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Design of a Mobile Based Assistive Technology for Students with Special Educational Needs and Disabilities in the North-East Nigeria to Improve Learning Mechanism Thematic Area (ICT and Education)

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----------ABSTRACT----------
This study explores the design of a mobile-based assistive technology framework to enhance the learning mechanisms for students with special educational needs and disabilities (SEND) in North-East Nigeria. Using a descriptive qualitative approach, the research investigates general awareness, availability, and challenges associated with integrating assistive technologies in SEND settings. Data were collected through structured interviews, questionnaires, and a review of relevant literature. Key findings highlight that while assistive technologies significantly enhance learning outcomes, challenges such as inadequate resources, limited teacher training, and high costs hinder effective implementation. To address these, a mobile web-based assistive technology application was developed using Visual Basic, HTML, and MySQL, focusing on improving accessibility and adaptive learning for SEND students, including those with Attention Deficit Hyperactivity Disorder (ADHD). The proposed solution aims to foster equitable access to education, ensuring inclusion and improved learning outcomes for SEND students.

Keywords: *Assistive Technology, Special Educational Needs, Disabilities, Mobile Learning, Inclusion, ADHD, Nigeria.*

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I. INTRODUCTION

Students with special learning needs or with developmental disabilities can be considered as a type of students with low academic ability. Some of the general learner characteristics include short attention span, low capacity of working memory, need for repetitive practice and feedback sessions, and difficulties to make connections between events and characters in the same story. Students with special needs and disabilities in higher education settings may experience many academic, attitudinal, and physical obstacles. Specifically, they are more likely to face many problems in their study, test, social life, and self-image.

As the vast majority of educators and policy makers strongly promote the philosophy of including individuals with disabilities to the maximum extent in the least restrictive environment the need to meet such an educational approach is critical and the challenges for adjustments and accommodations for all children and adults with disabilities are great as well (Dinsmore, & MacLachlan., 2018). According to the mandates in the Individuals with Disabilities Education act of 1997 (IDEA), all students must have the opportunity to access the core curriculum (Irish, 2003). Among those integrated individuals with disabilities are students with learning disabilities (LD) who are considered to be the largest student population with disabilities to be integrated within the general education system.

Technology plays a great role in this growing society and the ever-changing world. The advances that it brings to the lives of people are inevitable. The emergence of numerous innovations is influenced by the existence of technology. The advent of technology has brought several changes, even in the field of education. Specialized technologies will improve the classroom performance of a child with special educational needs and disability. In the education process, Assistive Technologies (AT) offers various solutions in providing students with support that meet their needs (Aslan, 2018). These assistive technologies significantly contribute to aiding persons with special educational needs in learning, building self-confidence, being independent and achieving a high quality of life (Bouck and long, 2021). The use of Assistive Technologies helps to facilitate the improved

performance of the students by providing support, such as adapting content and activities of the curricula, specific to their needs within a minimum- restricted environment. Alnadi (2014) pointed out that Assistive Technologies serve to increase both the functional performance and academic success of the students.

According to the Individual with Disability Education Act (IDEA), any equipment that is used to improve functional capabilities of individuals with disabilities is considered as Assistive Technologies (AT). It may include any software program or product system that can be used to increase, maintain, or improve the functional capabilities of people with disabilities (Ndakaitei, 2023). The purpose of this study is to design a framework that integrates Assistive Technologies (AT) to improve students' learning outcome.

Objectives: The goal of this project is to investigate the integration of assistive technologies for students with special educational needs and disabilities in North-East Nigeria. The specific objectives of the project are to:

i. Identify the general awareness on the use of assistive technologies for students with special educational needs and disabilities in North-East Nigeria
ii. Examine the availability of Assistive Technologies that teachers utilize in learning and teaching students with special educational needs.
iii. Identify the challenges encountered by teachers and the support mechanism they needed in integrating technology for teaching students with special educational needs and disabilities
iv. Identify the trends in scientific production on assistive technology for students
   a. with disabilities in the field of education
v. Design a mobile web Assistive Technology for students with special educational needs and disabilities in North-East Nigeria

II. LITERATURE REVIEW

Recently, technology has been viewed as a promising instructional tool to mediate and accelerate the learning of all students, including those with various types of disabilities (Svensson et al., 2019).

Simadi and Alqaryouti (2017) investigated the satisfaction level of students with disabilities regarding available educational services at Jordanian, Qatari and Yemeni universities. A total of 251 students with disabilities participated in the study. The study results show that the satisfaction of students with disabilities with social services came at the first level, and then psychological, educational, and health services. The results also indicated no statistically significant effect attributed to gender and degree of disability variables.

Al-Miqdad and Al-Qatawneh (2018) studied the services provided to students with disabilities in a Jordanian university. The study used a questionnaire consisting of (34) items distributed over (57) students with disabilities. The results showed that students with disabilities were delighted with administrative services, building facilities, and transportation services. On the other hand, students with disabilities' satisfaction with academic services were rated as acceptable. The study indicated no effects of the student's gender, the field of study, and the type of disability in the study result.

Kisanga (2020) explored the educational and social barriers facing students with sensory disabilities in higher education settings and their coping strategies. The case study design was used to collect data from (27) students with sensory disabilities selected from two higher education institutions in Tanzania. The study used semi-structured interviews, open questionnaires, and focus group discussions. The results showed that the significant academic barriers facing students with sensory disabilities were teaching and learning resources, teachers' practices, and communication barriers. Other academic barriers were exams, insufficiency of access to information, barriers in curricula, and inaccessibility to the environment, as well as negative attitudes and negative perceptions towards students. Students used problem and emotionally focused coping strategies to manage barriers.

Abubakar (2017) investigates the mobility experiences of staff and students with disabilities in Nigerian tertiary institutions, highlighting barriers and strategies for overcoming them within inclusive policies. Using qualitative methods like interviews, accessibility audits, and document reviews, the study focuses on two institutions in Kano State. The findings reveal that physical and attitudinal barriers have the greatest impact, while psychological barriers are less significant. Effects include demotivation, financial strain, and physical stress. Solutions include resilience, awareness, support systems, barrier removal, and improved policies. The research proposes a model to enhance inclusion and equality, supporting the global "education for all" goal.

Fernández-López et al. (2013) explore iOS-based mobile learning technology for students with special education needs (SEN). The study develops a user-centered iOS application with customizable content, multimedia resources, and adaptive features for various disabilities. Empirical testing demonstrates its effectiveness in improving motivation, participation, and learning outcomes. The research highlights the role of mobile technology in overcoming barriers to SEN education, fostering accessibility, and enhancing

personalization.The authors conclude that iOS devices, paired with tailored applications, significantly promote inclusion and equal educational opportunities.

Ismaili and Ibrahimi (2017) assess mobile learning as an alternative to traditional assistive devices for students with special needs. The study identifies benefits such as personalized learning, improved accessibility, and engagement through cost-effective mobile solutions. Customizable applications enhance independence and participation. The authors also highlight cost advantages over conventional assistive devices. They conclude that mobile learning is a promising approach to promoting inclusion, accessibility, and equality in education for special needs students.

Muazu et al. (2024) classify studies on mobile learning in special education needs and disabilities (SEND) settings. The review identifies trends, benefits, and challenges, showing how mobile learning fosters personalized education, accessibility, and engagement for SEND students. Mobile learning is adaptable and cost-effective but faces barriers like the digital divide and lack of teacher training. The study emphasizes its transformative potential in SEND education, promoting inclusion and equity, while recommending further research to address these challenges.

Karanfiller, Göksu, and Yurtkan (2017) develop a mobile application designed for students in special education. The application includes customizable content, multimedia support, and adaptive interfaces to meet diverse needs. Developed through a user-centered approach, it incorporates input from educators and specialists to ensure usability and effectiveness. The study demonstrates the application's ability to enhance engagement, accessibility, and personalization in education. The authors advocate for mobile technology integration in special education to promote inclusion and equity.

A major goal for educators working with students with special educational needs and disabilities is to provide appropriate support and alternative teaching strategies to enhance their performance in academic and social skills to the maximum of their potential abilities (Hetzroni and Shreiber, 2004). One of the promising fields in education that is connected directly with the work of both teachers and students is the use of technology and computers in various ways to promote their learning. Recently, technology has been viewed as a promising instructional tool to mediate and accelerate the learning of all students, including those with various types of disabilities (Atanga et al., 2019). Teachers' attitudes and views, according to Johnson et al. (2016), are critical elements in influencing the use and efficacy of technology in classrooms. Teachers believe that introducing technology into the classroom improves educational outcomes and promotes job satisfaction, according to the study of Cagiltay et al. (2019).

Assistive technology is an umbrella term covering the systems and services related to the delivery of assistive products and services. Assistive products maintain or improve an individual's functioning and independence, thereby promoting their well-being. Assistive technology enables people to live healthy, productive, independent, and dignified lives, and to participate in education, the labour market and civic life (de Witte et.l., 2018) .Any product whose principal objective is to maintain or enhance an individual's functionality and independence and consequently promote their wellbeing is considered Assistive Technology (AT) (McNicholl et al., 2021).

Assistive technology reduces the need for formal health and support services, long-term care and the work of caregivers. Without assistive technology, people are often excluded, isolated, and locked into poverty, thereby increasing the impact of disease and disability on a person, their family, and society.

III. METHODOLOGY

Research Design

This study used the descriptive –qualitative method of research. This involved the use of a structured interview guide; various literatures and studies was reviewed and considered before the formulation of the interview guide. The structure interview guide will be reviewed and validated by experts in the field. The project will also adopt the system development life cycle (SDLC) for the design.

Study Area

The project was conducted in North-East Nigeria. The North-East (often hyphenated to the North-East) is the one of the six geopolitical zones of Nigeria representing both a geographic and political region of the country's northeast. It comprises six states – Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe. Geographically, the North-East is the largest geopolitical zone in the nation, covering nearly one-third of Nigeria's total area. In terms of the environment, the zone is primarily divided between the semi-desert Sahelian savanna and the tropical West Sudanian ecoregions.

The region has a population of about 26 million people, around 12% of the total population of the country. Maiduguri and Bauchi are the most populous cities in the North East as well as the fifteenth and

seventeenth most populous cities in Nigeria. Other large northeastern cities include (in order by population) Bauchi, Yola, Mubi, Gombe, Jimeta, Potiskum, Jalingo, Gashua, and Bama.

Population

The population of the project covers selected special schools across the north-eastern region. Two Local Government areas were selected from each state in North-East Nigeria. The two LGA selected were based on the numbers of special schools located in the state.

Sample and Sampling Techniques

A total of 1320 respondents selected for the project, 110 respondents were selected from each selected LGA, three (3) LGAs from the selected states in North-East Nigeria. That means that 330 respondents were selected from each state in North-East Nigeria. The project was sample four states in the geo-political Zone. Namely: Adamawa State, Taraba State, Gombe State and Bauchi State. Simple random sampling was used to sample respondents in this project.

Research Instruments

The project makes use of structured questionnaires and interviews as a means of research instrument.

Procedure for Data Collection

The researcher recruits research assistants from the selected LGAs in each of the selected North East states in Nigeria. Two days of training was given to the research assistants on data administration and collection using interviews and questionnaires. The interview and questionnaire were used as a means of data collection for the project.

Method of data Analysis

The data collected was subject to statistical Analysis using statistical Package for Social Science (SPSS 23). Tables and simple percentage were used to analyze section A of the questionnaire while inferential statistics used to analyze the remaining sections in the questionnaire. Quirk software was used as a qualitative analysis tool.

Design Tool

The design consists of two dimensions. Namely; the technical dimension and the students with special educational needs and disabilities dimension. The project makes use of Visual Basic Version 6, HTML, Java script, CSS, and My SQL database for the design and development of the Assistive Technology Software tool for Students with Special Educational Needs and Disabilities.

The design work for this study was based on empirical studies, students with special educational needs, and disabilities research, and related work on assistive technology. In addition, data collected from respondents was also aid in designing the mobile web assistive technology software.

IV. RESULTS AND DISCUSSION

Presentation of Results

Table 1 and 2 displays the demographic information of the respondents in terms of gender and marital status.

Table 4.1: Gender of the Respondents

Gender	Frequency	Percentage
Male	599	
Female	721	
Total	1320	100

Table 4. 1 displays the gender of participants in the study. The results in the table indicated that 67 representing 56% of the respondents were males while 53 (44%) were females. This data shows that majority of the respondents are males

Table 4. 2: Marital Status of the Respondents

Marital status	Frequency	Percentage
Single	552	
Married	747	
Divorce	21	
Total	1320	100

The results in Table 4.2 indicated the majority of the respondents 69(57.5%) are married, followed by 51 (42.5%) are single. The results however show that none of the respondents is divorce with 0(0%).

Table 4.3: Working Experience of the respondents

Years of working experience	Frequency	Percentage
1-5 years	511	
6-10 years	307	
11-15 years	416	
16 years and above	86	1
Total	1320	100

Table 4:3 displays the working experience of the respondents on the study. The table shows that the majority of the respondents has working experience of 1-5 years 48(40%). 6-10 15(12.5%), 11-15 years 36(30%).

Table 4. 4: Qualification of the Respondents

Qualification	Frequency	Percentage
NCE/Diploma	657	49
BSC/HND	506	38
Msc	157	13
PhD	0	0
	1320	100

Data in Table 4.4 illustrates the qualification of the respondents. The results show that the majority of the respondents are NCE/Diploma holders 58(49%), followed by BSC/HND 46(38%). Those with Msc are 16(13%). The results also show that none of the respondents has a PhD degree 0 (o %).

Table 4.5: Religion of the Respondents

Religion of the respondent	Frequency	Percentage
Christianity	718	
Islam	602	
Other	0	
Total	1320	100

Table 4.5 shows the results obtained on the religion of the respondents. The outcomes of the results are Christianity 60(60%), Islam 48(40%) and other religions 12(10%). The results of the study indicated that the majority of the respondents are Christian.

Table: 4.6 Summary of Descriptive Statistics of Mean and Standard Deviation on the availability of Assistive Technology

S/N	Item	Mean	SD	Remark
1	We use Assistive Technology to teach students with disabilities	3.19	1.57	**Disagreed**
2	We have adequate knowledge on the use of ATs in Teaching students	3.42	1.49	**Disagreed**
3	There is need for capacity building on the use of modern ATs in teaching students with disabilities(ADHD)	3.85	1.05	**Agreed**
4	There is High cost on the use of Assistive Technology	3.61	1.27	**Agreed**
5	There is need for new trends in scientific production on Assistive Technology for students with disabilities (ADHD) in the field of education	3.69	1.32	**Agreed**
6	Assistive technology are very rare and often not available for teaching students with disabilities especially (ADHD)	3.70	1.33	**Agreed**
7	There is need to create awareness on the use of Assistive Technology	3.77	1.31	**Agreed**
8	Teachers mostly used old modern of Assistive Technology in schools	3.72	1.44	**Agreed**
9	Government has put in place a policy that establishes Assistive Technology to guarantee instructions with disabilities (ADHD) in the inclusive of primary and secondary setup in Adamawa state	3.73	1.45	**Agreed**

10	Integration of Assistive Technology for students with disabilities will burst and improve students' learning mechanism	3.95	1.42	**Agreed**
11	There are new trend of technology in area of Assistive Technology	4.05	1.49	**Agreed**

N= 1320

Data in Table 4.6 illustrates the mean response of respondents on their general perceptions on the use and availability of Assistive Technology in teaching pupils with disabilities and educational special needs. The results showed that respondents agreed with items 3,4,5,6,7,8,9, 10 and 11 with a mean score 3.59, 3.61, 3.69, 3.70, 3.77, 3 . 7 2 and 3.95 respectively and SD ranging from 1.31 to 1.57. Additionally, the respondents disagreed with item 1 and 2 with mean of 3.19 and 3.42 with SD of 1.57 and 1.49.

Assistive Technology Used by Teachers

S/N	ITEM	YES	NO
1	Hearing aid	1320 (100%)	0 (0%)
2	Adopted doorbell	98 (7.4%)	1222 (92.6%)
3	Telecommunication device for deaf	46 (3.5%)	1274 (96.5%)
4	Audiometer	702 (53.2%)	618 (46.8%)
5	Tympanometry	910 (68.9%)	410 (31.1%)
6	Head Pointer	476 (36.1%)	844 (63.9%)
7	Adopted chair	1123 (85.1%)	197 (14.9%)
8	Adopted table	987 (74.7%)	333 (25.3%)
9	Talking book	618 (46.8%)	703 (53.2)
10	Joystick	1320 (100%)	0 (0%)
11	Web (internet)	1202 (91.1%)	118 (8.9%)
12	Mobile learning	0 (0%)	1230 (100%)
13	Robotics	O (0%)	1230 (100%)
14	Computer	1320 (100%)	0(0%)
15	Corner Chair	1109 (84.1%)	211 (15.9%)
16	Digital Board	1115 (84.5%)	205 (15.5%)

Table 4.7 shows the respondents responses on the type of Assistive Technology used by teachers. The results revealed that majority of the respondents answered yes on hearing aid with 1320 (100%), Audiometer with 702 (53.2%), joystick with 1320 (100%) computer 1320 (100%), corner chair with 1109 (84.1%) and digital board with 1115 (84.5%) respectively and No on robotics with 1230 (100%), mobile learning with 1320 (100%), talking book with703 (52.2%, head pointer with 844 (63.9%) and telecommunication device for deaf with 1274 (96.5%) respectively. The results on table 4.7 revealed that there is a need for trends in scientific production on assistive technology for students with disabilities in the field of education.

Problem Faced with the of Assistive Technology

. Figure 4.1 shows the results on the respondent's responses on inadequate budgetary allocation on Assistive Technology for students with special educational needs most especially students with ADHD

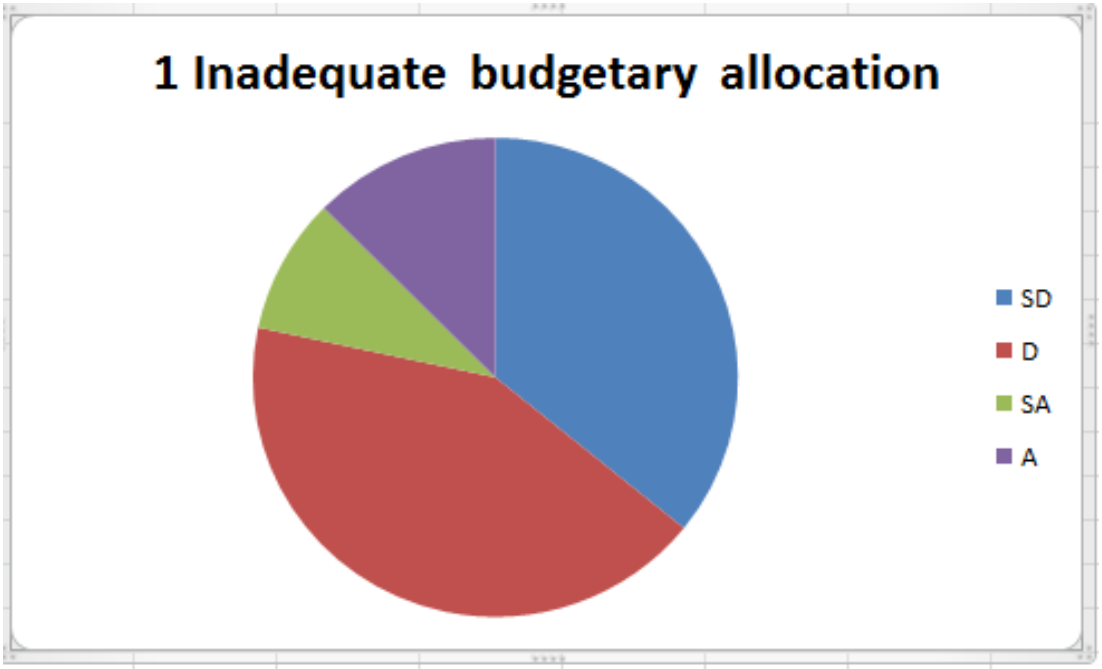

Figure 4.1 Inadequate Budgetary

The key in Figure 4.1 SD, D, SA, and A respectively represents Strongly Disagree, Disagree, Strongly Agree and Agree to the assertions.
Figure 4.2 shows the results on the respondent's responses on inadequate ATs on Assistive Technology for students with special educational needs most especially students with ADHD.

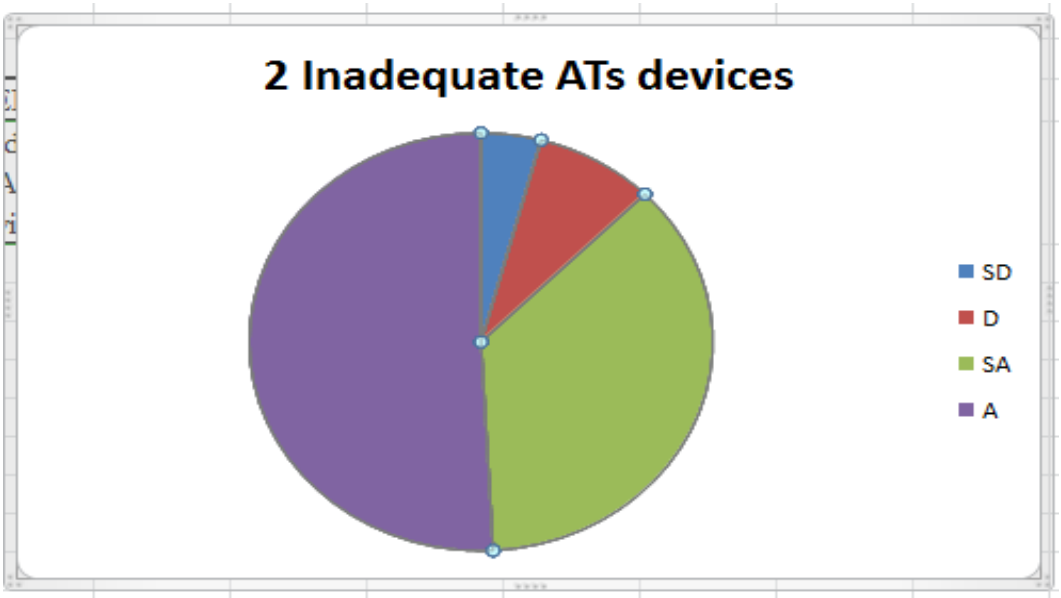

Figure 4.2 Inadequate Assistive Technology Device

The key in figure 4.2 SD, D, SA, and A respectively represents Strongly Disagree, Disagree, Strongly Agree and Agree to the assertions.

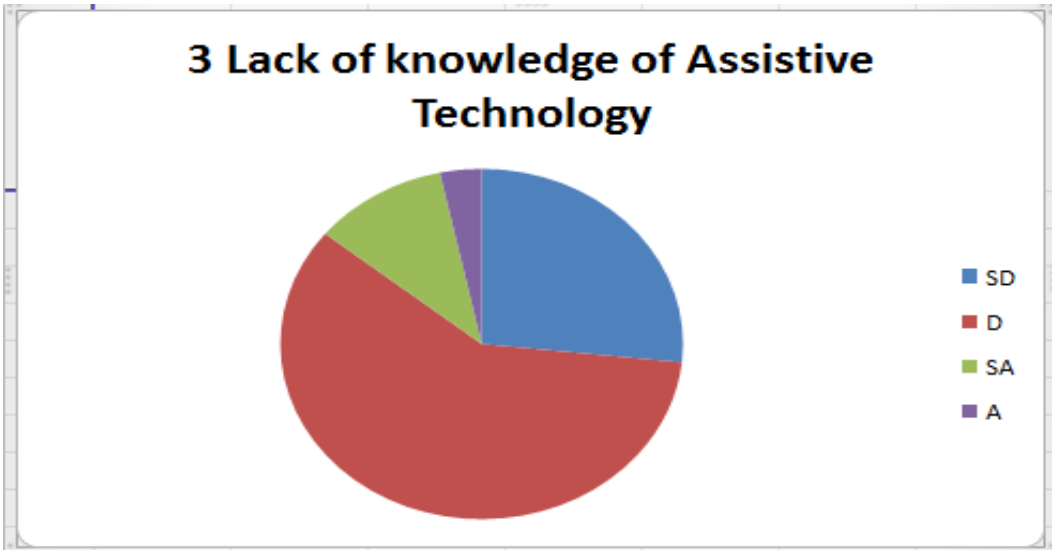

Figure 4.3 Lack of Knowledge on Assistive Technology

The key in figure 4.3 SD, D, SA, and A respectively represents Strongly Disagree, Disagree, Strongly Agree and Agree to the assertions. Figure 4.3 shows the results on the respondent's responses on lack of knowledge on Assistive Technology for students with special educational needs most especially students with ADHD.

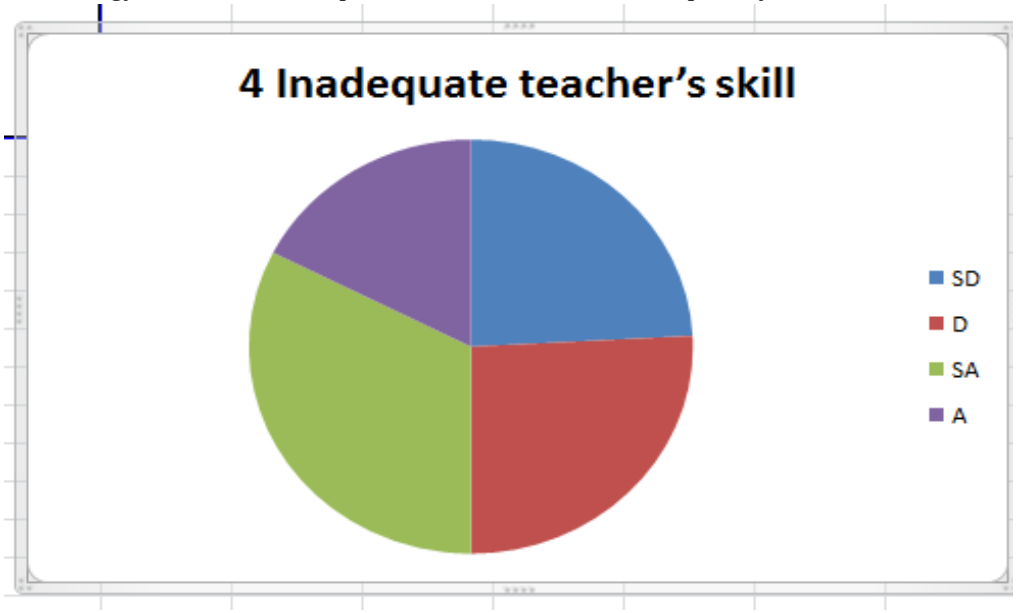

Figure 4.4 Inadequate Teacher's Skill

The key in figure 4.4 SD, D, SA, and A respectively represents Strongly Disagree, Disagree, Strongly Agree and Agree to the assertions. Figure 4.4 shows the results on the respondent's responses on inadequate teacher's skills on Assistive Technology for students with special educational needs most especially students with ADHD.

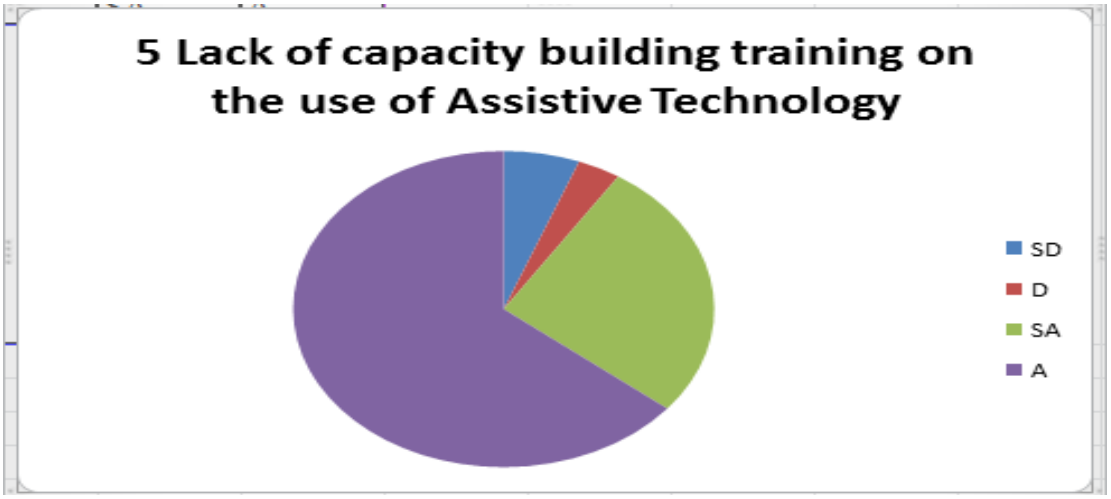

Figure 4.5 Lack of Capacity Building on the use of Assistive Technology

The key in figure 4.5 SD, D, SA, and A respectively represents Strongly Disagree, Disagree, Strongly Agree and Agree to the assertions. Figure 4.5 shows the results on the respondent's responses on lack of capacity building training on the use of Assistive Technology for students with special educational needs most especially students with ADHD.

Figure 4.1 shows that the majority of the respondents strongly disagreed that inadequate budgetary support is a major problem faced by teachers on the use of Assistive Technology. In figure 4.2 the majority of the respondents agreed that inadequate Assistive Technology devices is one of the problems faced by teachers in teaching pupils with disabilities and special educational needs. The findings in figure4.3 revealed that the majority of the respondents disagreed with the assertion that lack of knowledge on Assistive Technology is a problem. Figure 4.4 findings shows that the majority of the respondents agreed that inadequate teacher's skill is a problem faced by teachers teaching students with disabilities and special educational needs. Figure 4.5 results indicated that the majority of the respondents agreed that lack of capacity building on the use of Assistive Technology is among the problems faced.

It is based on the above findings and empirical review that the need to design An Assistive Technologies Framework for Students with Special Needs using Android Application.

Difficulties Encountered Using Assistive Technology

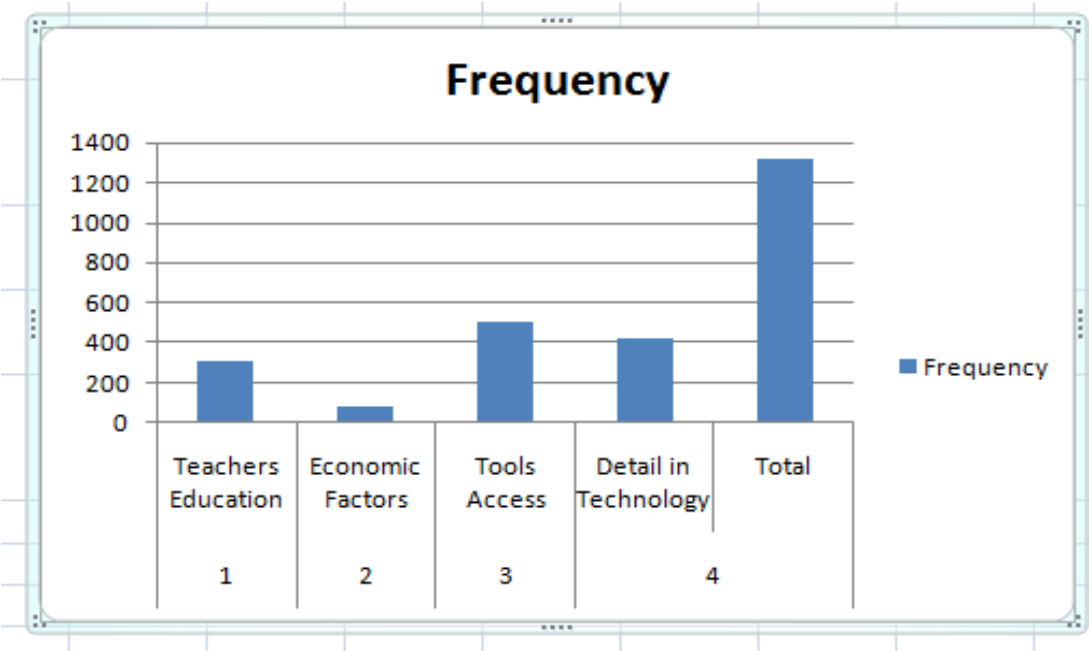

Figure 4.6 Difficulties Encountered Using Assistive Technology

Figure 4.6 presents the screenshot of the difficulties teachers encountered using Assistive Technology. The results of the findings revealed that the majority of the respondents indicated that access to Assistive Technology tools is the difficulties they encountered with a frequency of 503. Followed by detail in technology with a frequency of 424. The results show that 307 respondents indicated that teacher's education on the use of Assistive Technology. On the chat however, revealed that only very few of the respondents indicated that economic factors contribute to the difficulties faced using Assistive Technology with a frequency of 86 out of the total population of respondents.

V. DISCUSSION OF THE FINDINGS

The findings of the study revealed that majority of the respondents on item 10 and11 with a mean of 4.05 and 3.94 with standard deviation of 1.57 and 1.48 agreed strongly that there is need for a new trend in scientific production on Assistive Technology for students with disability and special educational needs which include students with Attention Deficit Hyperactivity Disorder (ADHD) in the field of education.

The results on item 6, 7, 8, and 9 with a mean of 3.75, 3.77, 3.72, and 3.73 respectively and standard deviation of 1.32, 1. 31, 1.1.43 and 1.45 indicated that the majority of the respondents agreed teachers Assistive Technology are very rare, there is need for awareness on its uses, teachers mostly used the old model of ATs. This also affirmed that the designing of a mobile- based android app is very vital.

The results of the findings equally revealed that there is need for capacity building on the use of modern Assistive Technology in teaching students with disability and special educational needs which include students with Attention Deficit Hyperactivity Disorder (ADHD). This assertion is affirmed by the respondents on item 3 with a mean of 3.58 and standard deviation of 1.36.

Based on the response by respondents, the findings of the study shows that inadequate Assistive Technology devices, inadequate teacher's skill on the use of modern Assistive Technology, lack of capacity building training on the use of Assistive Technology in teaching students with disability and special educational needs which include students with Attention Deficit Hyperactivity Disorder (ADHD) are among the problems the findings of the study revealed.

Android-Based Testing and Progress Monitoring Application for Students with ADHD

The mobile web Assistive Technology for Students with Special Educational Needs and Disabilities with a case study on Attention Deficit Hyperactivity Disorder (ADHD) is presented. Literatures revealed that there are many types of Assistive Technologies used in teaching students with special educational needs. This study is limited to only students with attention deficit hyperactivity disorder (ADHD). The application will be able to test the learner by engaging them in school activities and also monitor the progress of the learner. Based on the results obtained, the majority of the respondents agreed that assistive technology is very rare and often not available for teaching students with special educational needs. Majority of the respondents also agreed that there are new trends in scientific development on assistive technology for students with ADHD. Additionally, the majority of the respondents agreed that there is a need for the use of assistive technology in teaching pupils with special educational needs.

Android web mobile-based assistive technology was designed to assist students with attention deficit hyperactivity disorder (ADHD) improve their learning skills.

Figure 4.7 shows the authentication interface of the application. The phase allows only authorized users of the system to log in and continue using the application for learning and progress monitoring of the learner.

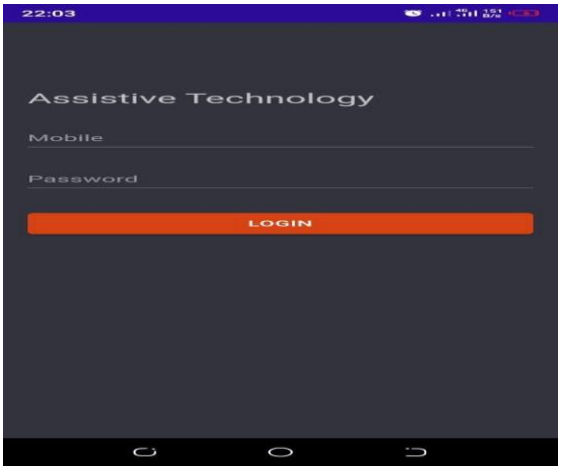

Figure 4. 7: Mobile Assistive Authentication interface

This is crucial because it hinders unauthorized users from gaining access to the learning platform. After the components have completed initialization, users encounter the authentication user interface. This interface serves as the secure entry point for accessing the application. It prompts users to input their credentials, comprising either their email or mobile number and password, to authenticate their identity before gaining access to the app's features and functionalities. Engineered with both usability and security in focus, the authentication UI guarantees that solely verified users can reach sensitive information and execute actions within the application.

Figure 4.8 displays the dashboard page for the learner. After successfully authenticating a user, they will be directed to a landing page designed to provide an overview of their activities and progress within the application.

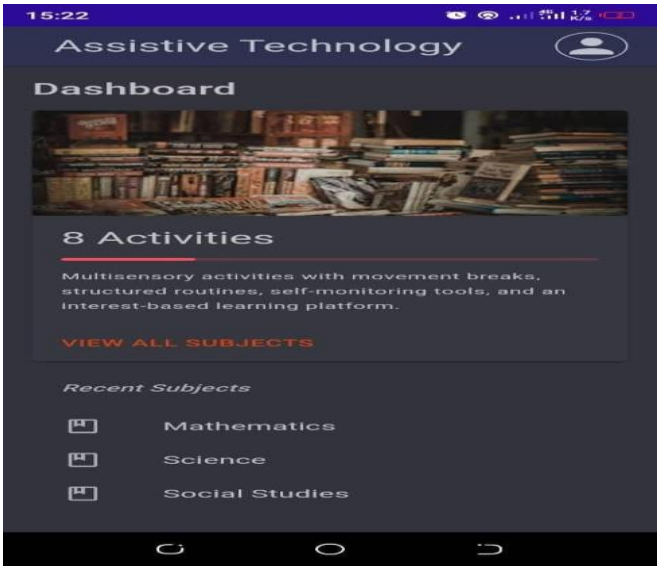

Figure 4. 8 Dashboard

Figure 4.9 displays the all subject page of the application. After the loading page is fully engaged next is the all subject page.

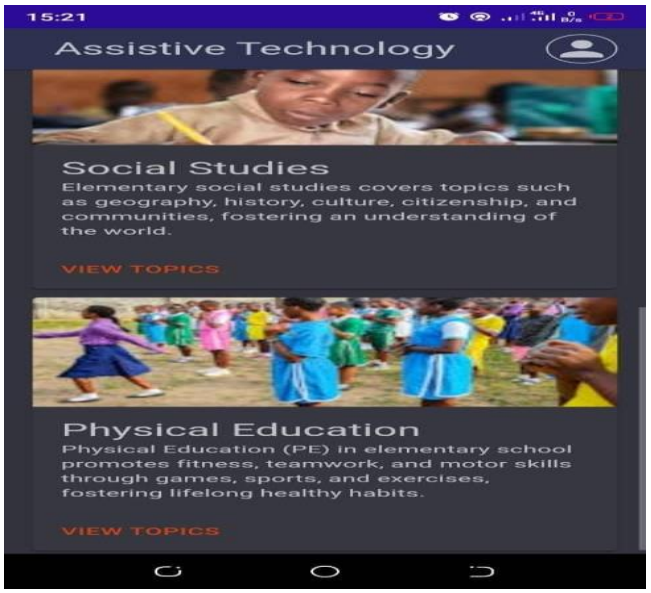

Figure 4. 9: All subject page

This is a critical aspect of the learner's activities. In this page a series of various subjects will be displayed for the learner to select a subject based on what he intends to learn. The application will then engage and monitor the progress of the learner. Within this section, users have the option to explore all subjects or

directly access any of the recent subjects listed. Each subject is represented by a card displaying its name, description, and cover image, offering users a visually appealing overview. To delve deeper into a specific subject, users can click on the "View Topics" link associated with each subject card, which navigates them to a topic listing page within the selected subject area.

Figure 4.10 displays the topic user interface of the application

Figure 4.10: Topics User Interface

When users access the Topics user interface, they encounter micro cards listing various topics, each featuring the topic name and description. Additionally, a link is provided to view associated content tasks. Clicking on the "View Tasks" link directs users to the Content Task user interface, which presents a list of tasks related to the selected topic.

Figure 4.11 displays the content task and monitoring interface of the application for students with ADHD.

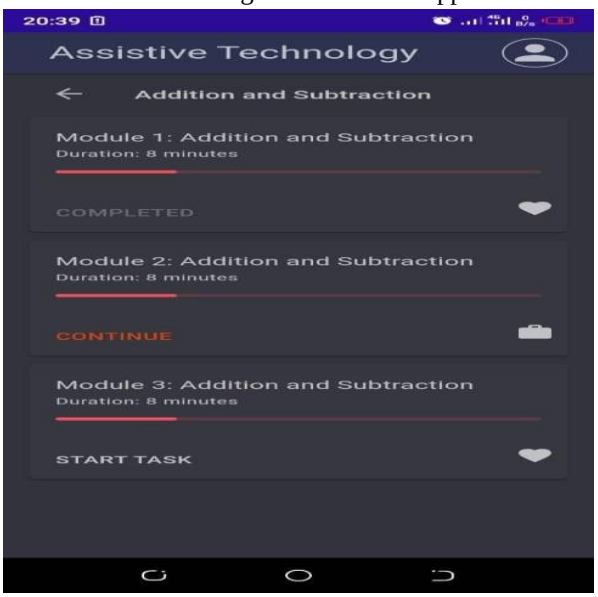

Figure 4. 11: Content Task User Interface

Each content task is designed to be an 8-minute engagement for the user. Users have the option to either start or continue a task, depending on its current status. Upon starting a task, a reminder alarm is automatically set if the task remains incomplete 30% past its designated end time. The user's progress is monitored through a scrolling text progress indicator, aligning with the completion progress relative to the task duration. In cases where the user falls behind the estimated progress value for the elapsed time, both a vibration alert and a toast notification are triggered. This alert may repeat twice if the user fails to interact with the device.

Additionally, users can utilize the read-aloud feature of the application, enabling them to focus on listening and achieve deeper concentration during task engagement.

VI. CONCLUSION

This study concludes that a mobile-based assistive technology has the potential to improve learning outcomes and increase accessibility for students with special educational needs and disabilities in North-East Nigeria. The technology can help address the challenges faced by this learner, including limited access to educational resources and specialized support.

VII. RECOMMENDATIONS

Based on the results and conclusion of this research, the following recommendations are made

i. **Implementation and Testing:** The proposed mobile-based assistive technology should be implemented and tested in pilot schools in North-East Nigeria to assess its effectiveness.

ii. **Teacher Training:** Teachers should receive training on how to effectively integrate the mobile-based assistive technology into their teaching practices

iii. **Accessibilities and Affordability**: the mobile-based assistive technology should be designed to be accessible and affordable for students with special educational needs and disabilities

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