities. As we can see, if we look at the job market, we can see that persons with disabilities still have difficulties to join an organization or find employment as organisations find it difficult to accommodate people with disabilities because they have special needs, and they require special treatment at work, for examples, they need a hearing aid they need special care from the organisation. The organisation has employees who understand people with disabilities because at times in people with disabilities get bullied or labelled so we have to remove the stereotypes and labels from people who are disabled. We need to understand and treat them as normal human beings, then only the environment can be a suitable environment for the person with disabilities to work in. I think we still need to educate our organisations and job sector in this area. Employers and employees need to learn about types of disabilities. The onus is on the people who work in an organisation to be confident enough to handle a person with disability when they enter their office and respect their rights. We still need to do a lot of awareness and training to cater for people with disabilities. I also think that in future, organisations need to have officers trained to cater for people with disabilities so they can be a form of support in the organisation if the rights of persons with disabilities have been violated, and to get support if needed.
<i>Which subjects do they find the most difficulty with? Why is this? How can we provide help or support?</i>	Accessibility and communication. The society does not make the full commitment to ensuring the reasonable accommodations are met for the deaf and hard of hearing individuals. Reasonable accommodations and accessibility mostly include sign language interpreters, TV	Deaf students need to be introduced to reading at an early age and families need to communicate with them using sign language. It often boosts the confidence of Deaf students.	People with disability have a lot of difficulties with literacy and numeracy. Literacy because when they are unable to hear the sound, it is hard for them to understand the actual sound and phonics of the words, so they cannot figure out what the word sounds like, so they have very low understanding of the concept of sounds.

	and video captions, text crawling, CART – Communication Access Realtime Translation, Audio Induction Loop systems, FM systems, loop systems, accessible telephones/videophones, visual alert systems, and much more. There are some useful apps for “speech to text” but it doesn’t make 100% accurate information due to the different accents. Most of the apps like ‘live to transcribe’ are customizable to American, Australian, and British English only. It would be great to know if there are any software developer who can develop software or app for the remote relay interpreting services just Deaf person can dial their mobile or computer to call anyone who is hearing and do not know sign language and talk on the mobile through the relay interpreter online. Also, we would like to see the CART being developed for everyone who needs to read live captions.		They also have difficulty in numeracy because numeracy deals with numbers, calculations and measurements, so if they are intellectually impaired, they have very limited understanding of the concepts that are used in mathematics, so our focus areas are always based on literacy and numeracy because these are the two areas which deal with the child’s daily life. They need to speak and know how to speak and how to understand and reply, and they also need numeracy to do the calculation, exchange of money, or bus fares, or when they are buying things, they need to understand about adding, subtraction, multiplication, how to tender notes, so numeracy and literacy is our main focus in special schools, but again it depends on the level of the child’s understanding. If a child is intellectually impaired and has difficulty in understanding the concept, it is very challenging to put across the information to the child. If he/she is deaf it is difficult for teachers to put across the actual sound that the letters have, because they have no understanding of the sounds.
<i>What do you think of the Sign Language Tool?</i>	I saw the sign language tool. It’s brilliant but some errors need to be fixed. Some signs are not incorrect. It would be best for this to be transferred to the online platform for everyone to access. It can be updated every day when the need arises. Our signs are not frozen and will evolve into slightly different signs later or new signs will come over time. The team will need to be consist of experienced deaf individuals and deaf experts with diverse background and knowledge.	Excellent!	Well, I have seen the sign language tool, and it is one of the best devices I would say that has helped many people in understanding about sign language, and I think it is also one of the easiest ways to learn some of the words that we use daily. Sign language tool has been very handy in resorts and schools because children can watch it in their free time and learn without an instructor, simply by playing the CD, watch it and learn from there.
<i>What was your experience in training sign language using the Sign Language Tool?</i>	I have not used it for any purpose yet since Fiji Association of the deaf mentioned that this is being on hold till the errors are fixed.	Very helpful and feedback has come back that it is self-explanatory and very easy to learn from.	I find sign language tool very easy to understand and use because we can just play it on any PC, watch and learn it. So, it is very handy and easy to understand.
<i>What are the issues you face in using and teaching the Sign Language Tool?</i>	N/A	Timing and availability of the team and the room.	Some of the difficulties we have, if the tools include pictures, it will help the students understand better to relate words to meaning, so I feel it can be further modified so it can be helpful for deaf and mute students.

What other ATs you are aware of which can help our students of special abilities? Are there other assistive devices would you like the research team to create?	There are some useful apps for "speech to text" and 'live transcribe'.	Deaf persons would be the best people to respond to this.	The Sign Language Tool should be converted into apps so it can be loaded on their mobiles phones because it is very easy for students to keep a mobile phone and load the apps so they can learn using their phone, because of most children. I have seen are very good with mobile phones as it is easy for them to get access to phone so they can use it anywhere, even while they are travelling, to learn the sign language I also think the braille that has been developed can be further modified so it is easy for people with disabilities can use it, and sign language tool should be developed in more languages apart from English for people who are not educated can also use the tools. We need to take this device to rural areas where people have limited access to schools and technology If this device reaches them through mobile apps, it will help the communities and society to learn and prepare themselves to talk anyone who has hearing and speech impairment.
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Table 5: Responses from the Interviewees.

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