

ARTIFICIAL INTELLIGENCE AND SOCIALLY ASSISTIVE ROBOTS IN SUPPORTING READING COMPREHENSION AMONG STUDENTS WITH ADHD: RELEVANCE OF VYGOTSKY'S MODEL OF "MORE KNOWLEDGEABLE OTHER"

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ABSTRACT

Students with Attention Deficit Hyperactivity Disorder (ADHD) experience major levels of difficulties while reading. These difficulties which often stem from knowledge retention and hyperactivity, have often make learning almost impossible. ADHD is a psychological disorder that makes it difficult for an individual to focus or pay attention for as little as a minute. The emergence and development of Artificial intelligence (AI) and robotics have made science more efficient and automated. This has led to inventions that are designed to assist students with ADHD learn with little difficulties. Artificial Intelligence pertains to the evolution of computer systems that perform tasks that naturally require human intelligence. The advancement in AI and robotics could yielded better results when applied to teaching students with special needs, specifically attention deficit hyperactivity disorder (ADHD). The paper also applies Vygotsky's model of More Knowledgeable Other (MKO) to new frontiers of learning by exploring the role of AI and robotics in helping students with ADHD read and comprehend. The paper specifically addresses current advancements in AI, robotics and the benefits of Socially Assistive Robots (SARs) in helping students with ADHD stay on task with minimal distractions.

Keywords: Artificial Intelligence (AI), reading comprehension, Attention Deficit and /Hyperactivity Disorder (ADHD), Socially Assistive Robots (SARs) and special needs education.

Introduction

Attention Deficit Hyperactive Disorder (ADHD) is one of the many mental health challenges that is associated with learning and attention. ADHD is a mental disorder that manifests in an individual's distractibility and inattention (Soreff, 2022). An observable element of ADHD is the individual's inability to pay attention for a reasonable duration. Empirical evidence (Fuermaier, Tucha, Koerts, Kaunzinger, Aschenbrenner, Weisbrod, Lange, Tucha, 2015; Rohlf, Jucksch, Gawrilow, Huss, Hein, Lehmkuhl, Salbach-Andrae, 2012) indicates that ADHD limits the attention span of an adult to as little as 3-5 minutes. The American Psychiatry Association (APA, 2013) submits that distractibility is a chief evidence of ADHD. By implication, while it is agreed that hyperactivity is a diagnostic feature of ADHD, attention deficit is most pronounced. Simply put, attention deficit disorder is often common to all the persons diagnosed with the condition.

Major symptoms of ADHD are chronic inattention (inability to focus for as little as five minutes), hyperactivity (excessive movement of the body) and sometimes impulsivity (hasty acts that occur in a moment without thought). (APA, 2025). The Diagnostic Statistical Manual, fifth revision, (DSM-5, 2016) adds that ADHD is a neurodevelopmental disorder characterized by impairing levels of inattention, disorganization and impulsivity. There is presently an unsettling estimate of persons with ADHD related disorders. The Centre for Diseases Control (CDC, 2024) submitted that in the United States alone, seven million (11.4%) U.S children aged 3–17 were diagnosed with the condition in 2022. While it has not been possible to get a reliable estimate of the number of persons suffering from the disorder in Africa, the World Health Organisation (WHO, 2019) estimated that no fewer than 5–8% of children in the world, mostly boys, suffer from ADHD, a condition that often lasts into adulthood.

Data from the CDC and WHO are consistent with findings from empirical research that ADHD impairs a person's ability to learn effectively. As one of the basic skills of literacy, reading comprehension is largely linked to an individual's ability to pay attention to written word in order to learn. Reading is an amorphous term. The nature of the term has led to different but related conceptualization. Goodman (1967) and Smith (1971) who are both Proponents of the top-down or concept-driven model, defined reading as the act of assessing the meaning of the text with the use of productive cues. That is, effective reading results from skills in selecting fewest and most productive textual cues necessary and not the precise perception and identification of all the elements in a word, sentence or discourse. This conception of reading conflicts with the views of bottom-up advocates like Gough (1972) who conceptualised reading as a phonics-based activity that proceeds in a serial fashion from letter to sound, to words and to meaning.

A juxtaposition of the models of reading reveals that reading comprehension is a meaning-making skill that every student needs to develop. A keen assessment of the models would also reveal that reading is a psychological process of meaning-making that fuses background knowledge with textual information. As a meaning-making process, reading comprehension becomes futile when an individual fails to understand the meaning that is inherent in a text (Nasir, 2024). In addition, attention is a key psychological index when addressing reading. By implication, ADHD, a disorder that affects attention, has a major effect on a person's reading comprehension. McGrath, Pennington, Shanahan, Santerre-Lemmon, Barnard, Willcutt and Olson (2011) emphasised that aside from problematic inattention, individuals with ADHD also demonstrate word decoding deficit, a condition that makes it difficult for them to identify and understand the meanings of words. The manageability of ADHD among children and adults has been improved in present years with the advancements in artificial intelligence and robotics.

The 21st century has so far been characterized by advancements in artificial intelligence and robotics. After the development of the first general purpose computer in 1946, the years

that followed featured a remarkable improvement in information and communication technology. The codes that ushered what is now known as artificial intelligence was first written in 1951 by Christopher Strachey. As a field of computer science, Artificial Intelligence (AI) makes computers to mimic human behaviour in order to help humans perform complex tasks (Ghosh & Arunachalam, 2021). Russell and Novig (2010) aver that AI currently encompasses a large variety of subfields, ranging from the general-purpose AI (learning and perception) to specifics such as playing chess, proving mathematical theorems, writing poetry, driving a car on a crowded street, providing therapeutics services and diagnosing and treating diseases.

The transformation of AI to physical machines have revolutionised the present century. This has led to a quantum leap in robotics. The word robot (worker or servant in Czech) was coined by a Czech novelist, Karel Capek. A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or perform other specialized tasks. Robotics is the science of designing and building Robots which are suitable for real life application in automated manufacturing and other non-manufacturing environments (Kapila,2025). The major categories of robots by functions are: industrial, educational, domestic, military and medical robots (Kapila,2025).

AI and robotics are distinct but related technologies. When they correlate, AI provides the brain while robotics provides the body (Marr 2024). To elucidate, AI gives robots the ability to learn and interact with the environment. To demonstrate the connection between AI and robotics, Marr (2024) explains that a simple robot can be programmed to pick up an object and place it in another location and repeat this task until it is made to stop. With the addition of a camera and an AI algorithm, the robot can “see” an object, detect what it is and determine where it should be placed. Marr refers to this as an “artificially intelligent robot”.

The combination of AI and robotics have been applied to science in the present century. This has culminated in the discovery of cures that were previously elusive . Apart from its applicability to the natural sciences, AI and robotics have also been applied to learning disorders (Olawade, Wada, Odetayo, Olawade · Asaolu & Eberhardt, 2024). Prominent among these disorders is ADHD. The thrust of this paper is to examine the applicability of AI and robotics as Socially Assistive alternatives to ameliorating the reading and comprehension difficulties of persons with ADHD.

The surge in ADHD, its associative consequences and the need to seek non-pharmaceutical remedies have led to the invention of socially assistive robots. The technology has been developed for years and is presently being perfected by tech companies around the world. To conceptualise Socially Assistive Robots (SAR), one must be able to cover its domains in relation to present strides in technological advancement. The earliest definition of assistive robot is robots that assist people with physical disabilities through physical interaction (Feil-Seiter & Mataric , 2005). With the present successful fusion of AI with robotics, SAR has been defined as autonomous robots that care for children, older adults, people with disabilities, or individuals with medical conditions (Cifuentes, Pinto, Céspedes & Múnera, 2020).

Studies have shown that SAR is currently been applied to improving children’s language development, therapeutic interventions and learning support (stévez, Terrón-López, Velasco-Quintana, Rodríguez-Jiménez, Álvarez-Manzano, 2021; Berrezueta-Guzman & Dolón-Poz, 2025). The first attempt at using SAR in helping children with learning disorders was pioneered by Weir and Emanuel (1976) who employed LOGO, a mobile robot resembling a turtle, to communicate with patients in a carefully controlled setting. Recent improvement in the field has led to the emergence of non-judgmental robots that help persons with ADHD to reduce their hyperactivity while concentrating on a reading content for a remarkable duration (stévez, et al..2021). Research has further shown that SAR provides coaching, motivation and

therapeutic interventions for persons with ADHD (Berrezueta-Guzman, Pau, Martin-Ruiz, Máximo-Bocanegra, 2021; Amato, Di Gregorio, Monaco, Sebillio, Tortora, Vitiello).

The help provided by SAR and AI has given them humanlike characteristics in teaching and learning. Although no robot can replace the human teacher in the formal school setting, the roles that these machines play in teaching and learning cannot be downplayed. Socially Assistive robots have improved classroom interaction by promoting students' cognitive and social development (Müller & Koltun, 2021). Since Vygotsky's model of "More Knowledgeable Other" encompasses the teacher and any other actor in the teaching and learning process that helps the students learn better, AI and Robotics could also be considered as MKOs.

Attention Deficit Hyperactivity Disorder (ADHD): Conceptual Clarifications and Topical Issues

The concept of ADHD is fairly new. The concept has undergone a series of transition from the 1800 till date. The condition which was first discovered among young children, was first called "the nervous child" or "hypersensitivity" (Morgan, 2024). These terms were consistent with symptoms like inattention and nervousness commonly associated with such children. In the years the follow, doctors began to refer to the condition as Attention Deficit Disorder (ADD). This change in nomenclature signaled reasonable interest in the condition. The American Psychiatric Association (APA) established that there were two variations or subtypes of ADD which were ADD with or without hyperactivity.

In 1987, a child psychiatrist named Eisenberg combined the inattention and hyperactivity that are associated with ADD and adroitly referred to the condition as Attention Deficit Hyperactivity Disorder (ADHD). The American Psychiatric Association (2013) described ADHD as having three subtypes, inattention, hyperactivity and combined, merged into one disorder. The Centre for Diseases Control (CDC, 2024) identifies the following symptoms as being associated with the condition:

1. Daydream a lot
2. forget or lose things a lot
3. squirm or fidget
4. talk too much
5. make careless mistakes or take unnecessary risks
6. have a hard time resisting temptation
7. have trouble taking turns
8. have difficulty getting along with others

The cause of ADHD has eluded scholars for years. However, researchers are of a tentative conclusion that it could be either due to genetic defect, environmental factors or both (National Institute of Mental Health, 2024). In this regard, previous studies in the field established that the mean inheritability of ADHD was 79% (Lichtenstein, Carlström & Råstam, 2010). In addition, although the connection between ADHD and environmental factors like maternal stress and maternal related cigarette and substance use are largely equivocal and leave more to be found, they seem to establish the link between environmental related factors and ADHD (Rice, Harold & Boivin, 2010)

Like other countries in the world, Nigeria has its unfortunate share of ADHD. According Oke, Oseni, Adejuyigba and Mosaku (2019), research in ADHD showed a prevalence of 8.7% in the south-west and 7.6% to 23.15% in south east of Nigeria. Not much is known about ADHD prevalence in hospitalized Nigerian children and few documented findings about the prevalence of the condition in outpatient settings (Chinawa, Odetunde, Herbert, Obu, Chinawa, Muideen, Bakare & Ujunw, 2014). Also, Institutional based studies revealed a prevalence level of 2.8% among 200 primary school children in Zaria, Kaduna State (Abubakar Abdullateef, Adedokun, Omigbodun, 2017) and

2.7% among primary school children in Ikot-Ekpene, Akwa-Ibom (Akpan, Hogan, Okpokowuruk, Ikpeme, 2020).

The prevalence of ADHD and its associative detriments have prompted a search for ways to ameliorate the condition. With no pharmaceutical remedy in sight, the American Academy of Paediatricians recommends parent training in behavior management for children up to age 12 and other types of behaviour therapy training for adolescents (CDC, 2024). Recent advancements in the field of artificial intelligence and robotics have made these interventions easy for parents who could afford assistive robots.

Artificial Intelligence (AI)

Artificial intelligence is a rising and thriving field in the domain of information and communication Technology (ICT). The United Nations (2025) defines AI as a diverse range of technologies referred to as 'self-learning and adaptive systems' that can be categorised based on technologies, purposes (like facial or image recognition) and functions (such as language understanding and problem-solving). Similarly, NASA (2024) sees AI as computer systems that can perform complex tasks normally done by human-reasoning. AI does not just perform complex tasks; they could also function in different settings.

The evolution of AI began in the later part of the 20th century. Advancement in the field specifically began in the 1930s with the work of Turing. In 1935, Turing described an abstract computing machine consisting of limitless memory that moves back and forth through the memory, symbol by symbol, reading what it finds and writing further symbols (Britannica, 2025). Turing's contribution was known as the stored-program concept. This marked major step in the field of AI. One of Turing's predictions was that computer would one day play very good chess. In 1997, barely 50 years after this prediction, International Business Machines Corporation (IBM) built "Deep Blue", a chess computer that beat the world reigning world champion, Kasparov in a six-game match (Britannica, 2025).

The new millennium (2000) marked a considerable advancement in AI. Abstract principles, theories and ideas that were once believed to be fictional now transition to practical realities. This was made possible by the convergence of large computer power, the proliferation of databases and significant breakthrough in machine learning algorithms (AI-PRO, 2025). In the years 2000–2010s, AI had addressed complex problems, providing solutions that were found to be useful in different application domains, including industrial robotics, logistics, business intelligence, banking software, medical diagnosis, recommendation systems and search engine (Blagoj, Tsinaraki & Kostić, 2020)

Types of AI Based on functionalities

The best classification of AI was done based on the functions they perform. In this regard, IBM (2025) categorised AI into:

Reactive Machines: Reactive machines are AI systems with no memory which were designed to perform very specific tasks. Since they cannot recollect previous outcomes or decisions, they only work with presently available data. Reactive AI can analyze vast amounts of data to produce a seemingly intelligent output. An example of reactive machine is the Netflix recommendation engine, an AI that makes recommendations to Netflix subscribers based on their previous search.

Limited Memory AI: Unlike Reactive Machine AI, this form of AI can recall past events and outcomes and monitor specific objects or situations over time. Limited Memory AI can use past and present moment data to decide on a course of action. The shortfall of limited memory AI is that while it can use past data for a specific amount of time, it cannot retain the data in a library of past experiences to use over a long-term period. Example of limited memory AI are generative machines like ChatGTP, Bard and DeepAI; Virtual assistants and chatbots: Siri, Alexa, Google Assistant and self-driving cars.

Theory of Mind AI: Theory of Mind AI is a functional class of AI that falls underneath the General AI. Though an unrealized form of AI today, AI with Theory of Mind functionality would understand the thoughts and emotions of other entities (including humans). This understanding can affect how the AI interacts with those around them. In theory, this would allow the AI to simulate human-like relationships.

Self-Aware AI: Self-Aware AI refers to algorithms that would possess super AI capabilities. Like theory of mind AI, Self-Aware AI is strictly theoretical. If ever achieved, it would have the ability to understand its own internal conditions and traits along with human emotions and thoughts. It would also have its own set of emotions, needs and beliefs.

The Evolution of Robots

From the construction of roads to the mechanisation of agriculture, machines have always played important parts in human existence. In fact, no nation has developed without advancements in mechanisation. The domain of robotics is concerned with the automation of these machines. Robotics, a term coined by Isaac Asimov, combines computer science, engineering and technology to design, construct and utilise machines that are programmed to replicate or substitute human actions and decision-making (Michigan Tech, 2025). The development of robotics in the 21st century has led to the discovery of different types of robots. While robotics applications vary greatly, robots are mainly designed to take directions, stock shelves and weld metal in dangerous environments. Today's robots can generally be grouped into seven categories:

Types of Robots

Although there are different types of robots, Ben-Ari and Mondada (2018) opined that robots can be grouped under the following types, based on features and functions:

Autonomous Mobile Robots (AMRs)

Autonomous Mobile robots, as the name implies, are robots that make real-time intelligent decisions. Sensors and cameras help the AMR take in information about their surroundings. Onboard processing equipment helps them analyse it and make an informed decision. Whether moving to avoid a worker, picking the right parcel or selecting an appropriate surface to disinfect, AMR is effective and productive. They are mobile solutions that require limited human input to carry out a task.

Automated Guided Vehicles (AGVs)

The Automatic Guided Vehicle (AGV) are automatically guided robots that came out during the mid-20th century to speed up movements of goods in warehouses and production centers. These robots are commonly used to deliver materials and move items in controlled environments such as warehouses and factory floors.

Articulated Robots

Articulated robots (also known as robotic arms) are designed to emulate the functions of a human arm. Typically, these robots can feature anywhere from two to 10 rotary joints (Ben-Ari, Mondada, 2018). Each additional joint or axis allows for a greater degree of motion—making them ideal for arc welding, material handling, machine tending and packaging.

SCARA Robots

Selective Compliance Articulated Robot Arm (SCARA) are a particular type of robotic arm made for fast and precise movements in a cylindrical workspace, perfectly suited for vertical assembly tasks where components need to be inserted from above. They are often used in packaging, assemblage and pick-and-place operations.

Humanoids

Humanoids is a term that is used to identify robots that perform human-centric functions and often take humanlike forms. Many mobile humanoid robots may technically fall under the domain of an AMR. Humanoids use many of the same technology components as AMRs to

sense, plan and act as they carry out tasks such as providing directions or offering concierge services.

The Fusion between Robotics and Artificial Intelligence (AI): Socially Assistive Robots

The collaboration between AI and robotics has in recent years produced efficient, intelligent and highly adaptive piece of technology. The amalgam of Robotics and AI is a worthwhile fusion that continues to revolutionise key sectors like healthcare, education, military, maritime and governance (Northrob, 2025). In Nigeria, the National Centre for Artificial Intelligence and Robotics (NCAIR, 2025) submits that the combination of AI and robotics have primarily led to smarter farming and higher yields, personalised learning for every child and the development of efficient counter-fraud banking through Fintech.

From the foregoing, the application of AI and robotics in solving complex tasks is no longer fictional and futuristic like James Cameron's (1984) movie, "The Terminator". In the field of education, AI-powered robots are now used to help students learn efficiently (Fonbona, Saez & Sanchez, 2025). Educational robotics have for years introduced tools that improve students' classroom interaction and the development of socio-emotional, cognitive and technical skills. Bulathwela, P'erez-Ortiz, Holloway, Cukurova, and Shawe-Taylor (2024) expressed confidence in the evolution of AI and robotics by stating that the next generation of educational AI will be marked by hyper-personalisation, where algorithms will analyse data in real time to adapt teaching methodologies and strategies according to the needs of each students in the class.

The fusion of AI and robotics has produced intelligent and autonomous robots that are relevant within our social space. Socially Assistive Robots (SAR) is a hybrid innovation that evolved as a result of the combination of assistive robots (AR) and Socially Interactive Robots (Feil-Seifer & MatariC, 2005). Socially assistive robots are highly adaptive and intelligent robots that are attached to humans. The goal of SAR is to create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation and learning (Feil-Seifer, Bulathwela, P'erez-Ortiz, Holloway, Cukurova, & Shawe-Taylor, 2024; MatariC, 2005).

Forms of Socially assistive Robots

Socially assistive robots come in different forms, depending on the functions they perform. In this light, Marcis and Perili (2022) and Mataric (2005) identified animal or pet-like AI robots (zoomorphic), humanoid and Machine-like (Non-biomimetic) robots. Below are pictorial presentation of these robots:

Fig. 1

Xiaoxiao, a Pet-like Social Assistive Robot



Image by Xinhua (2024)

Fig. 1 shows Xiaoxiao, a catlike AI powered robot designed by Groove X. The robot was unveiled in 2024 during the 7th China International Import Expo (CIIE) in Shanghai, East China. Like other assistive robots designed to perform specific tasks, Xiaoxiao was designed to provide emotional support for elderly persons in the society. Like Xiaoxiao, other Pet-like robots are designed to help individual with psychological, social and academic problems. The comfort these AI powered robots provide may also be tailored towards helping individuals with ADHD manage the condition. In this light, Shayan, Shamardi and Pirastehzad (2016) found that Roboparot, a parrot-like robot contributes significantly to improving the reading ability of persons with ADHD and autism . This milestone is also replicated in humanoid robots.

Figure 2 :

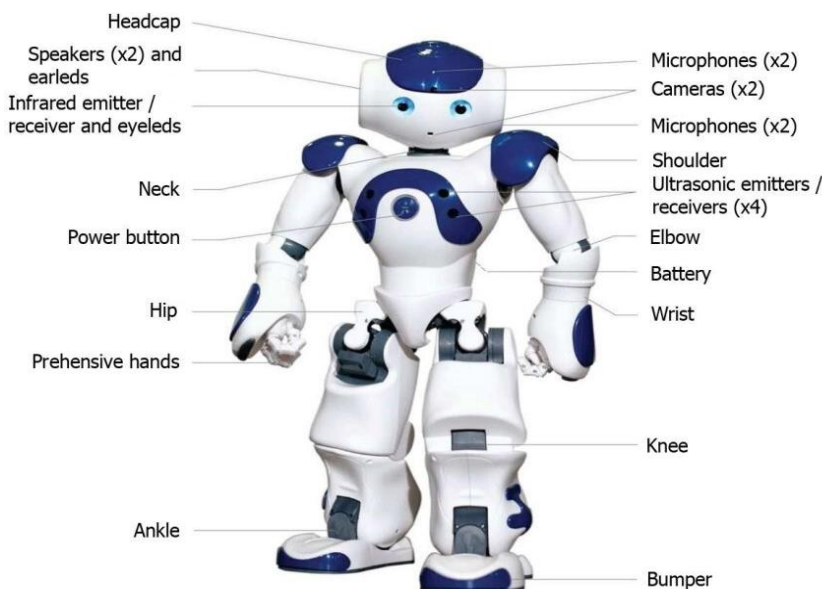
Ameca, A Human-like robot (Humanoid)



Image by EngineerArts (2024)

Figure. 2 above is a human-like robot named Ameca. Ameca is one of the advance humanoids designed by EngineerArt, a United Kingdom based company to help with social interaction and learning. Ameca is powered by AI and machine learning and can display a wide range of human-like emotions through its 62 actuators (EnginnerArts, 2025). As an advanced humanoid, Ameca can educate, entertain and inspire. These features make it relevant in helping persons with ADHD focus on tasks like reading comprehension.

Fig 3: machine-like Robot : Nao



From Tuna, Tuna, Ahmetoglu and Kuscu (2019)

Fig. 3 above is Nao, a robot designed by softbank robotics. The robot has enhanced social skills and it's able to emote through facial expressions, gestures, intonations and respond with appropriate body language (Lin, Abney & Bekey, 2011). Tuna, Tuna, Ahmetoglu and Kuscu (2019) add that Nao can also show emotions such as surprise, fear, anger and disgust. These features present The robot as a good guide, especially for special needs individuals with ADHD.

The juxtaposition of AI and robotic have culminated to renewed studies on the applicability of these technologies to education, especially reading comprehension. This fact is vital because it is almost impossible for one to be literate without mastering the skill of reading. Toh, Causo, Tzua, Chen and Yeo (2016) found that robots have significant influence on children's cognitive, conceptual, language and social (collaborative) skills. Similarly, in a survey on the use of humanoid robots in primary education, Tuna, Tuna, Ahmetoglu and Kuscu (2019) found that humanoid robots have great potential, especially in preschool and primary school education. These studies and many others have provided empirical data on the relevance of AI and robotics in education, thereby extending the frontiers of applicability of these technologies to education in general and learning disorders in particular.

AI and Robotics as More Knowledgeable Others

More Knowledgeable Other (MKO) is one of the models that was introduced by Lev Vygotsky in his sociocultural theory of cognitive development in 1978. As the name implies, the theory links an individual's development to active factors in the society. According to Vygotsky (1978), parents, caregivers, teachers and the culture at large are responsible for helping the brain achieve higher-order functions. Based on this assumption, an individual's learning is the product of the support offered by members of the society.

The major tenet of the sociocultural theory is that the learner learns in an environment and as a result, social components of the environment determine how learning can be improved. According to Vygotsky, learning is a complex process that is influenced by two major constructs. These constructs are: Zone of Proximal Development (ZPD) and the More Knowledgeable Others (MKO). The MKO and the ZPD are two different but interrelated constructs that are core in the teaching and learning process. The Zone of Proximal development, according to Vygotsky (1978) refers to the ability of the learner to extend beyond his in-born abilities with the help of others. The construct also extends to entail the difference between what the learner can do independently and what he or she can only do with the help of others in the environment. Vygotsky refers to the difference between these two zones (what the learner can do independently and what he can do with the help of other persons in the environment) as the ZPD and the key agents that determine this zones is the More Knowledgeable Others (MKO), a term that has undergone modifications in recent times due to advancements in technology.

The MKO is vital in the learning process. Traditionally, the MKO simply refers to someone with higher knowledge or skill than the learner (Vygotsky, 1978). The MKO is therefore the source of sociocultural theory as the teaching that leads to the expected learning comes from this individual. With the advancements in technology, the construct could now refer to artificially intelligent machines that are designed to help students learn better. consequently, MKO within the purview of this study are SAR and AI. These technologies are gradually imbibing humanlike characteristics in teaching and as a result, could be categorised as MKOs.

Conclusion

The fusion of AI with robotics has led to the advancement of machines that provide humanlike assistance to learners. Since reading comprehension is the crux of every learning and the inattention and hyperactivity that are associated with ADHD militate against the success of this skill, the applicability of robotics to solve this problem is crucial. In addition,

the humanlike help of these machines has prompted the present study to refer to them as More Knowledgeable Others in line with Vygotsky's theory of cognitive development.

Recommendations

Based on the status quo, the following are recommendations were made to major stakeholders in Nigeria on how to improve the development of AI and Robotics in the country:

1. The National Centre for Artificial Intelligence and Robotics (NCAIR), the body responsible AI and robotics research in Nigeria should partner with worldclass tech companies in order to produce AI-powered robots that could help persons with ADHD read and comprehend with limited problems.
2. Language teachers should collaborate with the school administration to adopt methods like observation and questioning to identify students with ADHD
3. The government should provide the needed funding that would enable tech startups in Nigeria to produce personalised socially assistive robots that would help persons with ADHD read and comprehend maximally.

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