Supporting Neurodiversity Using Mainstream Mobile Technologies: A Proposed Fourth Generation Model

Abstract

This article takes a philosophical approach to examining the use of mobile technologies by Students Who Are Neurodiverse (SWANs). The article is relevant, as it addresses issues of social justice for students with disabilities and special needs. Methodologically, the article uses the epistemological model of disability and a framework of active and passive exclusion to critically examine the nature of neurodiversity, the history of the development of accessible, assistive and inclusive technologies for SWANs, and the management strategies of supporting SWANs using different forms of technology in different learning contexts. The focus of this analysis is an examination of mainstream mobile technologies and apps, and the support people with disabilities in the modern era get, and the study is framed by two research questions:

1) How has technology attempted to support SWANs based on their individual learning needs?

2) Has the process of developing technologies for SWANs led to an efficient process of inclusion?

The article finishes by proposing a new model of technology usage and practice termed the Culture, Individuality, Multi-Modality and Portability (CIMPo) model, which it suggests represesnts a fourth generation of accessible and inclusive technology and a second generation of inclusion. The key conclusion from this article is that neurodiversity is often overlooked in education and that the culture of support using technology is burdened by its history of

exclusion. However, systematized management strategies using mainstream technologies can often address many historical issues and the hurdles presented during teaching and learning.

Keywords—neurodiversity; dyslexia; mobile computing; mobile devices; m-learning; inclusion; accessible technology

Introduction

This article discusses a model of learning to support Students Who Are Neurodiverse (SWANs) using mobile technologies such as mobile telephones and tablet computers as a means of learning support. The model of practice of using mobile technologies to provide support is termed the Inclusive-Mobile Learning model (i-m Learning model). The article includes: a review of the methodology used to analyse neurodiversity and the history of accessible technology; a review of the nature of neurodiversity and how it is used in this article; a short history of accessible technologies involved in supporting SWANS, the theoretical background on the i-m Learning model; the proposal for the i-m Learning model itself. The design of the model focuses on the improvement of the educational chances of SWANS, with many being accepted to prestigious universities (Hayhoe, Roger et. al. 2015) and the advantages and potential problems of using mobile technologies to provide support.

The methodology used to critically analyse the previous work in this field is the epistemological model of disability that is designed to define passive exclusion, and in this study this analysis focuses on improving learning with mobile technologies, access to education for SWANs, and the advantages or potential issues of learning with mobile technologies. During the study, historical and contemporary issues were investigated through three phases of analysis. In addition to reviewing issues relating to technologies relating to support, the analysis in this study was also designed to evaluate different forms of technology as instruments of inclusion. The epistemological model of disability, which is described in the section that follows, is premised on the finding from previous research that inaccurate knowledge about learners with learning impairments stereotypes what are usually classified as disabilities or difficulties. These stereotypes lead to strategies of learning where traditional forms of teaching are altered

according to cultural tradition, and these strategies have a negative effect on education of SWANs. Thus, the analysis in this article focuses on cultural issues of educational technologies, including: the acceptance of technology and its support of physical and online learning environments, gaps in research on inclusive technologies, and the practice of using such technologies as a tool of digital inclusion.

The study is necessary in 2022, as many technology companies have attempted to make their mainstream technologies inclusive to most users over the past decade (Martiniello, Eisenbarth, et. al. 2022), and yet there have been few studies that have evaluated or provided a model for practically implementing these technologies. As Microsoft founder, Bill Gates, stated earlier in the millennium, "Our vision is to create innovative technology that is accessible to everyone and that adapts to each person's needs. Accessible technology eliminates barriers for people with disabilities and it enables individuals to take full advantage of their capabilities." (Gates in Sinclair 2008). Thus, the primary aim of this article is to discuss the need for and a direction of research on the design and teaching of technology to improve inclusion. The secondary aim of this article is to provide the reader with an introduction to a broader debate on the nature and role of mobile devices in the learning support of SWANs, and to begin an epistemological understanding of neurodiversity and technology.

Methodology: The Epistemological Model of Disability and Passive Exclusion

The epistemological model of disability

The epistemological model of studying disability (the epistemological model of disability) is designed to assess processes of generating knowledge about disability. The model first evolved from observations on the effect of philosophical assumptions about impairments

(Hayhoe 2016), and then adapted to provide a link to Popper's (1979) critical theory of ethical positivism. Consequently, the epistemological model of disability also changed to address the ontology of classes of impairments as disabilities, and to examine the manner by which disability is felt to disable people from completing tasks. Thus disability is either defined by classifications of what are felt to be ethically less able people or through beliefs about a whole personality as a result of classification.

The epistemological model of disability then evolved to discover a different focus of examination through studies of the social history of disability, and evolved to encompass three core observations that it felt were neglected in previous social models of disability (Hayhoe 2016):

1. The first observation is that exclusion not only originates from a need to exclude and gain power over minority groups, but focuses on the processes of inaccurate knowledge creation that causes exclusion through the application of *bad* knowledge. This process also leads to the belief that institutions guide the need to supress or control deviance and abnormality through poor therapy or social care, and subsequently un-naturally classified disability as a single, inaccurate personal identity (Foucault, 2001a, Goffman, 1991).
2. The second observation of the epistemological model of disability is the role of power in developing knowledge, and how power is affected and affects the biases of the authors of written knowledge about disability. Academic authors of knowledge are thus the most important originators of negative beliefs about disability and take on a very powerful role as intellectuals. Intellectual disability that has been more recently described as neurodiversity is thus not just a function of knowledge but of power, and suppresses those who are a target or subject of this power (Foucault 2001b).

3. The third observation of the epistemological model of disability is that there are cultural differences between theories of disability, i.e. some disabilities are felt to make people less moral or see certain types of disability as biological and social problems in different eras and in different locations (Hayhoe 2016). In the epistemological model of disability, the differences in these theories are termed uneven theories of disability, and this unevenness is caused by the view that some disabilities point to a divine truth or moral deviance. For instance, it was observed that socially and culturally constructed knowledge on the use of touch was derived from pedagogies developed in institutions for people with disabilities, which were themselves influenced by a philosophy of Enlightenment from the 17th and 18th centuries. This philosophy was designed to further a human understanding of perception and consciousness, but in doing so caused widespread exclusion of people with physical and intellectual disabilities (Hayhoe, 2020a).

In accordance with the philosophy of the epistemological model of disability, the cultural process that is caused by these properties results in two distinct forms of exclusion (Hayhoe 2016).

Active and passive poles of exclusion

Epistemological forms of exclusion such as those related to the uneven and inaccurate understanding of disability, particularly those linked to powerful knowledge functions, give rise to two poles of exclusion: one pole of exclusion is created through the process of supposedly kind and liberal understanding that people are incapable of inclusion and is termed passive exclusion; whilst the other pole is caused by the active disliking of people with disabilities

because they do not fit a human ideal, and this pole is referred to as active exclusion (Hayhoe 2016).

The social process of active exclusion is often associated with the process of reinforcing knowledge and policy aggressively, in an openly discriminatory fashion, and this aggression is targeted at what are regarded as *the abnormal* and leads to violent and aggressive physical acts. For example, it has been observed that pernicious legislation based on what was believed to be the inferiority of people with learning disabilities led to eugenic health-based policies and malevolent discrimination against disabled people in US institutions for the disabled over the past two centuries (Pfeiffer 1994, Reinders 2008).

Active exclusion can be seen as a state of segregation, where the deliberate oppression of disabled people is seen as being sociallu justified by the oppressor and is therefore analogous to oppression based on race or gender or is conflated with these forms of exclusion. For example, Valeo (2009) observed that the exclusion of people with disabilities in Canada underwent a similar process as the prejudices shown to minority ethnic families in an earlier era. Alternatively, active exclusion can be a form of marginalisation, and is observed in the sneering attitude of people to the presence of people with a disability when they are included in regular societies. Hehir (2002) argues that the openly expressed opinions of society in the inferiority of the behaviour of people with disabilities threatens its function as an efficient and reliable unit.

By contrast, the passive pole of exclusion is observable in epistemological attitudes to disability as a concept by the authors of liberal theories of ability based on bodily functions, emotions, cognition and behaviour that are designed to make them ethically fair. Thus, passive exclusion exists in the psychological and social separation of teaching and technologies for what is felt to be the good of people with disability. This form of exclusion standardizes disability in

an attempt to treat disabled people *fairly*, and imposes as a fight for freedom that promotes a false sense of reality that is designed to gain power over people gently.

Passive exclusion can be observed in the unevenness of the knowledge about disability and how this knowledge changes in different environmental, cultural and historical contexts (Hayhoe, Roger, et. al. 2015). This change has real social and emotional effects on the humans that this knowledge is designed to benefit. Consequently, this second form of passive exclusion is largely the result of systems of classification that have left scientifically defined conditions vulnerable to over-simplified, mythologized hypotheses about the innate superhuman ability of disabled artists, or the innocence and goodness of people with disabilities (Hayhoe 2020a).

What now follows is an analysis of how the effect of philosophical speculation about impairments has led to negative academic theories about the human capacity of disabled people and subsequent disabling practices. Here it will also be shown that the process of constructing knowledge has led to largely passive exclusion of disabled people. In this case study, different attitudes to separate capacities of people with disabilities are also linked during an intellectual process through a passage of time. This leaves the removal of one form of ability linked to the removal of a number of other forms of ability through disabling practices.

What is Neurodiversity in Relation to Passive Exclusion?

SWANs in Education and Assessment

Neurodiversity can be defined as the appreciation of the way that alternative forms of learning have not been appreciated by traditional and formal systems of education and assessment (Rosqvist, Chown, et. al. 2020). Thus, SWANs are students who are passively excluded as their learning needs are not met by their current educational context, and thus find it

difficult to learn using traditional learning technologies, as their method of learning is not supported by these technologies and traditional teaching methods.

This mismatch between teaching and learning is arguably in large part due to the nature of education being to socialize students and for students to learn a standardized curriculum developed through cultural traditions from Ancient Greece until the present day (Joyal, Yardley and McDougall 2009). In addition to the social nature of education, there is disagreement about about biologically acquired learning and what is studied through processes of socialization, which in more recent years has led to a strand of psychotherapy based on tracing patterns of social learning (Biemiller and Meichenbaum 2017).

Despite mismatches between standardized forms of learning and theories of general learning, there is a general agreement that all humans are born with a capacity for some form of learning about the world around them, and that this natural capacity is based on sensory perception and symbolic representation (Dharani 2014). For instance, in the seventeenth century it was established that humans are born “tabula rasa,” i.e. a blank slate with no prior knowledge prior to birth, suggesting that all our learning is developed through lived sensory experience during lifecourse (Hayhoe 2020a).

What is also known is that, as humans age the state of their memory and the process by which human brains attain and develop relationships between sensory memories also changes, and leads to a latent form of learning (Claxton 1987). This change to, or what is inaccurately called a “loss” of previous memories, leads to unique changes to patterns of learning and the way we engage with our environments, i.e. what is termed memory loss is simply a problematization of finding or developing standardized connections between memories or developing a new neurological path to memories when their connections are broken (Deng, Aimone and Gage

2010). However, despite the dependence of memory on learning and learning on memory, social aspects of learning and memory are often observed in different ways (Baddeley 2000).

For instance, Piaget (1964) hypothesised approximate cognitive stages of child development at different ages, and although substantial parts of Piaget's theories are criticized for being too rigid in describing these stages and the ages at which they occurred, it is generally acknowledged that children do learn differently according to their personal age of development (Babakr, Mohamedamin and Kakamad 2019). However, although Piaget argued that the continued changes in the learning patterns and memorization of older teenagers and adults stabilizes or halts (Piaget 1954), it has been proposed that technological learning development never ends throughout life-course (Prensky 2001). Thus, a fundamental principle of constant learning, and in the context of this article technological learning, can be said to hold true throughout life course.

Given this understanding of learning, including technological learning, as an individualized process that is unique to the individual learner throughout their life, it is also important to recognise a continuum of what is termed in this article spectrum learning issues. Traditionally, learning disabilities have been on a spectrum from most significant to least significant (Maser and Akiskal 2002). This spectrum is based on the difference of the learner to the teaching process, although for practical purposes, this article will discuss support for SWANs who are higher on the spectrum of facing issues with learning in education, termed Neurodiversity Higher on the Spectrum (NHS), and who can be said to need greater learning support. Despite the redefinition of what have been called disabilities or specific learning difficulties as neurodiversity, the concept of spectra can be said to be useful, as it can identify the level of support needed by SWANs.

Neurodiversity Higher-on-the-Spectrum (NHS)

NHS is common for many, leads to problems with memorization, and what it is traditionally referred to as having a learning difficulty and significant issues with attention issues. NHS subsequently leads to difficulties in reading, writing, numeracy, the organization of learning, focussing on assessment, listening comprehension, social skills, motor skills and combinations of all these (Horowitz, Rowe and Whittaker 2017). NHS is thus not the result of low intelligence, or a lack of access to quality instruction, but instead is a result of regularizing, regulating and over-structuring learning and work that leads to passive exclusion.

As stated above, education is a system of learning developed by culture and communities to teach students about the rules of their cultures and communities, be it a culture or community of nation, religion, or even ancestry. As such, teaching to educate is rooted in language, symbols, and allegory, thus SWANs are typically referred to as NHS when they find it difficult to complete everyday tasks that are part of their lives, not just a part of schooling. Therefore, it can be said that NHS is an issue that slows learning and makes concentrating on a single problem or task for a protracted length of time difficult (Horowitz, Rowe and Whittaker 2017).

In this article, NHS can also be seen on a second spectrum perpendicular to the strength of neurodiversity. This second spectrum can be seen as combining NHS with related issues of communication, perception and physical strength and movement. One end of this spectrum includes issues such as dyslexia, dyspraxia, or dyscalculia, which are rarely associated with other learning issues. Given early identification and support, being on this end of the spectrum will not change a student's life in a significant way in comparison to many other life changes. At the other end of this spectrum is what is traditionally called "Down syndrome" (DS), a genetic condition that provides an extra chromosome in a foetus, causes physical, sensory, and health

issues, and consequently requires extra support and more adaptable technologies (Barbosa, de Oliveira, et. al. 2018).

The day-to-day understanding, self-awareness, and concentration by people with NHS are noticeably slower and harder, thus SWANs with NHS also find it increasingly difficult to remember information. In addition, although SWANSs do not find it difficult to understand, process or use concepts when presented in an alternative way, they find it difficult to read complex words, or grammatically process longer sentences or paragraphs, thus technologies developed to support SWANs usually emphasise the communication and interface design of such technologies (Motti 2019). It is also found that providing little support can stress SWANs and can lead to an avoidance of learning, low self-esteem and self-confidence, or increased levels of stress (Halder and Argyropoulos 2019).

This raises the following two questions:

1) How has technology attempted to support SWANs based on their individual learning needs?
2) Has the process of developing technologies for SWANs led to an efficient process of inclusion?

The History of Technological Support of People with Disabilities

It has been observed that there have been four approximate, dominant, historical eras of accessible technology development and technological support, although it should be noted that these eras overlap, and the dates differ for these eras in different societies. Thus, these eras exist as loose analytical concepts, and are the same for all people with disabilities, and is thus an example of passive exclusion (Hayhoe 2021).

The first generation of technological support was prevalent from approximately the eighteenth century until the early years of the twentieth century. During this era, there was a medicalization of conditions thought to be disabilities, with medical technologies designed to support illness or injury, i.e. disability was seen as a medical issue by the institutions said to be providing support for injured or ill people, and this medicalization often involved the separation of people with disabilities through their technologies in residential homes, asylums, or institutes according to impairment, such as asylums for the blind or for the deaf (Hayhoe 2016). This era thus highlighted issues of disability as issues of infirmity, incapacity, and injury, with technological support focussed on simply maintaining life rather than social integration, i.e. the aim of institutions was to look after ill people and relieve physical deficit, hence the term handicap being used in this era.

The second generation of technological support can be estimated to have started around the middle of the twentieth century as was observable until approximately the second decade of the twenty first century. This era can be described as the era of disability assistance, i.e. disability as needing task assistance by able bodied people in mainstream institutions. In this era, mainstream institutions attempted a form of social integration of people with disabilities in their spaces, such as schools, universities, workplaces, museums, and theatres, with support being provided through tools such as assistive technologies such as manual Braillers, captions and speech to text/text to speech (Dowling 2013). Although it was still the aim of institutions in this era to overcome deficit as it integrated people with disabilities in mainstream institution but not in mainstream tasks, this era was observably more technologically focused and involved a mixture of mechanical & electrical devices. These technologies were also increasingly associated

with activities such as education and assisted living, and practices such as mobility, reading, writing, or listening (Wolf-Meyer 2020).

However, in this era the disability studies movement began to question traditional assistive technologies, arguing instead that assistive technologies represented some of the last and most powerful social barriers to educational inclusion of people with disabilities (Burke 2014). In addition, the academic topic of assistive technology was a sub-discipline of Computing and Information Systems (CIS) and was thus mechanically focused and controlled by people without disabilities.

Consequently, assistive technologies were often developed by attempting to guess the needs of people with disabilities, develop a technology that would address the presumed needs of people with disabilities and then test these devices for the first time with end users after development. Consequently, CIS professionals often stereotyped what it is like to have and assume silos for individual disabilities, such as learning disability or physical paraplegia (Burke 2014).

Furthermore, assistive technologies in this era were often immobile, awkward and limited movement in mainstream learning environments, i.e. spaces developed by and for what were considered to be mainstream students and members of staff. Subsequently, traditional assistive technologies were used in separate classrooms away from mainstream students and needed specialist training for usage and maintenance, and thus often defeated the purpose of integrating students with disabilities in mainstream schools. In addition, it was observed that assistive technologies were particularly expensive to manufacture or buy, as only small numbers of single technologies were made to fulfil demand, and thus their manufacture was typically uneconomical (Lancioni, Singh, et. al 2019).

The third-generation of technological support began around the beginning of second decade of the new millennium, or very approximately from 2010 onwards and can be termed the disability and inclusion era (Hayhoe 2020b). This era emphasised inclusion in mainstream tasks and not just mainstream environments, as the second-generation era had done, with the aim of providing a more abstract notion of inclusion based and a fuller concept of equality "for all," especially in cultural tasks. Thus, in this era inclusion was seen as becoming more practice focussed with a greater emphasis on technology than even the second era, with the emphasis being on adapting mainstream technologies to become inclusive. This access to mainstream technology by people with disabilities also increasingly became recognised through other aspects of the physical design of digital technologies and their apps or operating systems.

For example, companies such as Apple and Android changed the look of their interface, improved the sound quality created by software, improved the touchable properties, the size and weight of technologies to name but a few of these adaptations. In addition, as they were developing these technologies, they consulted widely with disability organisations, such as the American Foundation of the Blind (Hayhoe 2015).

This new use of mainstream technology as instruments of inclusion, or inclusive technologies, was thus defined as any form of mainstream technology, including PCs, laptops, tablets, or telephones which, with minimal amendments, could be used effectively by people with what are traditionally termed disabilities. These technologies had specific advantages over traditional assistive technology, such as: the use of mainstream technologies in this way rather than separate assistive technologies provided social inclusion, particularly in institutions such as schools and colleges; inclusive technologies increased communication and interaction by people with disabilities with peers and allowed greater presence in mainstream society; these inclusive

technologies were also less expensive and more ergonomically designed than separate assistive technologies (Ellis, Pitman, et. al 2021).

However, there were problems with this final, arguably present era that technologists and educationalist still are yet to address, for instance: these technologies still classify people according to individual impairments, such as physical, visual or hearing impairment, or learning disability; although people with disability use mainstream hardware they often use separate accessible apps and can be culturally insensitive; although aesthetic, fashionable aspects of inclusive technology has reduced the stigmatization of students with disabilities, pedagogy has been arguably slow to adapt and to incorporate all students in mainstream learning, particularly in classroom settings (Hayhoe, Roger, et. al. 2015); although cheaper than many traditional assistive technologies, the mainstream technologies that include the most advanced inclusive features and apps are amongst the most expensive technologies (Sanders 2022).

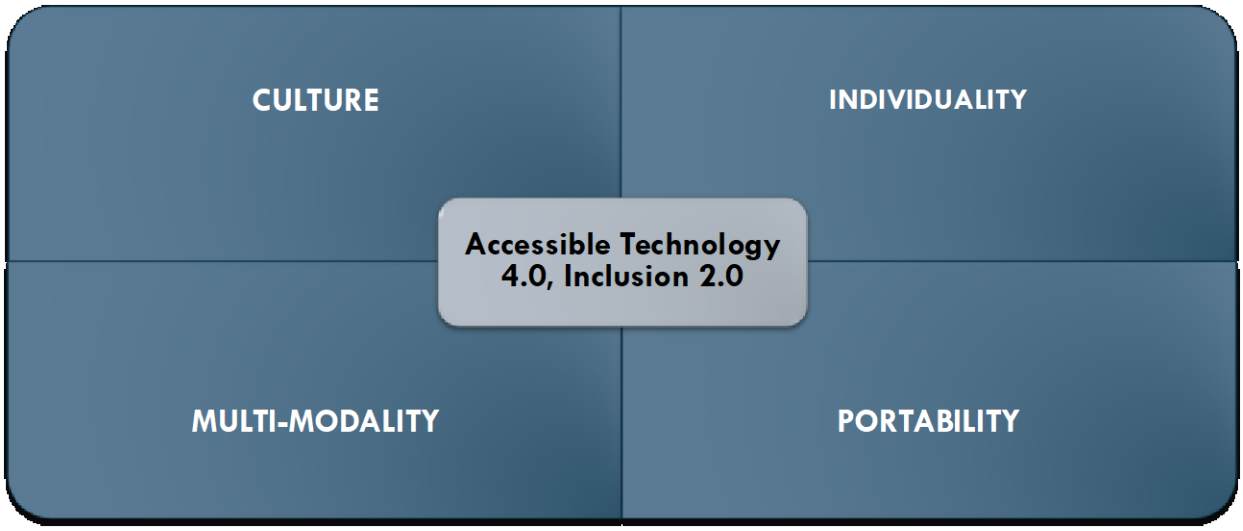
Consequently, what is now needed is a fourth generation, one which is developing what can be termed inclusion 2.0 or post-inclusive technology. This model needs to learn from the lessons of these previous three eras and promote inclusion by going beyond classification and examining the individual. This is discussed below as the Culture, Multi-Modality, Portability and Individualisation (CIMPo) model of technological support.

The Culture, Individualisation, Multi-Modality, Portability and (CIMPo) Model of Supporting SWANs Using Mobile Technologies

As stated above, in the early years of the twenty first century mobile technology became a powerful tool of inclusion, especially and has contributed significantly to a new form of learning that is termed Inclusive Mobile Learning (i-m Learning) in this article. However,

support remains inefficient and in need of further evolution, these elements are examined below as a part of the CIMPo model, which is illustrated in Figure 1, where the top two concepts (culture and individuality) can be said to be social issues, and the bottom two issues (multi-modality and portability) can be said to be physical technology issues.

Figure 1: the CIMPo Model of Culture, Individuality, Multi-Modality and Portability



Culture and Individuality

Although seemingly opposing concepts, culture should be seen within the context of individual wants and needs, and the individual should be seen within the culture of the supporting institution who also need to be sensitive to the culture of the diverse range of individuals they serve. As observed in the section on neurodiversity, education presumes a hypothetically normal student who reads and writes normally, thus the term learning difficulties has been associated with abnormality and lower learning ability through issues such as dyslexia, DS or autistic spectrum disorder. It has long been established that language matters and defines

capability (Miller 1966), thus people want to increasingly be identified as not having the label of learning disabled that they were forced to accept it in the past. Instead, people with what are traditionally called learning disabilities prefer to find a method of learning that suits them best and to be supported according to their support and access needs (Rix 2007). Students therefore prefer to focus on using mainstream mobile devices that means they are not separated from their peers culturally and socially (Zolyomi, Ross, et. al. 2018).

Future development of support also needs to understand that students increasingly want to own their learning, such as swapping tips about favoured or effective apps, training each other and discussing problems that each one encounters (Hayhoe, Roger et. al. 2015). This also means that pioneering the fourth generation of support will involve not only accepting the concept of neurodiversity and learning differences rather than a perceived learning deficit, it will also involve focussing on access needs and neurodiversity rather than redefining identities. This leads to the technological challenge that technology and education developers need to examine their cultural processes, especially the way they approach the production or use of learning and technology, making support person-centred not group-centred (Mirfin-Veitch, Jalota, Schmidt 2020).

Consequently, designers also need to just rely on universal design gained through a deep social and cultural understanding of people with access needs, developing participatory co-design with groups of people with a range of access needs who are stakeholders in the learning and technology, and that the targeted support management is designed to support in the educational environment (Garcia Carrizosa and Hayhoe 2019).

Multi-Modality and Portability

As this article discussed above, traditional models of learning have followed standard structures of communicating knowledge, usually through writing. Although third generation technologies included alternative forms of written communication, such as text-to-speech and zoom text, it is shown that cognitive processing does not rely on a single sense working independently, as it has been argued that the world does not present itself independent of language or personal memories (Kress 2007). It is also found that senses are reliant on each other for meaning, with vision even in the fully sighted being altered by surrounding sounds, touch and even smell and taste, this is a concept know as cross-modal attention (Hayhoe 2020a).

Thus, future technologies designed to support learning need to take advantage of all the senses and must not concentrate communication on a single mode of communication as traditional mainstream technologies tend to do even in their access settings (Hayhoe 2015). Instead, customisable multi-modal elements of the interface such as vision, sound, written and spoken descriptions and even tactile interfaces where available, need to be designed to interact with each other to stimulate a higher understanding of information and knowledge. To describe this in another way, information and knowledge needs to be understood as something that can be interpreted and understood in different ways and is not information because it is designed to be presented in a set way that is devoid of context.

The portability of all forms of technology, hardware, data, and software also needs to be considered completely in the design of education and the development of technologies. One of the most significant revolutions of the third-generation of support was the notion that technology was not fixed into a certain position or restricted to a certain environment, although it could perform most effectively in given environments. This allowed learning to come out of a

traditional teacher-facing-student model and allowed what are known as independent learning and so called flipped-classrooms to become popular (Awidi and Paynter 2019).

In addition, new advances in Artificial Intelligence (AI) and the Internet of Things (IoT) have suggested that a personal profile of an individual's access needs can be developed, and technologies automatically adapted to provide support for SWANs and other students alike. In addition, this profile can be made available to other mobile technologies without human interference so they can be setup automatically through a Digital Access Fingerprint (DAF) when a person enters an environment, rather than having to adapt each technology separately and manually. This will require something that has not been considered yet: a software protocol like IP addresses or URLs that relate to accessible features in digital technologies, with AI learning and then adapting multi-modal stimuli of perception and language (Hayhoe 2021).

There are admittedly dangers of this form of technological use and development. Data security will be paramount as an individual's access profile can act as a fingerprint used to manipulate or even blackmail users according to their needs. The misuse of legally collected and stored data can also lead to institutional biases and can be used nefariously by employers to project disability or deficit on employees with NHS, leading to discrimination and counterproductive acts of exclusion. However, if handled correctly and encrypted according to strict principles, then there is potential to gain far more from new technologies that are currently used by SWANs.

Conclusion

As this article has shown, the support of SWANs has developed over the past century, with what were traditionally considered to be disabilities being less often being regarded as deficit, and

people less often classified by a single impairment or physical or learning issue. In addition, people with disabilities are less often confined to separate environments or only given separate assistive technologies or seen as in need of help by those who are regarded as not having a disability. However, despite this social and cultural progress, traditions of inefficiently or unfairly supporting SWANs persist and, as technologies have provided a means of exclusion, it needs to be understood that they can also be the instruments of social and cultural inclusion given proper management. If used correctly, developed in conjunction with the stakeholders they seek to include and consider the task needs of their users rather than the traditional classifications their users are felt to belong to, technologies have the potential to transform learning culture for the social good. Thus, models such as CIMPo need to be considered in future learning support management and technological development, as without a coherent support strategy, those who support SWANs will fall back into the habits and negative cultural traditions of the past.

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