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Implementation of AI-Based assistive technologies for learners with physical disabilities in areas of innovation and special schools: a practical design thinking approach

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ABSTRACT

The inclusion of Learners with disabilities continues to extensively rely on digital and Artificial Intelligence (AI) enabled Assistive Technologies (AT) as enablers for Persons Living with Disabilities (PWD). However, the provision of ATs to meet the unique needs of PWDs continues to be a challenge. Moreover, such AI enabled ATs exist within areas of innovations, learning and working environments, hence the need for ease of learning, usage and cost effective acquisition and implementation. This paper introduces a systematic approach that matches the unique needs and abilities of innovators and learners in areas of innovation and special schools with AI-ATs that supports innovation and learning of PWDs. This approach applies Design Thinking (DM) approaches, participatory elements enhanced with online collaborative tools in three special schools and one area of innovation through two training cycles. The objective is to be able to better understand the target group of learners and innovators with physical disabilities, to enable accurate identification, evaluation and choice of appropriate AI-ATs so as to develop learning and innovation spaces that enable the creation, introduction and testing of AI-ATs for eInclusion. The approach was developed for an area of innovation that focuses on ATs and Special Schools for adoption in diverse settings with PWDs.

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Introduction

According to World Health Organization (WHO), (Report, 2019), over one billion people are estimated to experience disability corresponding to 15% of the world's population. Access to learning content (Kumar Basak et al., 2018) for access to affordable and relevant learning continues to raise interest among persons abled differently due to the advancement of technology after the Covid-19 pandemic (Nasajpour et al., 2020) for the realization of SDG 4 (Ferguson & Roofe, 2020) that aims at ensuring all people have inclusive and equitable quality education for lifelong learning. A physical challenge for a person abled differently relates to deficient abilities like mobility (Chung et al., 2020), visual , audio through hearing (Puschmann et al., 2019) and speaking (Chang et al., 2020). Persons living with physical Disabilities (PWD), hereby referred to as abled differently range from lack of motor skills, lack of sight and hearing impairments (Puschmann et al., 2019). However, this paper focusses on disabilities in the area of motor skills having been identified as one of the widely spread disabilities as it affects 6.4% of children of school going age in Africa, as less than 10% of children with disabilities under the age of 14 are attending school according to world bank 2018(Report, 2019). This percentage translates to about 300 million of people with disabilities in Africa. To help the persons with physical motor skill challenges, several researches have been conducted to make the environment more inclusive and hence ease their lives. Assistive Devices for mobility are among inventions that have been invented to aid them live independent lives. However, the Assistive Mobility Devices, are unable to aid them access digital content on digital devices. One such scenario is desktop computers and laptop computers. Despite the effort put by hardware and software developers to help the motor challenged users, it has increasingly become difficult for users without limbs to manipulate high-end digital devices and software for purposes of accessing learning content. Innovation spaces in Institutions of Higher Learning aid in addressing challenges in diverse fields like the field of digitization; through participatory experimentations, elucidation, and creation of new innovative solutions.

To address this issue, this study aimed at developing of a Digital Assistive Technology (Khasnabis et al., 2020) for use in areas of innovation and learning institutions for virtual assistance of the learners with physical motor challenges using a design thinking approach. The term Design Thinking (DT) (Brown, 2008) was created by Tim Brown. In 1969 Herbert A. Simon, a Nobel Prize winner and Computer Scientist was the first to accept design as a scientific way of thinking in his book entitled Sciences of the Artificial (Kimbell, 2011). Advances in AI-based recommender and recognition systems, has contributed widely in the design of AI-based Assistive Technologies to cub the challenges experienced by PWDs (Zouhaier et al., 2021). Design Thinking methodology is a person cantered approach that aids in the inclusion of PWD. The aim of DT is to develop products or services that are person-cantered, through empathy phase aimed at understanding the target group, definition phase aimed at defining the target group, ideation phase aimed at choosing how to support the target group by meeting the unique needs, prototyping aimed at coming up with prototypes as per the ideas and finally testing aimed at testing the prototype with the target group. Assistive Technologies (ATs) comprise of products, services, strategies and methods that are focused on reducing or lowering limitations imposed on persons living with disabilities. The ATs are aimed at ensuring the user is more independent for socio-economic inclusion for better quality of life and social inclusion for the persons abled differently.

AI-Based Assistive Technologies

Advancements of technologies in the area of disabilities has evolved over time from the use of Assistive communication, mobility and visual technologies; to the integration of Artificial Intelligence of Things (AIoT) devices that employee the power of artificial intelligence and machine learning in the enhancement of the ATs (de Freitas et al., 2022). The AIoTs consume data gathered over the internet and algorithms utilized in monitoring the persons with disability by creating solutions that extend the usability of their physical frame into a virtual environment that augments the reality of the user in interacting with Assistive Technologies (Kirongo et al., 2019). These advancements have been used in this study to assimilate a variety of hardware and software technologies through algorithms that interfaces the image processing aspects of the user, to enable user interaction. AI technologies embedded with formulated algorithms have proved to be beneficial in the utilization of existing technologies to enable PWDs to use computer devices to access learning content.

When applied to Assistive Technologies (AT), Artificial Intelligence (AI) enables PWDs through solutions designed for mobility and navigation, applied to persons living with physical and visual challenges. Medical aspects of PWDs is critical, and the application of eMedicine, telemedicine, mobile medicine so-

lutions inculcated with AI has enabled health monitoring of PWDs (de Freitas et al., 2022) facing terminal and critical illnesses through the digitization and automation of the detection, monitoring, diagnosis, and prescription of the medical conditions while ensuring the monitoring of those PWDs with threatening ailments including the sending of messages to remind them specific times for taking their medication. AI has been applied to solve challenges related to cognitive, visual, and communication systems that employ robotics, AI and ML techniques for ease of longevity of life among sick and elderly PWDs. While technology makes life easier for persons without disabilities, technology makes life possible for persons living with disabilities.

Several AI models have been developed to address the disability challenge among different populations (Kirongo et al., 2019). There exist frameworks that apply computer vision and machine learning techniques in an IOT network environment that employs cloud computing techniques for better capacity. The captured images are stored in a server that processes them to identify the different images captured, calculates the distances and ultimately converts the information to audio format to assist mobility guidance to persons living with visual disability (Junior et al., 2019). Wearable technologies have also been developed to aid visually impaired persons address mobility challenges through smart glasses, wearables to aid visually impaired persons in navigation, identification of medical pills (Chang et al., 2020) while administering prescribed medication on themselves, identification of the location a visually impaired person is located in a building and mobility on the roads. This study however identified less research input in the area of enabling learners access learning content especially in the post COVID-19 era among learners with physical disability in arid and semi-arid schools in sub-Sahara Africa.

Result and Discussion

Four Assistive Technology Centres were set up by the Competence Network for EInclusion and Assistive Technologies research team (Amos C. Kirongo, Benjamin Aigner, Guyo S. Huka, 2018) at their research centres and one area of innovation. The aim was to develop solution for persons living with disabilities in the tree pilot centres. The pilot centres are made up of primary school learners (Kirongo et al., 2019) that have physical challenges that impede them from accessing learning content in digital devices. The area of innovation created three solutions for mobility among learners. The solutions were designed to enable the learners navigate through software interfaces through AI enabled algorithms that detected specific parts of the body as extension of input devices usable among well abled learners. The different part of the face detected enabled the users to navigate pointing and mobility devices in the computer which enable opening and closing of the files and folders, typing and navigation through different web pages, creation of learning content among the instructors and learners, accessing the learning content and navigation in educational computer games among the learners. Users were taken through training following the Design Thinking approach. The users were learners and teachers, who through trainings were able to profitably use the devices just like theory well abled counterparts. The teachers were able to deliver learning content; learners were able to access the content. Through observation of their use of AI enabled ATs, the researchers were able to empathise with the users and modify the developed solutions to enhance usability of the devices and enhance the mobility of the users.

Conclusion

This article discusses the AI enabled to Assistive Technological solutions applied among learners in three elementary special schools and one area of innovation. The special schools were able to use the technologies efficiently. Interactions with the users using DT, and existing literature, showed an increased interest in the application and use of machine-learning algorithms and learning techniques in neural networks in the creation of Assistive Technology solutions. Further research can be done to fill the gap related to the utilization of techniques and algorithms for enhancing interaction with the environment among PWDs.

References

Amos C. Kirongo, Benjamin Aigner, Guyo S. Huka, C. V. (2018). PROCEEDINGS FROM THE 10 th ANNUAL DECOLONIZING THE.

Brown, T. (2008). Design Thinking por Tim Brown. Harvard Business Review, 10.

Chang, W. J., Chen, L. B., Hsu, C. H., Chen, J. H., Yang, T. C., & Lin, C. P. (2020). MedGlasses: A wearable smart-glasses-based drug pill recognition system using deep learning for visually impaired chronic patients. IEEE Access, 8, 17013–17024. https://doi.org/10.1109/ACCESS.2020.2967400

Chung, J., Lee, J., & Elswick, R. K. (2020). Life-space mobility in dementia patients and family caregiv-

ers: A dyadic approach. International Journal of Older People Nursing, 15(4), 1–7. https://doi.org/10.1111/opn.12341

de Freitas, M. P., Piai, V. A., Farias, R. H., Fernandes, A. M. R., de Moraes Rossetto, A. G., & Leithardt, V. R. Q. (2022). Artificial Intelligence of Things Applied to Assistive Technology: A Systematic Literature Review. Sensors, 22(21), 8531. https://doi.org/10.3390/s22218531

Ferguson, T., & Roofe, C. G. (2020). SDG 4 in higher education: challenges and opportunities. International Journal of Sustainability in Higher Education, 21(5), 959–975. https://doi.org/10.1108/IJSHE-12-2019-0353

Junior, M. J., Maia, O. B., Oliveira, H., Souto, E., & Barreto, R. (2019). Assistive technology through internet of things and edge computing. IEEE International Conference on Consumer Electronics - Berlin, ICCE-Berlin, 2019-Septe, 330–332. https://doi.org/10.1109/ICCE-Berlin47944.2019.8966148

Khasnabis, C., Holloway, C., & MacLachlan, M. (2020). The Digital and Assistive Technologies for Ageing initiative: learning from the GATE initiative. The Lancet Healthy Longevity, 1(3), e94–e95. https://doi.org/10.1016/S2666-7568(20)30049-0

Kimbell, L. (2011). Rethinking Design Thinking: Part I. Design and Culture, 3(3), 285–306. https://doi.org/10.2752/175470811x13071166525216

Kirongo, A. C., Huka, G. S., Bundi, D. G., & Muketha, G. M. (2019). Competence Network for e-Inclusion and Assistive Technologies. 24(6), 66–70. https://doi.org/10.9790/0837-2406076670

Kumar Basak, S., Wotto, M., & Bélanger, P. (2018). E-learning, M-learning and D-learning: Conceptual definition and comparative analysis. E-Learning and Digital Media, 15(4), 191–216. https://doi.org/10.1177/2042753018785180

Nasajpour, M., Pouriyeh, S., Parizi, R. M., Dorodchi, M., Valero, M., & Arabnia, H. R. (2020). Internet of Things for Current COVID-19 and Future Pandemics: an Exploratory Study. Journal of Healthcare Informatics Research, 4(4), 325–364. https://doi.org/10.1007/s41666-020-00080-6

Puschmann, S., Daeglau, M., Stropahl, M., Mirkovic, B., Rosemann, S., Thiel, C. M., & Debener, S. (2019). Hearing-impaired listeners show increased audiovisual benefit when listening to speech in noise. NeuroImage, 196, 261–268. https://doi.org/10.1016/J.NEUROIMAGE.2019.04.017

Report, D. (2019). Realizing the Sustainable Development Goals for persons with disabilities. In Disability and Development Report 2018. https://doi.org/10.18356/6b539901-en

Zouhaier, L., Hlaoui, Y. B. D., & Ayed, L. Ben. (2021). A reinforcement learning based approach of context-driven adaptive user interfaces. Proceedings - 2021 IEEE 45th Annual Computers, Software, and Applications Conference, COMPSAC 2021, 1463–1468. https://doi.org/10.1109/COMPSAC51774.2021.00217