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UTILISATION OF ARTIFICIAL INTELLIGENCE FOR EFFECTIVE COMMUNICATION AMONG CHILDREN WITH SPEECH IMPAIRMENT

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ABSTRACT

This study investigated utilisation of artificial intelligence for effective communication among children with speech impairment. This study was underpinned on Diffusion of innovation theory. The study adopted the survey research design. Results of the study showed that majority of the respondents are aware of the use of artificial intelligence for effective communication among children with speech impairment to a low extent. Also, it was revealed that 50% of the respondent's level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State is low. It was recommended that there should be strategic campaigns with the aim of increasing the awareness level of parents on the essence of AI for speech communication improvement. There is need to encourage parents especially on the use of AI for effective communication among children with speech impairment by speech therapists.

Keywords: Artificial intelligence, speech disorder, effective communication, parents

Introduction

Children usually pick up the fundamentals of speech and language at a young age. Speech and language abilities are essential for social interaction and learning. There are many children who have delays in their early speech development. Social interaction, academic performance, cognitive growth, emotion management, self-esteem and confidence, are capable of being impacted by speech impairment in children (Shriberg et al., 2019).

As demonstrated by a number of ailments, speech, language, and voice disorders (SLVDs) have a substantial impact on communication. For example, aphasia makes it difficult to read, comprehend, and communicate verbally and in writing. This demonstrates the complex relationships found in the language networks of the brain (Kohlschein et al., 2017).

The accurate and reliable production of speech sounds is also impacted by apraxia of speech. Stuttering is an example of a fluency disorder, which is another disruptive communication condition that disrupts rhythm and pace by interfering with the natural flow of words (American Speech-Language-Hearing Association [ASHA], n.d). Additionally, language disorders that impede efficient communication and comprehension of language principles include expressive and receptive problems (Albudoor & Peña, 2022).

Children with these kinds of communication disorders suffer from a variety of difficulties that interfere with their ability to communicate. Communication problems can cause significant barriers to children, preventing or discouraging them from taking part in family, community, and school activities (Columbia Engineering Boot Camps, n.d).

In the era of Information and Communication Technologies (ICTs), where artificial intelligence has taken the centre stage tools like Augmentative Alternative Communication (AAC) systems offer new

opportunities to address communication challenges. AAC's primary mission is to "compensate, temporarily or permanently, the patterns of disorder or disability of individuals with severe disorders of communication" Artificial intelligence (AI), particularly in the field of machine learning, is transforming the assessment of speech, language, and voice disorders (SLVDs). Machine learning algorithms, through the analysis of extensive data, can identify patterns and anomalies associated with specific disorders.

This approach offers an objective and data-driven method for evaluations, addressing challenges inherent in traditional assessments (Justice et al., 2019). The technology provides a level of precision and impartiality previously unattainable. AI's capacity to scrutinize and interpret nuanced speech, language, and voice features equips professionals with invaluable insights, significantly enhancing diagnostic accuracy (Compton et al., 2022; Day et al., 2021; Justice et al., 2019). The integration of AI in this domain signifies a noteworthy advancement, leveraging state-of-the-art technology to enhance assessment precision, efficiency, and depth (Oduenyi & Etumnu, 2024).

The study focused on how artificial intelligence is use for effective communication among children with speech impairment in Imo State. Another focus of this study are parents living within Imo State. The use of artificial intelligence in the psycholinguistic development of preschool children with speech disorders is a new and potentially important area of research and practice that needs to be explored. Hence, this study tends to investigate the use of AI for effective communication among children with speech impairment in Imo State.

Statement of the problem

Speech impairment is one of the many disorders among children of recent population. The disorder includes a variety of conditions, such as articulation disorders, phonological disorders, apraxia, and so forth. These disorders can significantly affect a child's ability to effectively communicate, interact with peers, and participate in learning activities.

The fact that AI has affected virtually all areas of human endeavours it is being deployed in an attempt to correct speech disorder among children as AI technologies perhaps can be used in the development of speech recognition systems that accurately analyze a child's speech patterns. These systems detect certain speech errors, incorrect pronunciation, and other phonological problems.

However, there is a dearth of empirical evidence especially within the region where this study was carried out that looked at the utilisation of artificial intelligence for effective communication among children with speech impairment in Imo State. Therefore, this study sought to investigate the use of artificial intelligence for effective communication among children with speech impairment in Imo State.

Objectives of the Study

The main objective is to examine the use of artificial intelligence for effective communication among children with speech impairment in Imo State. Why the specific objectives are to:

1. To find out the extent of awareness of parents on the use of artificial intelligence for effective communication among children with speech impairment in Imo State.
2. Examine the level of knowledge of parents on artificial intelligence tools for effective communication among children with speech impairment in Imo State.
3. Ascertain the extent of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State.

Literature Review

An Overview of Artificial Intelligence

John McCarthy first used the term "artificial intelligence" in 1956, and since then, it has developed into a disciplined area of research and engineering. There are eight well-known definitions of AI that can be used based on the context, design, and application of AI, claims Rapaport (2020). Standard or non-standard voice recognition systems used in artificial intelligence, for instance, can be classified as "computational intelligence" or "the study of the design of intelligent agents." The "rational agent" approach, which defines AI in this context as robots that can act and behave in "rational" ways and strive to reach the best conceivable end or the best-expected result, is reflected in the definition (Iovino et al., 2019).

AI has been offering our civilisation novel ideas and revolutionary possibilities in recent years. The accuracy of rational agents for common speech-recognition software has increased. Remarkably, no human programming is required to allow Machine Learning (ML) algorithms to carry out their responsibilities after the first training of the input algorithms (Parloff, 2016; Etumnu & Azubuike, 2024). Because of the availability of large datasets, the increased availability of vast computational power, and the decreased costs associated with accessing and storing large amounts of data, recent developments in Deep Learning and algorithm development have further enhanced standard speech recognition systems (Ark, 2018).

Artificial intelligence and Speech Impairment

Children with speech, hearing, and language problems have few choices for efficiently using speech-activated gadgets. Fast-evolving artificial intelligence (AI) research, however, is opening doors for the creation of fresh solutions meant to help overcome these communication obstacles. Studies have indicated that speech impairment is influenced by various risk factors (prenatal and perinatal difficulties, problems with ears, nose, and throat (ORL).

Two contemporary categories of speech disorders, both of which centre on functional (inorganic) diseases connected with development, include Masapollo et al., (2023) The first classification depends on etiological elements and distinguishes the following speech disorders: (Shriberg et al., 2019) unknown origin (probably genetic), (Feldman, 2019) verbal apraxia, and (Baltzki & Chlapana, 2023) psychological involvement (Wilson as al., 2019). Still another strategy revolves on the symptoms (Terband et al., 2019).

After surface error pattern analysis—that is, the count and kind of speech errors—the psycholinguistic flaws in the speech processing system become clear. Human speech is produced via the mouth, jaw, tongue, lips, palate, and other articulators taken together. Speech Sound Disorders (SSD) result from improper movement of these parts affecting speech intelligibility (Pennington et al., 2020). Weakness of the mouth muscles (dysarthria), structural problems (cleft lip and palate), as well as the inability to properly understand and execute impulses from the brain owing to a neurological condition (apraxia) are among the several reasons of SSD (Rodger et al., 2022).

In the earliest years of a child's life, speech and language development determines much of it. Early speech disorder intervention is more likely to produce better outcomes. The juvenile brain can reorganise neuronal paths and is more flexible. Geographic location, inadequate resources, or excessive cost are among the several reasons many children with speech impairments find it difficult to get a trained speech therapist (Brosseau-Lapré&Roepke, 2019).

By offering reasonably priced solutions available for use at home or in a classroom, artificial intelligence-based applications can close this disparity. Big volumes of data can also be processed and analysed by artificial intelligence to provide understanding of a child's speech patterns, development, and issues. Therapists, parents, and teachers can be informed about the success of therapies by this data-driven method, which also helps to guide child treatment plan decisions (Yang & Wang, 2020). Proloquo2Go (Collette, et al., 2019) is one such software designed for such youngsters. This program uses artificial intelligence-based language environment analysis. It lets those with speech problems express themselves via symbols, pictures, and synthetic voice. AI based virtual speech therapists exist as well. For instance,

Wizdy Diner, a virtual speech therapist run under artificial intelligence, presents kids with interesting settings to help with language development and speaking (Zhang, 2018).

Empirical Review

Almutairi (2024) carried out a study to identify the characteristics and outcomes of peer-reviewed literature on the application of Artificial Intelligence (AI) in assessing speech, language, and voice disorders (SLVDs) published in English from 2000 to 2024, we conducted a scoping review following the Arksey and O'Malley framework. Several databases were searched for peer-reviewed journal articles using the terms "artificial intelligence," "language," "speech," and "voice disorders" in their abstract or title.

A total of 21 articles were included. Key findings are as follows: 1. All papers were published within the past five years. 2. Each of the 21 reviewed articles found AI to be an efficient tool for assessing SLVDs. 3. Notably, geographical and research design gaps were identified. 4. It was observed that AI has not been applied to evaluate some aspects of speech-language disorders (SLDs).

Additionally, the review underscores advancements and limitations in utilizing AI for diagnosing SLVDs. It stresses the necessity for more extensive research, especially in underrepresented regions and disorders. The review advocates for inventive strategies in crafting culturally sensitive AI models and broadening the AI research scope to maximize its potential in comprehending and assessing communication challenges.

Utepbayeva et al. (2023) carried out a study to analyze the impact of artificial intelligence-based interventions on the psycholinguistic development of preschool children with speech disorders. To achieve this goal, the research included an experimental study conducted for five months. It rested on the intervention of AI tools and an assessment of progress. Participants were offered a program aimed at improving speech skills.

The program included sessions with speech therapists and classes based on AI-based applications (Fluency SIS, Articulation Station Pro, and Apraxia Farm). Additional methods were semi-structured interviews in focus groups with parents and speech therapists, as well as statistical analysis of the obtained data. The study participants were 170 children aged 3−5 years with diagnosed speech disorders, as well as 20 parents and 6 independent speech therapists. The Shapiro-Wilk test measured the normality of the data obtained in the study. The result of this test was 0.97 ($p = 0.23$), which indicates a normal distribution of data.

The moderate effect size (0.47) indicates a moderate difference between the scores of the two groups after the intervention. This result confirms the assumption that AI-based interventions contribute to significant improvement. The findings can become the basis for scientifically sound recommendations regarding the inclusion of AI interventions in preschool speech therapy practice. The study can aid in the development and revision of artificial intelligence applications according to the specific needs of this age group.

Murero et al. (2020) this paper aims to analyze how innovative Artificial Intelligence (AI) systems (Voiceitt®) for non-standard speech recognition may revolutionize Augmentative Alternative Communication (AAC) technology for people with severe speech impairments. By using built-in capabilities of portable devices, the AI-based algorithm may "understand" dysarthric speech and "translate" it into a fluid real-time user communication, thanks to a "voice donor" outcome system. The pattern classification algorithm is customized for non-standard speech recognition. The AI based system is personalized for each person unique language production and offers a real step forward in AAC efficiency.

Earlier empirical findings show limitations in analogic assistive tools addressing Speech, Language, and Communication Needs (SLCNs). Recently, Speech Generating Devices (SGDs) have been successfully used to support communication in patients with Autism and Dysarthria. With impressive improvements in recognizing non-standard natural language, AI-based technology (supported by deep learning, big data, and cloud processing) is offering a turning point for personalized Augmentative

Alternative Communication (AAC). Upcoming AI-based innovations promise to generate an immense transformative effect on the everyday life of the speech impaired people, their caregivers, significant others, and the entire society.

Vita et al. (2020) a study was carried out where literature shows as new technologies can aid different professional figures who work in various educational fields, from schools to rehabilitation. However, in a Landscape of technological tools, today many technologies are abandoned or used with little frequency and poor clinical interest by teachers and therapists.

TED was born with the need to be an all-inclusive tool, which allows the teacher/therapist, in a clear and specific way, to manage all aspects concerning the educational programming of the student with Special Educational Needs (SEN), from the initial evaluation phase to final phase, concerning the results of the personalized didactic action. Taking advantage of specific algorithms, which with the help of AI change over time becoming more and more precise, TED offers the user the opportunity to work on the fundamental areas of the individual's life (problem behaviors, academic skills, relational skills, etc.) and lends itself to be a complete tool for operators (in education, health, and school) who work with special needs daily.

Theoretical Framework

Theory of Diffusion of Innovation is the theoretical framework of this study. The idea of the spread of innovations is one of the earliest in the fields of social science and communication; it was created by Everett M. Rogers in 1962. As this theory explains, new innovations in information technology typically gain popularity and acceptance after a slow but steady trickle-down effect (LaMorte, 2019; Frank et al., 2020). Put simply, when people in a certain social system come across and adopt a new idea, practice, or product, they spread it to other people in that system or to bigger groups outside of the original population. According to this theory, the processes of concept perception, adoption, and dissemination are usually long-term and mostly creative. People in a social system don't always embrace new ideas at the same time.

The general public tends to warm up to novel ideas with time. The time it takes to complete this process, called adopter classification, might vary greatly depending on the circumstances (Dearing & Cox, 2018; Frank et al., 2020; LaMorte, 2019).

One way to understand why certain populations embrace new ideas while others reject them is by classifying adopters in this way. In their respective works, Dearing and Cox (2018) and LaMorte (2019) classify adopters into five distinct groups: (1) pioneers—those who are fearless and open to trying new things—will embrace innovation as soon as it's discovered without any convincing; (2) early adopters—those in positions of power who have a large following and can influence the opinions of others (i.e., these people can embrace innovative ideas without being convinced); (3) early majority—those who aren't in leadership roles but who are quick to adopt new, inventive ideas before the rest of the public, but who wait for evidence that they work before doing so; #4: The Late Majority: People in this group are notoriously slow to change, but they'll usually get on board with a new idea once the majority has already embraced and demonstrated it works; (5) Laggards: People who are very set in their ways and who aren't open to new ideas are the most difficult to convince; arguments based on fear, statistics, and peer pressure will not budge them.

According to Dearing and Cox (2018), there are three main factors that influence the adoption of innovative ideas: the pros and cons of the innovation itself, the characteristics of the adopters (such as their trust in opinion leaders' opinions on innovations), and the broader social and political context (including the innovation's persuasiveness to the population, its introduction timing, and it's implementation).

This theory is very appropriate for this investigation because the use of artificial intelligence for effective communication in children is innovative. As such, the current study, in a general sense, attempts to investigate how artificial intelligence can be use for effective communication among children with speech impairment in Imo State.

Methodology

The study used the survey research design to investigate the issue under discourse. When a researcher wants to probe about the traits, tastes, views, or beliefs of a particular group of people, a survey is a suitable option (McCombes, 2019). The population of the study according to Zhujiworl (2024) is 2,480,271. This population was drawn from the age group of 18-59 years of age. The sample size for the quantitative data was derived using the Wimmer and Dominick sample size calculator and it is 384.

For the sampling Technique, the multistage sampling technique was adopted. Multistage sampling is appropriate for a population that is geographically varied, it becomes simpler to favour it above any other sample approach (Sedgwick, 2015). Stage one: The study selected the three senatorial districts of the state, which is, Imo East, Imo West, and Imo North. Stage two: The area of study which is Imo state is made up of twenty-seven Local Governments Areas.

In this stage therefore, each of the local government are grouped accordingly. Ten (10) of these local government areas were randomly selected and sampled out. They include: Ngor Okpala, Mbaitolu, Aboh-Mbaise, Isiala-Mbano, Orlu, Okigwe, Obowo, Ideato North, Owerri North and Owerri Municipal. They were selected from each of the three senatorial districts that make up Imo State. The reason is that it will be impossible to accommodate the entire 27 local government areas of the State.

Stage three: from the selected LGAs two communities each were randomly selected that is to say 20 communities were used in all, for this study. At stage four the researchers with the aid of researcher assistants distributed 20 copies of questionnaire non-proportionately to respondents in these communities. Questionnaire served as the instrument for data collection. The questionnaire was designed in a closed ended questions format. Likert scale was used to design the instrument with the following numbers attached to each scale strongly agree (4), agree (3), disagree (2) and then strongly disagree (1). Communication experts in the department of Mass Communication, Imo State University, Owerri validated the instruments. The mean and percentage descriptive statistics were used to analyses the quantitative data.

Data Presentation and Analysis

This section focused on the data presentation and analysis. The researchers distributed 384 copies of questionnaire to respondents. Out of the copies distributed 373 copies were retrieved while 11 copies were invalid. Therefore, analysis was done with 373 copies which is valid for the analysis as the return rate was high.

RQ1: To what extent are parents in Imo State aware of the use of artificial intelligence for effective communication among children with speech impairment?

Table 1: Respondents response on whether they are aware of the use of artificial intelligence for effective communication among children with speech impairment

Options	Frequency	Percentage
Yes	344	92%
No	29	8%
Can't say	-	-
Total	373	100

Source: Field survey, 2024

Analysis of data showed that 92% of respondents are aware of the use of artificial intelligence for effective communication among children with speech impairment. This means that majority of the respondents are

of aware of the use of artificial intelligence for effective communication among children with speech impairment.

Table 2: Respondents' responses on the extent parents in Imo State are aware of the use of artificial intelligence for effective communication among children with speech impairment

Options	Frequency	Percentage
Very high extent	28	8%
High extent	57	17%
Moderate extent	107	31%
Low extent	152	44%
Can't say	-	-
Total	344	100

Source: Field survey, 2024

Analysis of data showed that 44% of parents in Imo State are aware of the use of artificial intelligence for effective communication among children with speech impairment to a low extent. This means that many of the parents studied are aware of the use of artificial intelligence for effective communication among children with speech impairment to a low extent.

RQ2: What is the level of knowledge of parents on artificial intelligence tools for effective communication among children with speech impairment in Imo State?

Table 3:

S/N	Item statement	SA	A	D	SD	X	TF	Remark
1	I know that augmentative and alternative communication (AAC) provide children alternative means of communication	75	40	136	93	2.2	344	Reject
2	I know virtual reality is an App that helps children with speech issues	87	159	56	42	2.8	344	Accept
3	Video games are used as an AI tool for speech reconstruction in children	156	62	45	81	2.8	344	Accept
	Grand mean					2.6		

Source: Field Survey, 2024

The items on table 3 were designed to measure the level of knowledge of parents on artificial intelligence tools for effective communication among children with speech impairment in Imo State. Therefore analysis of data in table 3 showed that respondents agreed to item 2 and 3 while they disagreed on items 1 with a mean range of 2.2 to 2.8 and with a grand mean of 2.6. The implication of this is that the level of knowledge of parents on artificial intelligence tools for effective communication among children with speech impairment in Imo State is low given the responses by respondents.

RQ3: What is the level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State?

Table 4: Respondents' response on the level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State

Options	Frequency	Percentage
Very high level	18	5%
High level	37	11%
Moderate level	117	34%
Low level	172	50%
Can't say	-	-
Total	344	100

Source: Field survey, 2024

Analysis of data showed that 50% of the respondent's level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State is low. This means that many of the parents studied confirmed low level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State.

Discussion of Findings

Finding showed that most of the respondents studied are aware of the use of artificial intelligence for effective communication among children with speech impairment. More specifically regarding extent, results showed that majority of the respondents are aware of the use of artificial intelligence for effective communication among children with speech impairment to a low extent as seen on table 2. Utepbayeva et al. (2023) in a study confirms that the assumption that AI-based interventions contribute to significant improvement.

Result of the second objective showed low level of knowledge of parents on artificial intelligence tools for effective communication among children with speech impairment in Imo State. A grand mean of 2.6 confirms the level of parents' knowledge on artificial intelligence tools for effective communication among children with speech impairment in Imo State.

The implication of this is that the knowledge level of parents on artificial intelligence tools for effective communication among children with speech impairment in Imo State is low given the responses by respondents. Almutairi (2024) in a study observed that AI has not been applied to evaluate some aspects of speech-language disorders (SLDs). Additionally, the review underscores advancements and limitations in utilizing AI for diagnosing SLVDs.

Finding revealed that 50% of the respondent's level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State is low. This means that many of the parents studied confirmed low level of artificial intelligence utilization by parents for effective communication among children with speech impairment in Imo State.

What this means is that level of usage by parents for effective communication among children with speech impairment. Murero et al. (2020) findings show limitations in analogic assistive tools addressing Speech, Language, and Communication Needs (SLCNs). Also, Vita et al. (2020) in a study revealed that new technologies can aid different professional figures who work in various educational fields, from schools to rehabilitation. However, in a Landscape of technological tools, today many technologies are abandoned or used with little frequency and poor clinical interest by teachers and therapists. This study aligns with the theoretical framework of this study.

Conclusion

Based on the findings, it was concluded that parents in Imo State have low level of awareness on the use of AI for effective communication among children with speech impairment and most likely this awareness could be linked to the level of knowledge of parents on the use of AI for effective communication among children with speech impairment. These results regarding awareness and knowledge maybe directly connected to the low level of AI utilization for effective communication among children with speech impairment in Imo State.

Recommendations

Based on the findings the following recommendations are put forward:

1. There should e strategic campaigns with the aim of increasing the awareness level of parents on the essence of AI for speech communication improvement.
2. Parents should be trained and sensitized on the use of AI for effective communication with the aim of improving the condition of children with speech issue.
3. There is need to encourage parents especially on the use of AI for effective communication among children with speech impairment by speech therapists.

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