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Harnessing Ubiquitous Learning to Support Autistic Children's Educational Needs

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The sole author designed, analysed, inteprted and prepared the manuscript.

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ABSTRACT

Autism, often known as autism spectrum disorder (ASD), is a neurodevelopmental disorder, marked by limited interests, repetitive behaviours and difficulties with social interactions. While symptoms might be identified at various stages of lifespan, they usually manifest in early childhood. The severity of the disorder ranges from levels 1 to 3 depending upon the support the individual needs. Autistic children often experience difficulties with communication, social interaction and sensory processing, making traditional learning methods challenging. Ubiquitous learning provides flexible, individualized learning experiences that can be adapted to their unique needs, preferences and sensory sensitivities. The ability to learn in familiar, comfortable settings also minimizes social pressure, enabling children to focus more on acquiring new skills. As autism often involves difficulty in generalizing learned behaviors to new contexts, U-learning's mobile and adaptive nature supports the transfer of skills across various environments, fostering independence and confidence. The paper discusses the issues and possibilities of designing a syllabus, based on

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Ubiquitous learning, taking into consideration, their medical conditions. Autistic children have visual, auditory or tactile issues in handling gadgets and hence a unique syllabus is tailor made for each child taking care of their difficulties. The Wisconsin Scale, often used to assess developmental and behavioral traits in autism, can guide the creation of tailored syllabi that focus on enhancing communication, social skills and sensory processing for autistic children.

Keywords: Autism spectrum disorder; ubiquitous learning; fMRI, syllabus design; neurodevelopmental disorder.

1. INTRODUCTION

The term "ubiquitous computing" was coined by Mark Weiser in 1980 to denote the pervasive use and blending of computers in our day-to-day life. The concept of Ubiquitous learning is derived from this idea. "Ubiquitous learning refers to learning environments that are accessible at any time and from anywhere, providing seamless access to educational resources and opportunities" (Lee & Choi, 2022). Ubiquitous learning is a setting that helps students learn through environment. The student should be in the environment and learning occurs automatically (Krumm, 2018). U-learning can be facilitated through wireless mode in tabs, mobile phones etc., The uniqueness of U-learning is that it involves more context awareness and provides adaptive contents for the learners at the right time, right place and in the right way. The learners move around the U-Space and utilize the U- learning materials that can be transferred to their mobile devices via cable or wirelessly and be operated in these mobile devices (Riga et al., 2020).

U-Learning is a new paradigm in education as it involves the sum total experience of an individual in learning. It de-limits the restrictions of teacher - centered classroom experience and extends it into all possible spaces like home, workplace, the playground, the museum, the library and shopping malls. "By leveraging mobile devices, ubiquitous learning enables learners to integrate learning experiences into their daily lives" (Hwang & Tsai, 2021). The use of mobile phones and personal digital assistants make interactions possible in all situations, regardless of time and space (Sanromà-Giménez et al., 2021).

The current paper discusses, methods of facilitating verbal and non-verbal communication skills to autistic children using Ubiquitous learning materials through mobile phones and tabs.

Though technology helps a long way in developing language skills among people with special needs, it is rarely used among autistic children. "... the varied use of technology for children with autism continues to receive limited attention, despite the fact that technology tends to be a high interest area for many of these children" (Nissan B. Bar -Lev, 2002).

Autism: Autism is a neuro developmental disorder which displays impaired social interaction and communication and repetitive behaviors (Juan et al., 2022; Mai & Tran, 2022). It poses "… persistent challenges in social interaction, communication, and repetitive behaviors" (Lord et al., 2020). It can be detected in early infancy from six months and it is established before the child reaches the age of six (Goswami et al., 2021). Due to communication issues children with ASD suffer from lack of expression and are unable to lead an independent life (Rea-Amaya et al., 2017; Vakadkar et al., 2021). These children need special remedial methods of teaching to enhance their communication skills (Raj & Masood, 2020). Ubiquitous learning is a natural way of technologically enhanced learning where the student acquires communication skills in a stimulated U-Space, using mobile phones, PDAs and tabs (Jacobs, 1999). Though there is much research going on in U - learning, research on ubiquitous learning among autistic children is at the stage of infancy.

A report published on Times of India in 2012 says that the rise of autism cases in India is six-fold with the total rise of autistic population in India rising up from 20 lakhs in 2003 to 1.36 crores in 2012. The number of cases is rising more in current days. "Recent reports indicate that approximately 1 in every 36 children in the country is affected by autism" (Nov 30, 2024, Times of India)

Autism spectrum rating scales: As per the guidelines of the diagnostic manual (DSM IV) of the American Psychiatric Association there are three main types of ASD namely, Asperger's Syndrome, Pervasive Developmental Disorder,

not otherwise specified (PDD-NOS) and Autistic Disorder. Often there is overlapping of etiological symptoms and all the three symptoms.

Several autism rating scales are widely used to screen, diagnose and assess the severity of Autism Spectrum Disorder (ASD). The Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) is considered a standard tool for observational autism assessment. It is a semi-structured tool that evaluates communication, social interaction and play, in individuals aged 12 months to adulthood. Another comprehensive tool is the Autism Diagnostic Interview-Revised (ADI-R), which involves a detailed interview with a parent or caregiver to assess developmental history and current functioning in areas such as communication, reciprocal social interactions and restricted, repetitive behaviours. This scale can be used for children with a developmental age of two years. The Social Responsiveness Scale, Second Edition (SRS-2) is used to assess the degree of social impairment linked to ASD in people, from 2.5 years and to adulthood. The domain-specific ratings for social awareness, cognition, and communication can be obtained by parents, teachers, or older people self-reporting.

Similarly, the Childhood Autism Rating Scale, Second Edition (CARS-2) is a tool used to diagnose autism and evaluate its severity in children, two years of age and above. This tool offers a customised version for high-functioning people and enables doctors to score observed behaviours across 15 areas, including communication and social interaction. For children aged 3 to 22, the Gilliam Autism Rating Scale, Third Edition (GARS-3) uses a questionnaire for parents or carers to determine an Autism Index, which is used to evaluate the likelihood of ASD.

The Autism Spectrum Rating Scales (ASRS) evaluate behaviours related to ASD in children aged 2 to 18 years and provide detailed reports on specific behaviours. The Vineland Adaptive Behaviour Scales, Third Edition (Vineland-3) is frequently used for assessing adaptive behaviour. It evaluates skills such as daily living, socialization and communication in individuals from birth to adulthood through interviews or questionnaires completed by parents, caregivers, or teachers.

Screening tools like the Modified Checklist for Autism in Toddlers, Revised (M-CHAT-R/F) are effective for early detection of ASD in toddlers aged 16 to 30 months. This parent-completed questionnaire includes a follow-up interview for further clarification. The Developmental, Dimensional, and Diagnostic Interview (3Di) combines categorical and dimensional approaches to diagnosing ASD and measuring symptom severity in children and adolescents through structured interviews with parents or caregivers. Lastly, the Autism Behaviour Checklist (ABC) is a quick screening tool included in the Autism Screening Instrument for Educational Planning, designed for individuals aged 3 years and older, to evaluate behaviours commonly associated with ASD.

These tools vary in their focus, administration and depth, making it common for clinicians to use a combination tailored to the specific needs of the individual and the context of the assessment. Apart from these tools and scales, the ATEC (Autism Treatment Evaluation Checklist) scale can also be used.

ATEC has its own benefits as it is employed by the researcher as it can be administered to parents or care takers and does not require a trained specialist. It can be used for the posttest also in order to check the effectiveness of both traditional and new interventions, apart from diagnosis of autism in children. The immediate online results of ATEC help researchers make effective interim evaluations. Patients' identity is kept confidential and diagnosis results can be sent through mail to parents or care takers.

The active participation of parents and caregivers is very much essential as ubiquitous learning extends beyond instruction hours at home and other places. This will give a clear picture of the patient to both the parents and the researcher to determine which particular module is more beneficial to the student. This will ensure the improvement in the quality of instruction and facilitation from the part of the researcher and in the quality of life for the participating child.

Triangulation Through Fmri: "Functional MRI is a non-invasive technique that measures brain activity by detecting changes in blood oxygenation levels, a proxy for neural activity." (Ogawa, et al., 1990). Since it may identify abnormal neural connections and patterns of brain activity, functional magnetic resonance imaging (fMRI) has emerged as a key tool in the study of autism spectrum disorder (ASD). Studies using fMRI have identified disruptions in

the default mode network and social brain regions, such as the medial prefrontal cortex and amygdala, which are crucial for social interaction and emotional processing. Task-based fMRI highlights differential activation in response to social cues, providing valuable insights into the neural underpinnings of social deficits in autism. Yeo, et al., (2019) explain the deficit of social skills in autism patients: “Aberrant functional connectivity in the social brain network, as identified using fMRI, underlies social deficits in autism." Additionally, resting-state fMRI has shown altered functional connectivity, suggesting global network inefficiencies. These findings not only improve our understanding of the neurobiology of ASD, but also help identify potential biomarkers for early diagnosis and intervention strategies. Hence, employing fMRI in assessing the enhancement of both language and social skills would be apt in this context. In order to conduct a triangulation, to check the authenticity of the results, neuroimaging can be done through fMRI (Functional Magnetic Resonance Imaging) by tracing the changes in blood oxygenation in the active area when a function is performed. fMRI does not involve radiation effects and is safe on patients and has great spatial and temporal resolution. "Functional MRI studies have revealed atypical connectivity patterns in the default mode network and other neural circuits in individuals with autism.*" (*Uddin, et al., 2013)

Depending upon the needs of the patients, a syllabus can be customized for each patient, individually. This can be done by preparing a schedule for each participant in accordance with Wisconsin Scale. The schedule should include at length the issues of the child -sensory, expressive, receptive, language skills, behavioral issues, social skills etc., Since all details pertaining to the children are recorded, during the intervention, it can be ensured that Ubiquitous learning enhances, not only language skills of the participants, but also other social skills including their face time. An assistive technology that best suits the need of the child can then be selected and a lesson plan be prepared employing Ubiquitous learning materials. A general plan is furnished below, though this may vary from individual to individual: 1) identifying objects, colors, shapes, 2) Identifying people, 3) identifying buildings, places, things, animals etc., 4) Nouns 5)verbs 6)Phonics, prepositions, adjective and adverbs, 7) Read aloud practice of single words, 8) From simple words to simple structures- action words - a consistent motor movement like hearing something or seeing something can be imparted through video lessons 9) Reading comprehension and 10) writing at the beginning level.

An abnormality in the cortical region of the brain may result in impairment of task performance. Integration of task is impaired when there is under connectivity of cortical regions. It is clear from this that the cognitive deficit in autistic children involves the inability to bind together a collection of separate features into a coherent concept even though their ability to understand and analyze individual features may be preserved and sometimes function effectively (Frith, 1989). Therefore, in children with high functioning disorders, the strength to process single words (a low-level task) is effectively high, whereas, their ability to process the meaning of complex sentences (a high level task requiring integration) is impaired (Goldstein et al., 1994). Later fMRI studies on written comprehension revealed that in high functioning autism there is reduced functional connectivity between Wernicke's area and Broca's area, though Broca's area, the region for processing single words is enhanced (Just et al., 2004). Appropriate software apps can be employed to enhance cognitive and motor skills involved in LSRW for children with such high functioning disorders. Children can utilize the U space and U earning materials as per thir wish and willingness to learn. This can also be done depending upon the difficulty levels of the modules and the cognitive levels of the individuals. The parents/care takers of the participants should be given an orientation to help their ward at home with the lessons and this is the advantage of U-learning, It can be ensured that the child receives continuous learning, irrespective of time and space, as long as the child shows interest to learn. The development in cognition can be evaluated after a period of intervention and learning. The evaluation can also be done employing fMRI.

Ubiquitous learning materials: There are many U-learning apps that are specially designed for autism. Google and Android apps that are designed for academic and non-academic purposes can also be employed for this purpose. iToucan Talk, Greenway, etc. are android apps designed for autistic people. There are other apps such as White board, Literacy Lab etc. from Mayer Johnson, which are generally used in ordinary classroom sessions. These can be

customized for children with ASD. White board has various templates and allows customization as per the demands of the learner. Literacy Lab has eight modules and takes up 7 to 9 months to complete all levels. Apart from these, there are other products such as PROJECT IDEAL specially designed for autistic children. The researcher will decide the "High function strategy tools" depending upon the demands of the audio, visual and tactile issues of the concerned individual.

'Touchless Motion-based' interactive X Box 360 Kinect games that suit the participants can be used in stipulated time to enhance control in body movements and gestures. This will improve the observation skills, joint attention, selective attention, sustained attention and turn taking in children. X Box is based on the Kinect motion sensing technology that senses body movements and identifies individuals involved in the game. Employing X Box to engage autistic children enhances their response capability. Apart from these, VR and AI tools and techniques are also used to help autistic people: “A VR intervention called Virtuoso, designed to support autistic adults in safely practicing public transportation use” University of Georgia College of Education (2024). Researchers at the University of Kansas have developed a virtual reality system enhanced with artificial intelligence to help students with autism improve their social skills (University of Kansas, 2024).

2. CONCLUSION

Autism is a neuro developmental disorder characterized by difficulties in verbal and non-verbal communication, social interaction and restricted repetitive behaviors. Though technology is being used extensively in main stream education, it is not commonly used among children with special needs. Autistic children enjoy learning through technology and Ubiquitous learning helps autistic patients acquire verbal and non-verbal communication skills (Lord et al., 2020). Ubiquitous learning is a natural way of learning that helps autistic children acquire language skills and enhance their verbal and nonverbal communication and hence can be highly recommended for children woth autism..

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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