Framework for building capacity for assistive technology and alternative augmentative communication for children

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Contents

1. Introduction

1.1. The Need for an AT Capacity framework to address the needs of children

UNICEF has identified the need to establish an Assistive Technology (AT) capacity framework that addresses the needs of children throughout their life course and across settings (home, school and community) to help low- and middle-income countries to improve national AT provision and build functioning AT ecosystems. UNICEF recognises that the greatest impact on the lives of children is most likely when intervention takes place as early as possible. The framework responds to the need to support each country to set up assistive technology services that are accessible to children and capable of responding to identified needs in their specific contexts (Borg, et al., 2015).

1.2. The wider picture

The development of AT capacity focussed on the needs of children can't refrain from considering the wider picture of challenges related to disability and AT.

1.2.1. Defining Assistive Technology (AT)

There are many different definitions of Assistive Technology. Some focus on the products, others on the outcomes for the user.

The definition of assistive technology based on US Federal law is extremely broad. It includes "*any item, piece of equipment, or product system whether acquired commercially off the shelf, modified, or customised, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities*". The definition focuses on any kind of product that used by persons with disabilities can have an important impact on their autonomy and independence.

Regarding the nature of AT, the Assistive Technology Industry Association (ATIA) suggests that:
"*AT can be low-tech: communication boards made of cardboard or fuzzy felt.
AT can be high-tech: special-purpose computers.
AT can be hardware: prosthetics, mounting systems, and positioning devices.
AT can be computer hardware: special switches, keyboards, and pointing devices.
AT can be computer software: screen readers and communication programs.
AT can be inclusive or specialised learning materials and curriculum aids.
AT can be specialised curricular software.
AT can be much more—electronic devices, wheelchairs, walkers, braces, educational software, power lifts, pencil holders, eye-gaze and head trackers, and much more.*"

The definition expands the range of educational applications focusing on technologies "*used to increase, maintain, or improve the functional capabilities of persons with disabilities.*" Improving such capabilities is an obvious aim for those supporting the development of the child in formal, informal or non formal education.

The World Health Organisation (WHO) defines Assistive Technology as an umbrella term covering the systems and services related to the delivery of assistive products and services. The definition highlights that AT is not just about products, but also about services and systems able to deliver these products and services. This is extremely important as having access to appropriate AT is not automatic. Professional services and providers are needed that can support the user in defining the right AT solution that can be effectively used in an enabling environment.

1.2.2. Defining Augmentative and Alternative Communication (AAC)

The International Society for Augmentative and Alternative Communication (ISAAC) defines AAC on its website as "*a set of tools and strategies that an individual uses to solve everyday communicative challenges. Communication can take many forms such as: speech, a shared glance, text, gestures, facial expressions, touch, sign language, symbols, pictures, speech-generating devices, etc.*" It further highlights that everyone uses multiple forms of communication, based upon the context and our communication partner. It concludes by saying that "*the form is less important than the successful understanding of the message*"[1] When we consider AAC, high-tech devices could include computers, tablets, phones, electronic equipment, and software or apps. These need not be expensive. Low-tech devices are manually operated and might consist of simple communication books or cards. Even in these cases, increasingly, a high tech option is used to create low tech resources for a child.

1.2.3. Benefits of AT for children

The benefits of AT for children with disabilities are well described by Borg et.al. in the UNICEF discussion paper Assistive Technology for Children with Disabilities: Creating Opportunities for Education, Inclusion and Participation (2015). AT is life-changing for children with disabilities. It enables communication, mobility and self-care, helps build relationships with family and friends, and allows access to education, health, social services, and employment opportunities. For a child in a low- or middle-income country, access to AT can make a difference of $100,000 in lifetime income. Furthermore, research has suggested that investment in the provision of four assistive products- hearing aids, prostheses, eyeglasses, and wheelchairs – can result in a return on investment of 9:1 (ATScale, 2020). It is not unreasonable to suggest that the further use of technologies for early intervention that unlocks learning and potential have an equally significant impact.

1.2.4. Policy frameworks - Access to AT and AAC as a human right

The most important policy driver that fosters the provision of AT and AAC to persons with disabilities is the UN Convention on the Rights of Persons with Disabilities (CRPD)- adopted in 2006. Article 4 lists among the obligations of the signing state parties:

(g) To undertake or promote research and development of, and to promote the availability and use of new technologies, including information and communications technologies, mobility aids, devices and assistive technologies, suitable for persons with disabilities, giving priority to technologies at an affordable cost;

(h) To provide accessible information to persons with disabilities about mobility aids, devices and assistive technologies, including new technologies, as well as other forms of assistance, support services and facilities.

Article 7 of the Convention is on children with disabilities, and comma 3 reads:
States Parties shall ensure that children with disabilities have the right to express their views freely on all matters affecting them, their views being given due weight in accordance with their age and maturity, on an equal basis with other children, and to be provided with disability and age-appropriate assistance to realise that right.

The Convention on the Rights of the Child (CRC) – adopted in 1989 – spells out the rights that all children have, including children with disabilities. Some of these rights are particularly relevant to assistive technology such as the rights to the protection and care necessary for well-being and health, including rehabilitation. But also to develop to the fullest; to education; to freedom

[1] https://isaac-online.org/english/what-is-aac/

of expression; and to participate fully in family, cultural and social life. In Article 23, the CRC specifically recognizes the right of children with disabilities to special care and assistance, which should be provided free of charge whenever possible.

1.2.5. Increasing global attention

UNICEF highlights that globally, it is estimated that over 1 billion people need at least one form of AT. Still, over 90% do not have access to the AT they require. The UNICEF report on children with disabilities (2021) estimated 240 million children with disabilities globally and 10.8 million in Europe and Central Asia. Globally 1 in 10 children lack access to the assistive technology they require (UNICEF, 2021).

Over the last decade, there has been increased attention and support for the provision of assistive technology. Key events such as the Global Summits on Disability, the launch of the ATscale Partnership and AT2030, and ongoing initiatives driven by UN agencies, USAID and EU actions have increased awareness and available funding for action.

The World Health Assembly Resolution 71.8 (WHA71.8) urges Member States to:
(1) develop, implement and strengthen policies and programmes, as appropriate, to improve access to assistive technology within universal health and/or social services coverage;
(2) ensure that adequate and trained human resources for the provision and maintenance of assistive products are available at all levels of health and social service delivery;
(3) ensure that assistive technology users and their carers have access to the most appropriate assistive products and use them safely and effectively;
(4) where appropriate, based on national needs and context, develop a national list of priority assistive products that are affordable and cost-effective and meet minimum quality and safety standards, drawing on WHO's priority assistive products list;
(5) promote or invest in research, development, innovation and product design in order to make existing assistive products affordable; and to develop a new generation of products including high-end or advanced assistive technology, taking advantage of universal design and new evidence-based technologies, in partnership with academia, civil society organizations, in particular with persons with disabilities and older persons and their representative organizations, and the private sector, as appropriate;
[..]
(9) promote the inclusion of priority assistive products and inclusive barrier-free environments within emergency preparedness and response programmes.

UNICEF has joined these efforts as a member of ATscale and is jointly working with WHO on the GREAT report, APS and Procurement manual, details of which can be found at https://www.unicef.org/supply/press-releases/first-ever-global-guide-assistive-technology-improve-lives-millions

1.3. AT capacity frameworks

In scoping the framework to be produced, UNICEF highlights the challenges that people with disabilities, and in particular children, face in the European and Central Asia region in accessing quality and affordable AT. These seem to be similar to those reported worldwide: inadequate funding and lack of inclusion of AT in insurance schemes; fragmented procurement; weak national policy frameworks; complex distribution and logistics; limited-service delivery capacity; insufficient product and service standards for various contexts; an inadequate number of trained providers and appropriate products; and stigma and discrimination. This is coupled with the lack of awareness of available AT among users, potential users, professionals in health, education, social care, service providers, and country governments. A coordinated approach to overcoming identified barriers is needed to continue building and shaping an AT ecosystem. The framework produced seeks to address these key issues.

1.3.1. The limitations of existing frameworks for measuring capacity with children

Most frameworks for the provision of assistive technology are based upon assistive technology as a subset of health technology. As a result, they tend not to directly address the needs of children across the life cycle and particularly their learning needs and provision within educational settings. The rapid development of children as they grow is also not always accounted for, notably in the areas of physical development and, language and skills acquisition, cognitive and emotional development. In some countries with a well-developed system of AT provision, the use of technology to support education has a lengthy history, with computers in schools dating back to the 1980s. As a result, there is a certain availability of accessible Educational Technology (EdTech) and assistive technology for learning, even more than for some other domains.

As a result, in developing this framework, the international frameworks and experience from countries with well-developed AT provision for children and those with more limited resources will be considered. This approach will assist in ensuring the applicability of the framework to the widest range of settings, including low and medium-income countries.

1.3.2. Developing the framework

As suggested above, assistive technology, including technologies for communication, are a significant means of unlocking the potential for learning amongst children with disabilities. The evidence strongly suggests that any approach that is purely product-driven will have less impact than one which is embedded into "fertile territory" with confident teachers employing universal design principles in teaching and learning (Banes et al., 2020). The framework outlined allows us to consider the status of that territory or ecosystem, including both the process of implementing and providing AT and the environment within which it will be made available.

In preparing the framework, the authors were mindful of the key principles of the child rights-based approach that underpins the work of UNICEF. Hence the questions suggested and data collection required were designed to be in keeping with the core principles[2] of:

- Dignity
- Interdependence and indivisibility
- Best interests
- Participation
- Non-discrimination
- Transparency and accountability
- Life, survival and development

The framework was developed through desk research and validated by experts within the field. Other experts included those working within educational settings as well as those working in the wider area of assistive technology, including adult provision.

Desk research was undertaken to identify any relevant frameworks for developing the UNICEF model. Search terms included:

- Assistive Technology provision Framework
- Assistive Technology provision capacity
- Assistive Technology provision for children
- Assistive Technology policy
- Building capacity for assistive technology
- Assistive technology provision in education/schools

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[2] https://www.unicef.org.uk/child-friendly-cities/crba/

- Funding models for assistive technology
- RATA
- ATA-C
- WHO GATE
- 5 P's and children

The search terms generated areas for further investigation, such as abandonment and trends in emerging technologies that would influence AT Capacity.

Further recommendations of research and reports related to the key topics were suggested by experts working in policy and provision. Experts were also able to help identify other useful sources of related information that allowed the authors to expand search terms using Google Scholar to source materials.

Following delivery of the first draft, the authors invited feedback from the UNICEF team to refine and revise content and validate the links between the research and the data gathering tools.

This framework is accompanied by a toolkit to support data collection and capacity assessment.

2. Defining the Ecosystem

An ecosystem can be defined as a network of organizations, such as suppliers, distributors, customers, competitors, public bodies and agencies that seek to deliver a product or service through both competition and cooperation. At the centre of such an ecosystem is the person with a disability, the ultimate beneficiary or customer of the product or service. Each stakeholder impacts and is impacted upon the others. This creates a constantly evolving set of relationships in which each activity is flexible and adaptable, for all to thrive. Whilst different authors have made efforts to conceptualise this ecosystem for AT and AAC, they do have much in common.

2.1. The WHO's 5P's model

To provide a coherent framework to evaluate the status of AT capacity for children within a region or country, the widely used WHO GATE initiative structure referred to as the 5P's model can be considered as a starting point.

GATE, the Global Cooperation on Assistive Technology, is an initiative of the World Health Organisation (WHO) that seeks to assist Member States in improving access to assistive technology as a part of Universal Health Coverage. The GATE initiative focuses on five interlinked areas (5P's): people, policy, products, provision and personnel.

Figure 1. GATE's 5 key topics for building AT capacity: Policy, People, Provision, Products and Personnel

The 5 P's are described as below[3]:

People
A user-centred approach is critical to make sure that users' needs are addressed when developing policies and provision services. Services should not just be physically accessible but also culturally appropriate and tailored to users' needs. WHO not only promotes a user-centred approach but also works closely with users and user groups.

Policy
WHO seeks to support countries in developing national policy and programmes to ensure everyone, everywhere can access assistive products. These include an assistive technology assessment toolkit and guidance on financing mechanisms, such as health and welfare insurance programmes, to ensure sustainability of service provision and universal access. It will also include guidance on implementation of the Priority Assistive Products List, minimum standards, appropriate training and service provision.

Products
In May 2016, WHO launched the Priority Assistive Products List, which includes a list of a minimum of 50 products selected on the basis of widespread need and impact on people's lives. The Priority Assistive Products List encourages countries to develop a list of national priority products and is a guide to enhance production, procurement and service provision, develop reimbursement policies and shape markets. Future work will also relate to standards and procurement for priority assistive products.

Provision
WHO is developing guidance on innovative models of service provision, including good-practice examples from across the globe. Fundamental components include the integration of assistive products service provision into the health system and a network of specialist referral centres connected to the primary health care infrastructure. This would enable most people to access assistive products for all their functional needs from a single point and would support universal access and early intervention.

Personnel
WHO is developing an Assistive Products Training Package on the provision of a range of simple assistive products selected from the APL, including assessment and prescription, fitting and user training, follow-up, maintenance and repairs. The package will support countries in building the capacity of their community-level workforce.

This framework has underpinned the creation, and use of several data collection tools, including the rATA and ATA-C, used to measure capacity in many countries, including those with low and medium income status.

rATA, the "Rapid Assistive Technology Assessment" tool[4], was designed as a stand-alone tool for efficiently and rapidly assessing the need, use, supply and impact of AT in a population. Where required, the rATA can be incorporated in other surveys to allow further in-depth analyses or disaggregation of data concerning AT use by a broader set of characteristics.

The ATA-C tool (Assistive Technology Capacity Assessment)[5] is a system-level tool that can enable countries to better understand the current status of assistive technology and identify key actions to improve access. It can be used for:

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[3] https://www.who.int/news-room/feature-stories/detail/global-cooperation-on-assistive-technology-(gate)
[4] https://www.who.int/publications/i/item/WHO-MHP-HPS-ATM-2021.1
[5] https://apps.who.int/iris/handle/10665/343615

- Awareness-raising
- Policy and programme design
- Ongoing monitoring and evaluation

The 5P's also provide the basis of reports provided by the GATE initiative, including reports from the GREAT summit.

The use of the 5P's has been closely related to the priority assistive product list[6] developed by the GATE initiative. Whilst this provides a broad categorisation of essential products across life stages, it does not focus on the needs of children and education settings.

2.2. Other models and frameworks

Since the publication of the 5P's ecosystem model , further analysis has been undertaken of what constitutes a healthy ecosystem for AT. That ecosystem outlines the key areas of capacity upon which a framework can be built. The following are worth mentioning::

- **De Witte et al. (2018) "***Assistive technology provision: towards an international framework for assuring availability and accessibility of affordable, high-quality assistive technology"* offers a position paper describing the elements of an international framework for assistive technology provision that could guide the development of policies, systems and service delivery procedures across the world. It describes general requirements, quality criteria and possible approaches that may help to enhance the accessibility of affordable and high-quality assistive technology solutions.
- **WHO's Rehabilitation in Health systems: Guide for Action (2019)** was developed to assist countries to develop a comprehensive, coherent and beneficial strategic plan. The programme Guide for Action resource leads governments through a four-phase process of (1) situation assessment; (2) strategic planning; (3) development of monitoring, evaluation and review processes; and (4) implementation of the strategic plan. This process utilizes health system strengthening practices with a focus on rehabilitation. It is based on the definition of broad principles and sets of assessment tools to collect evidence. It outlines an example of what any framework for rapid assessment could look like as a form of self-assessment tool accompanied by reflections and possible strategies.
- **MacLachlan and Scherer's (2018)** *"Systems thinking for assistive technology: a commentary on the GREAT summit"* introduces an enhanced model based on 10 P's. Besides those identified by the WHO, also Promotion, Partnership, Pace, Procurement and Place are considered relevant domains.
- **Banes (2017**) offers an ecosystem model based on 8 areas for effective implementation of assistive technology based on a service delivery model for grassroots and frontline AT services.

2.3. Commonalities and key differences between ecosystem models

Each of the models stresses the importance of **systems thinking**. This refers to the integration and interdependency of each ecosystem element in addressing needs.

Any framework for gauging the capacity of systems to implement AT must recognise that provision comprises a series of links in a delivery chain. Where one of those links is weak or non-existent, the total system is weakened or may break down entirely. As a result, each framework provides a basis for developing a gap analysis of each link against effective practice. Recommendations can be made in each area to strengthen the overall ecosystem.

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[6] https://www.who.int/publications/i/item/priority-assistive-products-list

In understanding the extent to which the frameworks reflect a similar analysis and structure, it is possible to map the models against the 5 P's, as done in the table below. In some cases, the granularity of some of the issues from different models will help to inform the data gathering when related to support for children and learners.

WHO GATE 5 P's	De Witte et al.	Rehabilitation In Health	MacLachlan and Scherer	Banes
5P's and their overlap with other frameworks				
Policy	Eligibility and funding mechanisms Coordination	Integration into health services Role of insurance	Policy	Coordination/Policy Research and development
People	Information Systems User influence.	Service location	People	Awareness Information Assessment
Provision	Service delivery systems and models Infrastructure for maintenance and repair	Financial Resources Training	Provision	Provision Training Support Accessible Digital Content
Personnel	Professional services, advice and support Competence.	Availability of workforce	Personnel	Assessment Training Support
Products	Availability Affordability Quality	Funding	Products	Provision Development Support
Additional elements				
	Flexibility Efficiency		Promotion, Pace, Procurement, Place, Partnerships	Research and Development Accessible Digital Content

Whilst there is considerable consistency in the factors identified and a common agreement that systems thinking and an ecosystem approach of interrelated elements is at the heart of effective change in the availability of assistive technology and technology readiness, there are some additional factors that should be taken into account in evaluating the landscape for AT provision for children.

Of particular interest are pace, place and partnerships drawn from Maclachlan and Scherer (2019) and the importance of accessible digital content with research and development (Banes, 2017). These can be elaborated and applied to work with children as encompassing:

Pace
Pace is concerned with the speed at which change can take place. This is driven not only by a willingness to adopt change but also by the readiness and capacity of teachers to integrate both products and approaches into their practice and by the underlying economics, costs and benefits of the identified products and services.

Place
Place refers to the physical setting within which the technologies are used but is expanded to include societal infrastructure, government, policies, institutions and broad context. This allows for greater consideration of changing circumstances and leads to more resilient systems. With systems thinking, the focus is on the entire context, which for children includes both educational and non-education settings and the ecosystem at individual, classroom, school, district and national levels.

Partnerships
In a systems thinking model, partnerships are at the heart of the process. They link together the diversity of stakeholders and recognise the roles and value of each. In educational settings, this is likely to include not only the school and educators but might include therapists from health and social care, technologists engaged in the design and use of assistive technology and advocates for awareness and progress drawn from civil society. When each plays a role and are linked to one another, the system as a unit is stronger.

Accessible content
Inclusion in learning requires not only assistive technologies but also learning materials that address learning objectives and meet standards for accessibility. Evidence suggests that the initial procurement of accessible content offers a more cost-effective means of addressing the learning needs of all students than remediating content for individual learners.

Research and Development
A healthy ecosystem looks ahead and anticipates needs. In order to achieve this, a commitment to continuous improvement and investment in emerging technologies ensures that children have access to the most appropriate and effective tools.

2.4. Appropriateness and relevance to children

The Five P's developed by the WHO provide a validated starting point for any framework to measure assistive technology capacity within a country or region. However, some of the assumptions underpinning the WHO Framework may need to be reconsidered regarding provision for children, notably in developing AT capacity for education that promotes learning.

In this case, it is useful to consider the overarching goals of an AT ecosystem to ensure that all parts of the framework contribute to the overall goals to enhance **inclusive education, participation** and **quality of life** for children.

Below we have defined for each P of the five P's and the three additional ones described a specific performance indicators that relates to access to AT and AAC for children. This list of high level indicators can form the basis of any assessment of AT and AAC ecosystems.

People: The disabilities and educational needs of children are identified as early as possible, and provide the basis for allocation of support, including assistive and communication technologies, to achieve their full potential.

Policy: Policies are in place that guarantee that children with disabilities have access to appropriate assistive and communications technology to develop their full potential and for their inclusion and participation.

Products: A range of AT and AAC products are available that address the needs of children with a disability and are distributed across the country in a timely and cost-effective manner.

Provision: AT and AAC Provision systems offer effective supply and support of the technologies required by children with disabilities and are flexible, efficient, competent, and outcome-oriented.

Personnel: Professionals in Education, Health and Social Care have the skills, knowledge, attitudes and understanding to provide guidance and support needed to fully implement AT and AAC solutions into practice.

Pace: AT and AAC intervention is timely and adapts to the changing needs of the child.

Place: AT and AAC is provided taking into account the wider life experience of children with disabilities in different settings and circumstances.

Partnerships: AT and AAC provision and support is provided by an ecosystem in which adults in different roles work together for the best interest of the child.

However, it is important to understand the difference between the requirements for an ecosystem when applied to children and young people instead of adults, although AT provision for education should build upon and integrate with broader AT capacity for all.

Some of these variations include:

- **The needs of children change rapidly as they grow and develop.**
  As a consequence their AT and AAC needs change rapidly. Timely intervention is a key factor for keeping pace with the child's needs.
- **AT provision to children may fall under different laws and guidelines than for adults.**
  Most of the time this is a positive factor as the specific needs and best interests of children are likely taken into account. Nevertheless when laws segregate children with disabilities or foster institutionalisation their effect might be the opposite.
- **A wider network of professionals may be engaged with support to children.**
  The presence of well trained professionals that work for the best interest of the child is a positive factor, especially when intervention comes early and the whole family is supported.
- **Children are likely to demonstrate increased motivation for the use of digital technologies.**
  It is indeed the experience of many professionals that children are more likely to engage with digital devices than older adults. For children with disabilities this is not different, although barriers related to stigma might remain (Cranmer, 2019).
- **Access to learning is a key priority for AT provision.**
  AT ecosystems might prioritise supporting children in education as the potential impact is high.
- **AT provision may include provision to a school as well as to the individual.**
  In many countries AT is provided directly to the schools. There are risks related to this approach that should be carefully considered, in particular the readiness level of the school to work proficiently with the technology should be considered.

- **Accessible EdTech may address some or all access needs of children.**
  Increasingly technology is playing a part in the classroom experience of all children. Much of this will have access features integrated into the operating susyem or applications. These may provide the functionality that many children need to have access to educational content.
- **Children do not have the same life experience as adults.**
  Adults often bring long experience with technology, both that they have used and which they have seen others use. The insights that they have gleaned from this will contribute to making decisions about the technology they now require. Children have much less experience to draw upon and hence may be less able to contribute in the same manner to decisions.
- **Children will need a different learning curve in using AT and AAC.**
  With that limited experience, the learning curve for children will be quite different. They are less likely to have developed general ICT skills, and their physical, language and cognitive abilities will be continuing to develop. Hence the learning curve for children may require more foundational work to be completed in conjunction with learning to use AT.
- **Parents, families and carers are important partners in the provision of AT and AAC.**
  Compared to young adults with disabilities that can decide for themselves, the role of the families is of fundamental importance for the success of any AT adoption process of children. If the circle of informal caregivers is not the primary advocate for AT, professionals should support them in adopting a constructive, collaborative and encouraging attitude. Also siblings should be involved.

AT provision is best made within a framework of Universal Design for learning, including the availability of accessible educational content.

In seeking to understand the needs of children, it is useful to overlay the SETT framework for individual AT provision upon the 5 P's. The SETT framework (Zabala, 1995) identifies four areas for consideration in making provision.

The four areas are:

S - The identified needs and impairments of the child.
E - The context and setting within which the proposed solutions will be delivered.
T - The tasks that the child will undertake and be able to complete as a result of AT intervention.
T - The technologies and tools available for the provision and use by the child.

These issues must be addressed in shaping the framework under each of the 5 P's. As we gather data to inform our understanding of AT capacity, the SETT framework helps to ensure that both questions and responses are firmly grounded in experience and evidence and that the child remains in the centre while focussing on personal and environmental factors.

3.Defining aspects of a framework

Rohwerder (2018) investigates the provision of assistive technologies in low and medium-income countries. She suggests a series of **factors to consider** that have relevance when designing any framework for evaluating AT capacity and provision. These include:

3.1. Factors to consider

Access and needs
- Over one billion people need one or more assistive devices, with a projected two billion in need by 2050, yet only 5-15% of assistive technologies needs are currently met.
- People living in different countries or regions of a country, under different economic conditions, and people with different impairments, genders, ages, languages and cultures do not have equal access to assistive devices and services.
- Lack of access to assistive devices is due to high costs, limited availability, lack of awareness, lack of suitably trained personnel, lack of governance, and inadequate financing of assistive technologies.
- Providers of assistive technologies include government health services, international humanitarian aid, development, charity and religious organisations, and the private sector.
- Availability: The assistive technology industry is limited and mostly serves the requirements of high-income settings. The small scale local assistive technology producers and providers in low-income countries cannot meet the needs of all those who need assistive devices. Assistive technology services are also often in short supply.
- Challenges in ensuring a reliable supply of assistive products and their replacement parts due to a lack of policies, funding, logistics, research, or high customs and excise charges mean there is only a limited range of assistive devices available to a small number of users.
- Affordability: The cost of assistive devices can be unaffordable in low-income contexts. Indirect costs and the cost of maintenance can be additional challenges.
- Quality: Poor quality assistive devices can lead to secondary health complications and abandonment of the assistive device. Suitable assistive device service provision is essential to the success of any assistive device programme.
- Design: Assistive devices should be appropriate for the environment and individual characteristics of the user to ensure there is a demand for them, that they are used, and that they are safe.
- Design standards have been developed for many assistive devices.
- Awareness: Users and service providers are unaware of the range of available assistive devices and their benefits, limiting demand and incentives to supply.

Affordability and accessibility of assistive technology
- The market potential is huge for developing and producing the right assistive devices at an affordable cost.
- At a global level, efforts are being made to improve access to high-quality, affordable, assistive products through the Global Cooperation on Assistive Technology (GATE) and the WHO's Priority Assistive Products List
- UNICEF and WHO have worked together on a UNICEF Supply Division in collaboration with WHO have developed the Assistive Products Specifications (APS) and a Manual for

procurement of assistive technology. UNICEF is introducing 24 new assistive products and accessories into the Supply Catalogue-available for procurement to UNICEF offices, partners and government.

- WHO and UNICEF are also supporting governments in developing national assistive technology programmes.
- Taking a systems approach could help improve access to affordable assistive technologies.
- Actors could engage in market shaping to help reduce transaction costs and balance supplier and buyer risks.
- The eye health sector has several initiatives to improve access to affordable eyeglasses, including through school health programmes and optical shops, helped by the low cost and availability of glasses.
- Community-based approaches may be a way to enable underserved groups to access assistive technologies.
- Non-profit and faith-based organisations aim to increase the accessibility of assistive devices by distributing them to populations who could not afford them otherwise. However, this model has sustainability issues, which rely on donations.
- Partnerships of international governmental organisations, governments, NGOs, and the private sector may be a promising way of distributing assistive devices.
- Actors such as China have been rapidly accelerating their activity in assistive technology. This has expanded the availability of lower-cost products into emerging markets and offered a greater diversity of suppliers for procurement

These features and trends provide a useful backdrop to the framework's design and indicate areas of questioning for data collection. They also provide a set of statements for us to consider in making any analysis. The extent to which the statements are found to be true of a country or region can be a valuable part of the process of undertaking a gap analysis and then building recommendations and a roadmap.

Similarly, the AT2030: Assistive Technology Scoping Exercise (2018) undertaken by the GDI Hub suggested that whilst levels of Assistive Technology market development vary across countries, key issues are common. They categorised these into the five main categories related to supply and demand factors across the 5P's of People, Products, Provision, Personnel, and Policy.

People
- Need to measure impact
- Evidence is a key tool to promote investment, as well as to prioritise interventions.
- Stigma and discrimination
- Although discrimination and stigma are worse for some types of disabilities, they permeate all sectors of the disability community.
- User-centred design
- Products designed with users' participation are ultimately much better in meeting users' needs; they are used more and abandoned less.

Policy
- Lack of coordination
- Lack of coordination between parties responsible for the development and delivery of Assistive Technology results in decreased efficiency of many programmes, with increased cost and an uneven distribution of the Assistive Technology network across the territory.
- Policies without implementation

- Policies must be implemented and reviewed periodically.
- Legislation to facilitate rather than hinder
- Excessive bureaucracy can become a significant barrier to the development and delivery of Assistive Technology.
- Funding clarity
- A more effectively managed funding system is essential, which is clear and transparent for all parties involved.

Products
- Affordability, availability, and quality
- Affordability, both of the product and related service delivery, was mentioned by all stakeholders as critical to success.
- Standards needed
- The lack of globally accepted specifications and standards for Assistive Technology is a significant barrier to accessing effective and appropriate Assistive Technology.
- Need for a critical mass of innovation
- There is a need to open channels for collaborative innovation, as most Assistive Technology is designed, developed, and sold by large, private companies.

Provision
- Need for a sustainable approach
- Providing a person with Assistive Technology is not a "one-off" occurrence; rather, it is an end-to-end process, beginning with screening activities and encompassing assessment, selection, fitting, user training, follow-up, and maintenance. A sustainable systems approach is therefore essential.
- Fragmented services
- Fragmented, geographically distant service delivery may discourage and even prevent users from accessing services.
- Donor dependent supply
- Donor-dependent supply chains can have a detrimental effect on the continuity and effectiveness of Assistive Technology provision.
- Low demand, high cost
- Low demand for Assistive Technology and materials results in a much higher cost per unit. A globally coordinated effort to bulk purchase, combined with regional distribution hubs, may mitigate the problem.

Personnel
- Expanding current Assistive Technology workforce
- Assistive Technology service delivery models are dependent on the availability of highly qualified professional staff. Task shifting might be a potential solution.
- Harnessing the power of technology
- Mobile technology is a powerful tool in improving the capacity of personnel involved in Assistive Technology development and provision and being a mode of new Assistive Technology delivery.
- Continued development of the workforce
- There is a need for continued training. One-off training provides little opportunity for follow-up or to further expand knowledge.

Other
- Need for an accessible environment
- Access to Assistive Technology is not a sufficient condition for independence. An inaccessible environment can prevent or limit the use of Assistive Technology.

The statements made here can also help us to interpret the data gathered within the framework and suggest useful areas to study the data in undertaking future planning for provision.

3.2. Key principles for intervention

The AAATE/EASTIN position paper on AT service delivery systems defines criteria for the quality of AT service delivery processes. The quality of the service delivery process is vital for the success of the intervention. The six criteria are **accessibility, competence, coordination, efficiency, flexibility, and user influence**. (Andrich et al., 2012)

The paper also moves away from a device or product focussed approach to a more **holistic view** of responding to needs seeing **AT as part of a wider Assistive Solution**. In this model, it is a combination of assistive technologies with personal assistance and environmental adaptations that leads to greater access and inclusion. This is helpful to consider as it gives focus to the need to **integrate action at multiple levels** and for elements of provision to be mutually supportive. This has relevance to our consideration of provision for children as we should be conscious of the relationship between AT Capacity and the wider environment, including the status of Universal Design for Learning, the extent to which the built **environment is accessible** and **underlying attitudes** that facilitate or hinder the promotion of inclusive education. For this reason a multidisciplinary approach and interdisciplinary collaboration is recommended for assessment and support services providing independent advice (Hoogerwerf, 2002).

In establishing a common framework for evaluating AT capacity for children and in education, these features are useful to incorporate either as part of data collection or in undertaking analysis of that data and establishing strategies and actions for capacity building.

4. Refining the 5P model for children and educational settings

4.1. People

Here we are referring to the population that will become the users of the assistive technology products and services and AAC systems. Addressing their needs places them at the heart of any ecosystem.

4.1.1. Definitions of disability

The definition used for disability will be critical in determining eligibility for assistive technology. This is significantly impacted by the extent to which a medical model is applied to defining disability, as an impairment within the child, as opposed to a social model which focuses on the barriers inherent in the environment that mitigate against inclusion.

The UN Convention on the rights of people with a disability does not have a simplistic definition of disability. Instead, it suggests that disability is an "evolving concept" that "*results from the interaction between persons with impairments and attitudinal and environmental barriers that hinder their full and effective participation in society on an equal basis with others.*" Article 1 CRPD states that people with disabilities include:
"*those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others.*"

Whilst different models of disability have evolved, the two most influential models are the medical or functional model and the social model. The first focuses on capacity and rehabilitation, often describing disability as a result of a health condition, disease or trauma that disrupts personal functioning. The model tends to see disability as a condition that a person has and hence focuses on the prevention, treatment or curing of that condition. The related functional model also conceptualises disability as an impairment or deficit that is caused by physical, medical or cognitive deficits. The disability itself limits a person's functioning or the ability to perform functional activities.

However, the social model focuses on the barriers facing people with disabilities rather than on impairments and deficits. In this model, activities are limited not by the impairment but by the environment and barriers they encounter.

The social model is based upon the interaction between the child and their environment and seeks to promote participation and inclusion. The application of a Universal Design for Learning approach and the support of assistive technologies promotes access and participation in learning as a rights-based approach which emphasises the autonomy and agency of the child.

These distinctions are especially relevant to any discussion of provision for children within the education system. In most countries, the greatest number of learners in need of support is likely to be those with cognitive impairment or developmental delay. The disabilities, as a result, are often hidden, and identification may well take place within the education system rather than through health services.

4.1.2. Assessing demographics, age and Incidence within a social model

Corradi, Scherer, and Lo Presti (2012) point out that although the ICF was not specifically developed to guide the provision of assistive technologies, the literature shows that it lends itself as a descriptive model for the evaluation process. Furthermore, the ICF can capture the complex aspects of the impact of AT, and it can assist the professional in decision making (Bernd et al., 2009). In many cases, assessment processes based on the ICF assist professionals in understanding the intended individual's needs and prioritising goals for intervention. In these cases, the core focus is driven by a health-based model, where assistive technologies are subject to "prescription" by a professional. When considering a framework for children in education, the WHO definition of AT as any device or system that enables a person to perform a task that would otherwise be too difficult to execute (WHO 2004) will have to be broadly applied and must address the functioning, participation and learning needs of the child. In applying a social model of disability, our assessment of needs will need to be holistic in nature, recognising the breadth of influences, including environmental factors as well as social attitudes that create barriers to participation.

Smith et al. (2021), in considering how to gauge levels of AT demand across the whole population, suggest a need for consistent AT indicators and an understanding of assessment approaches to improve supply and demand data. These have the potential to inform investments and innovations for market-shapers, including those for children. Within our context of children and schools, these include:

- Standardised indicators should be used to compare results across educational and daily life. The most relevant and comprehensive measures should be reported.
- Agreed methods for measuring indicators with children should be used to collect more systematic and comparable data on impairment, functioning, and indicators. Rapid assessment tools should ensure that indicators are well-integrated as viable, convenient options for improving data collection.
- An indicator of essential services for children and education should be included. The absence of such services will impact AT use and related demand and influence supply decisions. Indicators will be more comprehensive where the need and coverage of associated services are also evaluated.
- Data generated through the supply process should be well-defined and collected at each stage to help evaluate the chain evaluation and facilitate the identification of bottlenecks that limit provision.

4.1.3. Changing user expectations of technology

In addition to a desire for portability, expectations of customer services, ease of access and value for money are changing, influenced by the experience of on-demand entertainment and services where content is driven by ease of use and on-demand delivery. The integration of technology into daily life is more pervasive than ever before. As the functionality used by people with a disability is more fully integrated into and onto portable and mobile devices, the solutions will be less apparent and more widely available to all.

The use of such mobile devices is driven by the widespread availability of social media platforms, and connecting with other people who have similar needs is easy, regardless of location. This brings about greater peer and professional support for AT when and where needed.

4.1.4. Awareness and information

DeWitte et al. (2018) note that people must know of the existence to benefit from any AT. This implies that information systems are crucial to the AT provision system. Information should be available to end-users as well as to professionals. Effective awareness-raising is challenging, and information provision is an ongoing process rather than a one-off action. The number of assistive products and related services is large and continues to grow due to developments in technology. The challenge is to provide information about the existence of assistive products alongside their quality, usability, effectiveness and availability. Where possible, such information should be neutral and independent of any vested interests, based firmly on user experiences.

4.1.5. Matching user needs to tools and technologies - self determination

With adults, we are seeing a growth in people with disabilities being active in determining the assistive technologies they wish to use. This concept is reflected in the NDIS system in place in Australia and the proposed AT Passport for Ireland. Increasingly databases and AI-driven matching tools appear on the market to assist adults in making informed decisions. Such systems include Databases such as the EASTIN network, and ATvisor developed in Israel.

In most cases, children and young people are not given the same opportunity and responsibility to make choices related to their AT needs. However, some exceptions, such as the voting system for selecting AAC symbol sets developed by Global Symbols, are providing children with a much greater opportunity to influence and shape the assistive technology and AAC solutions that are available to them. However, even if many cases, children cannot choose and determine the specific AT they want, their active engagement in the selection process is highly recommended. Research into the abandonment of AT and AAC systems suggests that abandonment rates are much lower, where children are active partners in the selection process.

4.1.6. Culture and context

Culture has a significant influence on the way disability and independence are perceived. Assistive technology provision within the UNCRPD moves the agenda from a medical via a social to a rights-based model. Countries are in different stages of their perception of disability, levels of stigma and discrimination and their readiness to invest in children with disabilities. This is not a judgement on the intrinsic values held by a community but only on its perception of the rights of individuals to equal opportunities and access.

4.1.7. Key areas for questions

- At what age and how are children with disabilities identified?
- What is the incidence of disability for each age group?
- How many children with disabilities live with their families, and how many live in institutions?
- How are children with disabilities perceived by their parents, society, and educational professionals?
- What is the impact of cultural values on parents' expectations of their children?
- How are their needs identified and assessed?
- How are communication/AAC needs identified?
- What are "critical moments" (decision points) in the life of a child with a disability, such as formal identification?
- How many children with each form of disability are in the educational system?
- How many children with a disability are educated in mainstream settings?
- How many children with a disability are educated in specialist settings?
- How many children with a disability are "out of school"?

4.2. Policy

4.2.1. Aspects of policy

Policy refers to the framework of law, guidance and programmes that shape Assistive Technology and AAC provision usually driven by government and public bodies. Well formed policy will co-ordnate the actiosn taken to deliver assistive technology and AAC into the hands of those that need them.

Understanding the policy landscape for the provision of AT products and services requires a careful review of law and official guidance at different levels. In outlining a framework to review policy related to AT Capacity, we are conscious that policy may be derived from a range of sources. These may include:

- National or Federal Government Policy on Disability, Education, Health, Welfare and Family affairs, social inclusion, diversity, others
- Ministry of Health Assistive Technology policy that relates to provision to children
- Local or regional Government policy on disability, education and social inclusion
- Ministries of Justice
- Equal Rights legislation
- Guidance and initiatives from Ministries of education
- Local Education Authorities or regional boards
- International law and conventions
- Policy and guidance from ministries responsible for disability, health, rehabilitation, education, social development or welfare

In any single country, one or many of these sources may be relevant. In designing and implementing a framework to measure AT capacity, it will be important to carefully define the relevant authorities and seek the policy and guidance issued by each.

Also non specific AT focused policies are relevant to consider for their enabling role. This include for example deinstitutionalisation policies and early childhood intervention policies that in some countries are currently high on the agenda.

The Agora project of the European Association on Early Childhood Intervention (EurlyAid) and the European Association of Service Providers to Persons with Disabilities (EASPD) demonstrated the importance of Early Childhood Intervention (EIC) and its impact. Research on ECI (Carvalho, 2016) support that the use of family-centred practices within each child and family's natural environment are evidence-based, up-to date, and the recommended way to provide effective early childhood intervention services. In the project 15 service providers from Bulgaria, Hungary, Poland and Slovakia markedly improved their practices and the services they delivered to children and their families. Positive findings were reported both by professionals and families. For countries to adopt ECI policies and strategies it will be necessary to maintain a continuing investment in professional development through reflective supervision and professional training (Fričová, 2021 & Naso, 2020).

DeWitte et al. (2018) identify the importance of defining eligibility and funding mechanisms within policy. They note that many people with disability who would benefit from AT do not have the means to pay for it themselves. Without clarity of funding and eligibility, significant risks will emerge that prevent the uptake of potential products by those with disabilities. This is particularly true in low- and middle-income countries but also in high-income countries in the provision of expensive and complex products.

In most cases, there will be a need for some financial support. However, according to the WHO and USAID Joint Paper (2005), about one-third of the countries surveyed had not allocated financial resources for developing and providing assistive products or associated services. In countries with an allocated budget, the financing policies may vary from covering the full cost of AT to partial costs of a limited list of assistive products. In some countries, having a personal budget or a voucher system that gives users a choice within a specified price and/or assistive product range is possible. In undertaking the collection of data, it will be useful to review the extent of a shared understanding of these issues across different stakeholders.

Policy should seek to determine who is eligible for obtaining AT and the range and extent of related funding. This is a complex issue, and in many cases, countries rely on medical definitions and diagnosis to determine eligibility rather than a rights-based approach that seeks to reduce barriers, including barriers to learning and enhance the autonomy and agency of the child.

Developing eligibility models that start from a functioning perspective and assess needs for participation, and consider the aspirations and setting of a person with a disability suggests a challenge to be addressed in seeking to improve AT provision and promote inclusion. Some aspects of the ICF framework can be used to shape some aspects of the model, and tools have been developed to assist. But no single tool or approach has been adopted and validated. The development of such a model could help nations to distribute resources in a fair and equitable way to those who need them most, with impact, irrespective of the chosen funding mechanism.

Other issues requiring data that emerge when reviewing policy within any country or region include:

- What are the levels of responsibility, such as delegation of responsibility for policy to regional government?
- How is AT for children and schools linked to wider availability across life stages?
- What distinctions are made in legislation based on the type of disability (such as physical, cognitive, sensory etc.?)
- What support is made for Inclusive Education vs special education vs institutionalisation?
- What support is provided for the full implementation of the rights of all children, including those with disabilities?
- What specific legislation is in place to support families and children with disabilities?
- What reference can be found to age and context related support services, including early intervention strategies and AT-provision systems?
- Which policies exist to foster independence in education and daily life?
- Which policies exist to foster an individual approach to children with disabilities in rehabilitation and education?

It will be important to consider the extent to which policy that influences provision for people with a disability is explicitly stated within a national framework or is implicit within broader inclusion policy or anti-discrimination laws and whether all disabilities are treated equally.

4.2.2. Key areas for questions

- Is the country a signatory to the UNCRPD?
- What policy at the national or regional level defines the rights of children with a disability?
- What policy at the national or regional level defines the rights of all children with a disability to have access to Assistive technology across the lifecycle and in different settings?

- What is the policy related to the education of children with disabilities?
- Does the policy for education explicitly refer to an inclusive model?
- Does the policy for education explicitly refer to the provision of assistive technology to support learning?
- What explicit reference to AAC provision is made for children?
- What implied reference to addressing AAC needs is made in policy and guidance?
- How is funding allocated for assistive technology within public policy?
- What criteria of eligibility are stated in public policy?

4.3. Products

Products include both technologies and systems that are designed specifically to address the needs of those with disabilities, and the features and functions of mainstream products that benefit those with disabilities. Porducts will include those that enable the child across all apsets of their lives and those that are mpre specific to facilitating learning.

4.3.1. Availability and affordability

Any analysis of the availability of a range of products will need to consider the wide variety of available products. DeWitte et al. (2018) note that the availability of affordable, high-quality assistive products and services is a significant issue to consider. The market for assistive products is characterised by relatively small companies, mostly with a national or regional scope. Exceptions are in the fields of wheelchairs, prosthetics and orthotics. Still, the numbers of products sold are insufficient to reach economies of scale to reduce production costs and lower prices. As a result, most assistive products are expensive. The consequence is that, even in high-income countries, many assistive products are only available to those who can afford to buy them privately rather than through a public provision system.

These assistive products are simply out of reach for low- and middle-income countries. Although everyday ubiquitous technologies like smartphones and tablet computers are becoming more easily available and affordable, and these technologies increasingly offer assistive solutions, the majority of the existing products are not within reach for the majority of the people with disabilities.

The availability and affordability of assistive products can be stimulated by challenging companies to produce and sell high-quality products from the WHO Priority Assistive Products List (APL) at affordable prices and encouraging research into new production techniques, including local production of proven technologies. UNICEF has also been engaged in this activity to assist countries in procuring resources for a high quality that are affordable. In recent years this has been expanded to include aspects of assistive technology.[7]

In a study of the provision of assistive technologies for literacy in low and medium-income countries, Banes et al. identified that in many cases, the cost of products used in pilot studies and the assumptions around skills and knowledge in the workforce were powerful determinants of the likely capacity of a country to replicate any pilot action into a wider population. In most cases reviewed, the costs of both the products and the training required meant that there was little likelihood of replication. (Banes et al., 2020)

An important development is those mainstream technologies, notably smartphones and tablet computers, that offer features that function as assistive products. This has opened a whole new market of apps and other digital products developed for specific populations of people

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[7] https://www.unicef.org/innovation/disability-friendly-supplies

with disability. Examples include navigation support apps for persons who are visually impaired, speech-operated environmental control systems that run on a smartphone, and augmentative and alternative communication (AAC) apps. These applications have the potential to become available to large user groups at very low prices, although buying mainstream technologies is often not within reach of people with disability.

The use of mainstream technologies as a generic platform for specific assistive products and services should be strongly encouraged. A particular area that deserves attention is that of self-provision. People often develop assistive products themselves with very simple and cheap means. Such products can be very effective. It would be worthwhile to disseminate information about such affordable solutions and develop guidelines/tips for making them.

4.3.2. Diversity of technologies

Procurement will need to accommodate both mainstream/consumer technologies and products designed specifically for children with disabilities. Mainstream technologies such as phones, tablets, computers, and smart speakers can provide the basis upon which specialist technologies can be added or may have many integrated features that facilitate access and mitigate barriers to inclusion. These are in addition to traditional products such as mobility, care or health products.

Mainstream Consumer Technology: These technologies, such as digital television, are designed for the widest population and may include no specific features to facilitate their ease of use by a person with a disability. Television may not enable access to captions for hearing loss or audio descriptions for the blind, but the large screen and control may work well for some people with some forms of disability. Feature phones may be examples of such technology with relevance to our discussion.

Accessible Technologies: Accessible technology includes products, equipment, and systems that can be customised and provide persons with disabilities access to all services and content therein. Some examples might include smartphones with integrated speech-to-text that can be used for dictation or creating captions. Such devices are widely used, and the features may benefit any user of the equipment and are designed to be used with minimal effort to meet the needs of a wide population. Most especially, any framework will need to consider the availability of accessible EdTech within the ecosystem.

Assistive Technologies: "Assistive Technology" refers to products, equipment, and systems that enhance learning, working, and daily living specifically to address the needs of persons with disabilities. Many assistive technologies are unlikely to be required for most people in the population. Such technologies can include screen readers, braille output, connections to hearing aids and alternative access technologies for those with a physical disability, including pointing devices or switch access. The World Health Organization's 2016 priority list of assistive products includes devices such as braille notetakers.

Much of the functionality of what is described as assistive technology can now be delivered through the integrated features or additional apps on a smartphone or similar device.

Kintsch and DePaula (2002) note that "*with over 1,000 assistive technology products coming to market each year, the task of figuring out what is the best tool for a particular goal and functional limitation can be overwhelming*." Consideration of all stakeholders, particularly the user, throughout the adoption process is crucial. During the design phase, designers must be aware of the two users for whom they are developing. They should hold a deep understanding of the functional limitations of their customers, but they must also realise that caregivers may become designers of the product for the user. These caregivers are not necessarily skilled in the field.

Low tech vs high tech

In shaping a framework for assistive technology for children and to support education, we recognise that tools and technologies can take different forms. A low-tech solution may be the most appropriate option as it is affordable, easy to adapt or personalise, and often less likely to be lost or damaged. In other cases, electronic or digital technologies may be more appropriate. This is perhaps best illustrated with the example of technology for learners with low vision. Broadly three options are available

- Handheld glass magnifying lens
- Dedicated electronic magnifier
- A digital magnifier installed on a phone or tablet

In determining the most appropriate product for a specific child or setting, a range of factors will be considered. Hence we do not judge which product is most suitable for procurement within the framework, but that capacity exists to procure whichever of these products is the best fit for the child and the setting in which they live and learn.

4.3.3. Economy of scale vs individual needs

It will be important to recognise that products can be implemented in different ways when selecting products and making provision. Some technologies are implemented on behalf of one child as an individual. For instance, the availability of an AAC system will be made available to one child and individualised for their needs, including vocabulary. However, other products may be implemented for whole populations and hence a very low unit cost per child. For instance, immersive reader in Microsoft office is integrated into the Office Suite and available to all learners. It, therefore, provides an extremely low-cost way of offering first intervention to those with reading and writing needs.

4.3.4. Responding to AT trends

Assistive and accessible technologies evolve, and innovation has an impact. The critical need for a common platform to build upon and encompass innovation becomes vital. Some of the relevant emerging trends in AT include the growth of

- Use of mobile devices across all parts of daily life.
- A sharing economy and open licensing
- Remote/online support
- Wearable technology
- The Internet of Things and location-based services
- Disruptive models of service delivery.

The disruption of service delivery models has been accelerated by the period of the Covid-19 Pandemic. But even prior to this, there was a growing recognition of the need for change to address the scale of demand for products globally. This need has led to greater use of digital technologies in the design of products and, moreover to the related services. For instance, there has been considerable investment in the use of artificial intelligence-driven tools to match technologies to people to reduce the need for intensive services where these are not required. Similarly, digital approaches to training and support, using conferencing and collaboration tools, have provided a means to reach a greater of people with needs without the additional costs of travel or co-location.

Studying the products element of the framework, we should consider how new and emerging technologies can be readily incorporated into provision and procurement to enhance ease of access and address long-standing barriers.

4.3.5. Key areas for questions

- Which assistive technology and AAC products are available for children in schools and at home (define products/categories)?
- What access features are identified for use in EdTech products?
- How is accessibility weighted in the procurement of EdTech?
- How is AT/AAC procured for use by individual children?
- Who are the key vendors for each product category?
- How many vendors are national vs International?
- What is the policy related to the use of open-source assistive technology?
- What post-sales support is required for products?
- What training is available on AT/AAC products?
- What warranties are required of AT/AAC products?
- Who is responsible for the research and development of new products?

4.4. Provision

In our context, provision describes the process by which children and young people obtain the assistive technologies they require. Provision includes funding mechanisms but also the ways in which the most suitable technology is made available and supported.

4.4.1. School-based models and home-based

Provision models may be categorised in multiple ways. However, one important distinction that the funding process may drive is between systems that are initiated and focused upon the school and those founded upon the home and family.

School-based provision models tend to focus on providing those assistive technologies that enhance and facilitate learning. These might include screen readers for the blind or reading support for those with print impairments such as Dyslexia. Some school-based models only provide equipment for use in school, equipping the school to accommodate needs. Such equipment may be used at home for learning but cannot be transported in some cases.

Home-based models tend to address needs across all aspects of daily life and encompass wheelchairs, care aids and support for independent living. Equipment provided may be installed at home, such as grab bars in the bathroom, but others will follow the user, such as a wheelchair. In these cases, some of the equipment, wheelchairs, hearing aids, and self-help aids are likely to be available in school, even if not funded and provided explicitly for that purpose.

As we consider the different forms of provision, we should recognise that an individual child may benefit from funding based on very different criteria and drawn from more than one source, which might make it very complicated to navigate for parents or other caregivers.

However, it is worth summarising some of the key principles that should be applied in evaluating provision models and practice.

Zabala (1992) summarised some of the key principles for provision for children as being related to the primary goal of assistive technology provision to enhance capabilities and remove barriers to performance. She further notes that when guiding provision, we should be conscious that:-

- Assistive technology can be a barrier.
- Assistive technology may be applicable to all disability groups and in all phases of education.
- Assistive technology is related to function rather than to a specific disability.
- The least complex intervention needed to remove barriers to performance should be a first consideration.
- Assessment and intervention form a continuous, dynamic process.
- Systematic problem analysis and solving are essential.
- Assistive technology does not eliminate the need for instruction in social and academic skills.
- A team approach is required.

Within any setting, the impact of each of these can vary, but they provide a useful framework when thinking about provision and the data gathered

In addition, Andrich et al. (2019) suggest that a provision process usually consists of seven steps that can be recognised in most existing service delivery systems: 1) initiative; 2) assessment; 3) solution; 4) products; 5) authorisation; 6) implementation; 7) management. However, they continue by suggesting that a series of criteria can be applied to this process as principles of a quality framework. These criteria include judgements about the accessibility of the process, the competence of those involved in the process, how the process is coordinated, the efficiency and flexibility of the process, the involvement of the user and the quality of infrastructure. These criteria provide a further lens to interrogate the data gathered from our framework.

4.4.2. AT Adoption and children

Successful provision of assistive technologies can be validated through a review of the extent of medium to long-term adoption and ongoing use of technologies. Kintsch and DePaula (2002) suggest that an adoption process be navigated before success can be assured. This process involves developing assistive technology, assessing needs, aspirations, and available devices, training, customising the tool, and facilitating its use in daily life.

Of fundamental importance is the role of the family that needs to be involved in all stages of AT needs assessment and provision. The family might have different attitudes, ranging from those that proactively trigger the demand for AT to those that have difficulties in accepting AT (and very often the disability of the child.) Early Childhood Interventions will help parents to look at their children with different eyes which will facilitate the acceptance of AT and AAC interventions.

Failure in any one of these areas, particularly in failing to respect the user's aspirations and preferences as well as that of the formal and informal caregivers, can lead to abandonment. Understanding the adoption process and supporting implementation is vital in ensuring that provision has the desired impact. In schools, it is equally essential to understand the role that teachers and other professionals play in ensuring such adoption.

Recurring features of abandoned technology often relate to the lack of involvement in the choice of assistive technology by the user. Whilst abandonment of assistive technology tools is often considered undesirable, it is not always the case. Abandonment can be a positive event where a user no longer needs the device, such as having recovered from trauma or accident. Equally, and especially in the case of children, they may still experience a functional limitation but have outgrown a specific device.

Children develop rapidly and can soon move towards needing a more complex device, especially in the field of AAC, that will enable them to do more. While much abandonment occurs for negative reasons, an understanding of context and recording that context is especially relevant to assistive technologies for children.

4.4.3. Funding models and models of procurement and distribution

Models of procurement and funding for Assistive technologies vary significantly from country to country. In a recent study by the Mobile Manufacturers Forum (in print) on the provision of assistive technologies, a range of funding models were identified. These included:

- Domain-Specific Funding (education/health/social development etc.)
- Direct payments to the family, either reimbursements of expenses or vouchers
- Public and Private Insurance schemes (usually, children are dependents of the parents)
- Not for profit and charitable funding (including charitable funding specific to children)
- Private funding (funding by friends and families or sponsorships from companies)
- Refurbished and reuse models (including second-hand sales)

To understand the capacity of systems to pay for the assistive technologies required, there will be a need to understand the interplay and extent of each model. Community support for assistive products for children has historically been much greater than for adults, with local fundraising and donations helping to fill gaps in public funding sources.

Most countries or regions have evolved a form of mixed funding, which may be complex and confusing to the end-user. The lack of clear criteria for provision can be a significant barrier. In the case of children with disabilities, this can be enhanced as different institutions can be involved that do not necessarily collaborate.

Procurement has to engage with various stakeholders to ensure the availability of products and specialist services. There is a range of providers of AT products and services to consider. These include:

- AT Companies
- Developers of Open source and Free Assistive Technologies
- AT Centres and Services, many of which provide assessment, training and customisation
- Providers of both Hardware and software solutions
- Sellers of mainstream technology (tablets, PCs, smartphones, etc.)

4.4.4. Breadth of technology provision required and availability

There is a wide range of assistive and accessible technology options available for both AT and AAC provision. Only through an analysis of both historical and anticipated demand by those responsible for provision can we understand the range of products required to facilitate access and inclusion in education.

Having determined the current and immediate levels of demand for products and services, it is then possible to consider whether there is sufficient availability and diversity of the necessary products to meet that demand.

4.4.5. Key areas for questions

- Who is responsible for the provision of AAC/assistive technology for children?
- How is information about current and future demand gathered?
- Which products are approved for funding for children?
- Are processes for the identification of assistive technology/AAC needs in place?
- Are there independent AT services in place?
- How are parents and other family members involved?
- How is assistive technology/AAC procured for use by Children?

- How is assistive technology/AAC distributed for use by children?
- Who funds assistive technology/AAC for use in schools?
- Who funds assistive technology/AAC for use at home?
- What is the annual expenditure on assistive technology/AAC for school or home?
- Who are the key vendors for each type of assistive technology/AAC?
- How are new and emerging technologies incorporated into provision?
- How are accessible education materials made available for learning?
- Are products available to support user language and cultural needs?

4.5. Personnel (teachers, therapists, AT professionals, parents and carers)

In our context, personnel refers to all professionals and carers who are involved in the identification and implementation of AT and AAC products and services. A key principle is that they will have the skills, knowledge and competencies required to do so with high standards and confidence.

Kintsch and DePaula (2012) suggested a framework for the components involved in the successful adoption of assistive technology. They observed that the informed and active participation of all participants to varying degrees throughout the adoption process is essential. Adoption involves a collaborative interaction among four groups:
- The user
- Persons around him/her who support and interact with him/her on a daily basis, including families members, friends, educators, teachers, therapists, doctors, and employers
- Assistive technology specialists who have knowledge of many tools and who facilitate a collaborative decision-making process
- Developers of assistive tools

Hence the quality of personnel is at the heart of service delivery to support the effective implementation of assistive and accessible technologies. One broad definition of service delivery is provided by the United States Assistive Technology Act (United States Congress, 2004), which seeks to clarify the general term "service delivery" by referring to "assistive technology service". The act specifies the variety and nature of the services provided by an AT service, listing seven different services :

- Services delivering the evaluation of the assistive technology needs of an individual with a disability, including a functional evaluation of the impact of the provision of appropriate assistive technology and appropriate services to the individual in the customary environment of the individual.
- Services consisting of purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by individuals with Disabilities.
- Services consisting of selecting, designing, fitting, customising, adapting, applying, maintaining, repairing, replacing, or donating assistive technology devices.
- Coordination and use of necessary therapies, interventions, or services with assistive technology devices, such as therapies, interventions, or services associated with education and rehabilitation plans and programs.
- Training or technical assistance for an individual with a disability or, where appropriate, the family members, guardians, advocates, or authorised representatives of such an individual.
- Training or technical assistance for professionals (including individuals providing education and rehabilitation services and entities that manufacture or sell assistive technology devices), employers, providers of employment and training services, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of individuals with disabilities.

- Services consisting of expanding the availability of access to technology, including electronic and information technology, to individuals with disabilities" (United States Congress, 2004, p. n. a.).

The diversity of possible assistive technology services will need to be incorporated into any data gathering and analysis of the capacity of personnel to deliver an effective implementation of AT and AAC.

In the case of delivering AT services to children, specific attention must be paid to the factors that are directly related to the child's condition and the purpose of the use of AT and AAC. These would include early intervention and community-based services specific to children

Building such AT and AAC services will require a skilled and knowledgeable workforce with a grounded understanding of the use of assistive technology for children and in the classroom.

4.5.1. Development of staff skills and capacity

An understanding of the breadth of knowledge required within the workforce is suggested in the list below outlined by Root-Elledge and Bowser (2014). It suggests how an effective ecosystem/infrastructure would present itself at the school level and be realised at a professional level. In seeking to gather information about teachers' capacity to use and implement assistive technology in the classroom, it provides some useful indicators.

General assistive technology Knowledge
Indicator
- I know what AT is.
- I understand how AT can benefit students with disabilities.
- I know about the legal requirements to provide AT for students with disabilities.
- I know how AT services are defined.
- I know the implications of local, state, and federal AT rules and regulations.
- During every IEP meeting for my students, the team considers the child's need for AT.
- I can describe student achievements that result from AT use.
- I can identify at least one new AT topic I would like to know more about.
- I know and use at least three sources of information about AT (websites, blogs, electronic lists, journals, etc.).
- I know where to find in-person and just-in-time training about AT.

Assistive Technology Process Skills
Indicator
- I have the necessary level of understanding of AT to fulfil my role as an IEP team member in considering the need for AT.
- I know how to use information about the Student, Environment, Tasks and Tools to implement an AT assessment.
- I know how my agency wants me to respond to a parent's request for AT.
- I know how to implement a trial period if I believe that a student needs AT.
- I know who to contact when I need additional assistance with AT questions.
- I know how to use data in making AT decisions.
- I know how to include AT in IEPs.
- When disagreements or conflicts arise over a student's need for AT, I know what I should do.
- I know how to teach a student to use a new AT device.
- I know how to help a student integrate AT use into his/her daily educational program.
- I know how to assess the effectiveness of a student's AT use.

- I know and observe copyright rules regarding materials developed or adapted for use by children with disabilities.

Assistive Technology Use Skills
Skill Area
Access
- Determine a way for students to access toys, games and other materials through enlarging, stabilising, use of switches, etc.
- Determine an effective way for a student to operate/access a computer and/or other AT.

Activities of Daily Living
- Select and use various low-tech aids to position and stabilise items.
- Select and use adaptive utensils and aids for eating, drinking, dressing, hygiene and cooking
- Identify a child's need for greater control of his/her environment.
- Design opportunities to use aids to daily living and select appropriate AT.
- Operate and use a variety of aids in daily living.
- Adapt or select and use adapted toys, games and recreational sports equipment.
- Select and use a variety of AT, including software, for access and interaction

Alternative and Augmentative Communication (AAC)
- Identify important features of AaC devices.
- Match student needs with features of AAC devices.
- Operate/utilise a variety of AAC devices from simple to complex.
- Determine the best form of vocabulary representation (e.g. pictures, symbols, words), select, and organise vocabulary in a usable system.
- Train communication partners.

Hearing Technology
- Identify when sound amplification may be necessary for a student in an educational setting.
- Operate/use assistive technology for telecommunications, assisted listening and alerting.

Learning/Studying
- Develop and use a variety of print and picture schedules.
- Select and use a variety of aids, including handheld and online tools, to locate, highlight and track information.
- Use software to highlight, manipulate and/or organise information.

Math
- Identify and use a variety of math aids and low tech AT.
- Select and use a variety of voice output aids for math operations (e.g., counting, measuring, computation).
- Select and use software to provide cueing assistance in math operations

Mobility/Seating/Positioning
- Recognise and analyse the impact of seating/positioning on the child's attention, energy and ability to access AT devices.
- Determine when and why a child may benefit from assisted mobility.
- Identify important features of mobility devices.
- Select and utilise AT for mobility or stabilisation.
- Design and implement a sequenced intervention to teach a child to operate/use an assisted mobility device.

Reading
- Identify the need for, and use an array of low tech solutions to assist with reading text (changes in colour, size, font, use of guides, etc.).
- Create and use pictures with text to support reading.
- Use various tools to speak text to accompany the printed words (talking books, software, eReaders, etc.).

Vision Technology
- Use low-tech vision aids to enlarge text.
- Operate and use text-to-speech, screen reader and screen enlarger/magnification software.
- Operate and use Braille printers, Braille translation software, refreshable Braille, Braille keyboards and Braille notetakers.

Writing – Composing Written Material
- Identify and use a continuum of AT solutions from low to high tech for composing written material.
- Complete informal assessment techniques (e.g., environmental inventory, interview, observation) to determine the need for AT.

Writing – Motor Aspects of Writing
- Identify and use a continuum of AT tools from low to mid-tech for difficulties with motor aspects of writing.
- Identify and use software to decrease or change the motor demands of writing.
- Understand and use tools to augment writing skills, such as word prediction, macros and electronic word walls.

There are, in addition, self-identified skills that a professional might suggest.

4.5.2. Initial training

Recognising the skills and knowledge above, we note that in undertaking a review of initial training for workforce entry, it will be important to consider the specific roles and positions required and then the entry requirements for the workforce. Clear identification of those responsible for initial training at the undergraduate or professional certification level should be undertaken, information gathered on the content of any syllabus and curriculum related to AT and AAC, and then finally, who within the country or region is responsible for maintaining professional status and accreditation.

4.5.3. Continuous and further professional development

Smith et al. (2018) suggest that whilst continuous education and training may lead to individual certification, that this is a second priority when compared to the development of competency-based training programs to address the skill mix necessary for effective AT and AAC provision. They further suggest an identified need to establish a set of process and skill-based competencies for AT and AAC provision personnel to ensure that individual needs are met in specific contexts. They place such development within the wider provision process to ensure sustainability. This would include service planning and coordination , not only building competence with specific assistive technologies. Such a focus on building competence in the full process, allows teachers to further develop their skills to respond to continuous change.

In anaysing the extent to which workforce development is addressing the breadth of need (Mavrou et al., 2022). It can be useful to develop a matrix of competencies, such as those proposed by the

Entelis+ project[8], to gauge education and training programs for teachers and other stakeholders. A scalable competency matrix with skill proficiency levels will best meet the needs of both high and low resourced countries in planning and executing education and training programs and certification. This could be developed through the use and evaluation of best practice case studies that address the skill mix required to meet a range of individual needs and allow health systems to apply best practice findings in a contextually relevant way. Such framework for the development of competences among staff should distinguish between roles and responsibilities and adopt a lifelong learning approach (Gresswell & Hoogerwerf, 2007).

Such a set of core competencies should include those required by all those involved in the provision process.

4.5.4. The role of schools

In understanding the breadth of capacity to deliver assistive technologies, it is important to consider the delivery at the school level. Whilst it is not possible for a framework for national AT capacity to gather data from all schools, there is value in encouraging the use of self-evaluation tools such as the Entelis+ framework "*Digital skills development and ICT in inclusive education – A Self-Assessment framework for Schools*" to gather information at a local level before seeking to establish provision at a local level (Hoogerwerf, Mavrou & Traina, 2020).

4.5.5. Key areas for questions

- What content related to disability is required of teachers and therapists undergoing undergraduate courses within the country?
- Who is responsible for continuing professional development and accreditation of teachers, therapists and other stakeholders supporting AT and AAC for children?
- What content related to AT/AAC is included in the curriculum at undergraduate and postgraduate levels?
- Who provides training on the use of AT/AAC for children and education?
- Who supports the choice of appropriate AT/AAC for children with disabilities.
- How is training provided to children using AT/AAC?
- How are communication partners prepared for AAC and communication?

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[8] https://entelisplus.entelis.net/results/

5. Collecting data for the ecosystem

5.1. Principles of study

Smith et al. (2018) suggest that the development and implementation of assistive technology policy that meets citizens' needs depend on accurate data collection and reporting of assistive technology use and unmet needs on a national level. This study reviews the methodology from instruments intended to capture national statistics on assistive technology use across eight case countries from varying regions and income levels. Recommendations are provided, highlighting the need for mandatory, census level data collection according to international standards for data collection in disability and assistive technology.

"*Meeting individual needs is challenging given the diversity of contexts and commitment to AT provision. Furthermore, AT provision is complex, and the products prioritised in different settings will vary. In order to address these disparate needs on a global scale, it is important to have a full understanding of the current use and need for AT both on a national and a global level*".

Accurate, comprehensive, and current data on AT use and unmet need are required to justify investment in AT policy, programs, and spending. Understanding the prevalence of use and need helps direct funds where they are most needed and inform program decisions at a national level. Without reliable data on AT use, and unmet and projected needs, planning for and investing in appropriate and sustainable provision is compromised.

Furthermore, it may be difficult to develop systematic and context-specific policies, guidelines, and standards for a systems thinking approach. This may leave national governments vulnerable to the delivery of inefficient and ineffective services, resulting in poor quality and unaffordable AT. Improving national statistics provides indicators for context-specific planning, evidence for advocacy groups, and opportunities to promote cost-effective national procurement methods through bulk purchasing for items of the greatest need".

Therefore, the data may enhance equitable access to AT required by all people with disabilities regardless of gender, age, race, or ethnic characteristics. Regular data collection also promotes monitoring and reporting on the progress of existing or new policies and programs by providing baseline and follow up data to complement additional evaluative measures.

Based on their analysis, there were several recommendations proposed to enhance the collection of national statistics in the area of AT:

• "Data is ideally collected at the population level, within or secondary to a mandatory national census. If secondary to a national census, it is important the data can be linked to demographic and socio-economic indicators collected during the census. Population-level statistics include all members of society and would acknowledge the use of AT as a universal experience for all individuals of all ages.
• Where sampling frames are used instead of population-level data, sampling should not rely on self-identification as a person with a disability. It should apply methods or tools that represent the population as a whole. Sampling frames must also carefully consider the potential for the underrepresentation of marginalised and vulnerable groups and take steps to ensure these groups are accurately represented.

- Global alignment with a minimum set of questions, including a single classification system for assistive products, would enhance the comparability of data. Alignment with the Washington Group on Disability Statistics should be considered, with modifications to the AT related questions to align with the WHO Global Cooperation on Assistive Technology (GATE) initiative list of the 50 priority assistive products (1). Specifically, an amended set of questions in the Washington Group Expanded Question Set should reflect the variety of AT used across all impairment categories, with notable changes in communication and cognition.
- Where possible, researchers should endeavour to access the microdata to publish the data on AT use and unmet need and identify strengths and limitations within the dataset in their published material. Microdata analysis allows researchers to identify inequities in the AT provision process, contributing to the rationale for adjusting policies regulating funding and provision models".

5.2. Developing a baseline

The gathering of data for analysis through this framework is based upon a tried and tested methodology, including that used for the r-ATA and ATA-C. This should help to ensure that the data gathered is compatible with further data that could be available for the wider population of people with disabilities. The baseline is developed through a process of analysis of documentation. That initial analysis is validated and enhanced through a combination of semi-structured interviews and focus group discussions, which should provide further evidence that the initial sources are being correctly interpreted, that the processes and polices are being implemented and have impact and suggest further sources of evidence to clarify and support the development of recommendations and a roadmap.

Walker et al. (2020) describe the process of collecting data to support AT Capacity evaluation in Indonesia. They describe how the data was best collected through semi-structured interviews and focus group discussions (FGDs) with various stakeholders. They offer examples of semi-structured questionnaires and interview guides used for further reference.

In the WHO, ATA-C manual, when referring to the collection of data, the WHO offers a useful approach to the adaptation of questionnaires to the multiple stakeholders who will be involved. It stresses the need to ensure that questions in interviews and focus groups are relevant to the stakeholder without changing the meaning of the questions asked.
By combining the desk research with the extra information gleaned from stakeholders a clear baseline can be established. This can then provide the basis for a gap analysis between the current status of AT provision and the stated aims with recommendations and a roadmap for action.

5.3. Sources of data

To undertake a thorough review of the capacity to deliver AT within a country or region, several data sources should be incorporated. The data extracted from each should be collated to provide a coherent evidence base for the analysis and recommendations.

- Public statistics on disability and AT spend
- Public Policy, including laws and Guidance
- Prior research papers on provision
- Position papers from stakeholders, including disabled persons organisations
- Reports on responses to UNCRPD
- Interviews and focus groups with key stakeholders

5.4. Refining the model for demographics and context

The framework for measuring AT capacity for children and schools seeks to provide a wide-ranging model for use in any country. Before using the framework and associated tools, the team responsible for implementation should review it for the use of appropriate language that will be familiar to stakeholders and relevant cultural assumptions. Ensuring that all key stakeholders are identified and their relevant responsibilities are integrated into the questions and data gathering will be critical in ensuring that responses are valuable and informed.

6. Summary and conclusions

The development of this framework outlines a structure by which data can be gathered and analysed. This helps to build a gap analysis of AT capacity within a country or region and leads to recommendations and a roadmap for further development. Our work is informed by different souces among which the precious recent work of many colleagues, thus providing state of the art knowledge in this field.

We have sought to allow for a process of rapid assessment of AT capacity using existing public data that is enhanced and validated through interviews and focus groups.

The data should illustrate the current status to build a national, regional or local ecosystem across the 5 Ps.

The framework should both gather information and provide a structure within which further national actions can be identified.

The framework and tools offer a format by which stakeholders within other countries could undertake an assessment of their AT Capacity and build strategies for action.

This framework is accompanied by a toolkit to support data collection and capacity assessment.

Glossary

There are several glossaries in the Internet that provide definitions and descriptions of terms and concepts that are relevant for the advancement of technology enabled inclusive education.

The following two are relevant because of their specific focus on accessibility and assistive technology in (inclusive) education.

The Glossary of the Accessible Digital Learning Portal (ADLP).
https://accessibledigitallearning.org/glossary The Accessible Digital Learning Portal (ADLP) was developed with support from UNICEF with funding from the Global Partnership for Education. Ninetyfour terms are listed in alphabetical order, defined and with additional comments for clarification.

The ENTELIS+ Project glossary
https://entelisplus.entelis.net/results/

The ENTELIS+ project taxonomy and glossary (2021) is a revised and extended version of the ENTELIS project glossary (2016) which focussed largely on Information and Communication Technology (ICT), digital assisitive technology, learning events and processes in various educational settings. The revised version adds many accessibility-related terms covering topics such as practices and procedures, tools, design methodologies, policies and frameworks. For the scope of this publication and without the pretention of completeness, the authors made a shortlist of the most relevant terms, taking them from one of the mentioned glossaries without altering the original text.

AAC (alternative augmentative communication)

An AAC system increases or improves the communication abilities of individuals with receptive or expressive communication impairments. Systems can include sign language, graphic symbols, digital speech, dedicated communication devices, and applications for computers, phones or tablets. AAC technology spans a wide range of products, from low-tech picture boards to high-tech speech recognition programs. AAC components may have value for other learners, including second language learners, the deaf and those experiencing barriers to literacy.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Accessibility features

Accessibility features are a range of product functions that allow users to adjust settings to meet their individual needs. Devices can come with various accessibility features that can adapt to meet visual, mobility, hearing, language, and learning needs. Accessibility features allow those with disabilities to access products and services that may not otherwise be available and may operate as assistive technology in themselves. Accessibility features can often be found within devices, operating systems and productivity software. They are not all limited to people with a disability and may be of value to those with preferences or to make the digital experience more comfortable.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Accessible formats

The information available to people with different types of disabilities, including displays of text, Braille, tactile communication, large print, accessible multimedia, written, audio, plain language, human-reader, and augmentative and alternative modes, means and formats of Accessible formats

are sometimes described as being those that are usable by all people. In contrast, alternative formats are designed to accommodate a specific need for an individual to access. Alternative formats can be helpful for those without a disability but who may find it easier to listen to a document rather than try to read text, for instance- such as when driving.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Accommodations

Accommodations are the modifications that are put in place to help a person with a disability to complete the same task as others. Accommodations can also include changes in setting, timing, scheduling, and/or response mechanisms.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Alternative access or input device

An alternative access or input device allows individuals to control their technology using tools other than a standard keyboard or pointing device. Examples include alternative keyboards, pointing devices, switches, sip-and-puff systems, wands and sticks, joysticks, and trackballs. Most alternative access devices work best when they are tuned to the response of the user through the accessibility features on the device they are connected to.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Alternative keyboard

Alternative keyboards may be different from standard keyboards in size, shape, layout, or function. They offer greater efficiency, control, and comfort. Choosing a keyboard will require consideration of where and how it will be used and the user's needs. Keyboards can include ergonomic keyboards to reduce strain and can be combined with work prediction software to speed up typing.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Assistive Technology

Assistive technology describes additional software or hardware that can enhance the operation of a digital device to serve users' needs with or without a disability. Assistive Technology can be defined more widely and includes wheelchairs, mobility aids etc. It may also include self-care products and aids to daily living. Some examples include Refreshable Braille Display, Orbit Reader, JAWS, and Switch Control.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

The WHO organisation defines Assistive Technology as "*an umbrella term covering the systems and services related to the delivery of assistive products and services.*"

Source: https://www.who.int/news-room/fact-sheets/detail/assistive-technology

Assistive Technology Centre

An institution that supports the development of assistive technology learning through various activities of education, assessment, and implementation of AT for people with disabilities of all ages, families and professionals.

Source: The ENTELIS+ Project glossary

Assistive Technology Service/Provider

Any service that directly assists an individual with a disability in selecting, acquiring or using an assistive technology device.

Source: The ENTELIS+ Project glossary

Assistive Technology team

A multidisciplinary team including various professionals in education, rehabilitation and technology (e.g. assistive technology specialist, teacher/educator, special education teacher, occupational therapist, speech and language therapist, provider, designer, etc.), family members/carers and the end-user that collaborate for the assessment of needs, selection of solutions, implementation and follow-up for the effective use of AT by a person with disabilities (end-user).

Source: The ENTELIS+ Project glossary

Audio description

AD is a form of narration used with video to describe the visual elements of action, characters, locations, costumes and sets without interfering with the production's dialogue or sound effects. They allow those who are blind or have vision impairments to access and enjoy video in greater depth.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Augmentative and Alternative Communication devices

An AAC system increases or improves the communication abilities of individuals with receptive or expressive communication impairments. Systems can include sign language, graphic symbols, digital speech, dedicated communication devices, and applications for computers, phones, or tablets. AAC technology spans a wide range of products, from low-tech picture boards to high-tech speech. AAC components may have value for other learners, including second language learners, the deaf, and those experiencing barriers to literacy recognition programs.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Authoring tool

An authoring tool refers to a resource such as software or a website that provides functions and features that can be used to create resources for use by learners. Authoring tools can range from those used by large numbers of people, such as slideshow software or may be more technical to create eLearning resources, videos, audio files or eBooks. Some of the authoring tools are standalone solutions, whilst others "plugin" to other learning management systems software.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Braille display

Braille displays are tactile devices with a row of cells. Each cell has 6 or 8 pins made of metal or nylon; the pins are controlled electronically and move up and down to display characters as they appear on the display of a computer or Braille notetaker. A number of cells are placed next to each other to form a refreshable Braille line. As the pins of each cell pop up and down, they form a line of Braille text that can be read by touch.

Braille Displays can be combined with text-to-speech and a keyboard to create an aid for the blind, referred to as a Braille Notetaker. Innovations have been driving down the cost of notetakers in the last three years.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Braille notetaker

A braille notetaker is a portable device with a refreshable braille display that is used by people who are blind or visually impaired. This device is used by people who want to read and write electronically in braille. Typically, a notetaker allows the user to read and write files in several formats, listen to media files, handle email, and create voice memos. Traditional notetakers are highly expensive, and great care should be taken in selecting one that fits the purpose.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Digital literacy

The acquisition of knowledge and skills and the development of attitudes or values for effectively choosing and using ICT and ICT-AT. It is a blend of information, communication, and technology literacy, including the basic knowledge and skills for using technology, acknowledging its possibilities, and developing critical thinking for uses and resources.

Source: The ENTELIS+ Project glossary

eBook Reader

eBook readers are handheld devices that store and present books on screen. Some have text-to-speech integrated and can read books out loud. Many smartphones and tablets have apps to replicate this functionality. eBook readers can also be software and apps for phones and tablets and can access the same content as a hardware device. Some people prefer a dedicated device, others like an app.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Environmental control

Environmental controls allow people to control devices in their environment through many access methods, including touchscreens, such as switches or voice. These include lights, televisions, telephones, music players, door openers, security systems, and kitchen appliances. These systems may also be referred to as Electronic Aids to Daily Living (EADL). Environmental control systems need to be installed with due regard to safety measures These systems are increasingly being replaced by smart home technology, which includes AI and Machine learning to automate control.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

End-User

A person with disabilities of any age that uses or will use any ICT-AT product or service

Source: The ENTELIS+ Project glossary

Eye Tracking device

Eye gaze or eye tracking technology is a way of accessing a computer or communication device by focusing the eyes on a picture or area of the screen. The technology can determine where a user is looking and operates as an input alternative to a mouse and keyboard. Eye tracking fundamentally replaces a mouse to navigate a screen, "dwelling" in one location to activate a "click". Eye-tracking technologies are increasingly seen as an option for mainstream access for people who need to be hands-free. The first eye-tracking devices are being integrated into the latest high-end phones and tablets.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Graphic thought organisers

Graphic thought organisers present ideas and the links between ideas and information as visual charts using shapes and text connected by lines or arrows to structure the reading or writing process. These can include mind maps and concept spiders. Graphic thought organisers can use different resources, including text, images, diagrams, sound, and video. Software for graphic thought organisers is available for both computers and most mobile devices.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Hearing aids

These can help wearers feel more confident when talking to people and make it easier to follow conversations in different environments or enjoy listening to music and the TV at a comfortable volume for others around the wearer. Hearing aids can only help if the wearer has some residual hearing. They can take two forms – in-ear and behind the ear. Hearing aids can be connected to phones and other devices to help provide clear information and communication.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Individualized Educational Programme (IEP):

A learning plan with individualised learning objectives, proposed learning/teaching methodology and evaluation strategies for the needs of an individual learner with disabilities.

Source: The ENTELIS+ Project glossary

Inclusive school

A formal education school designed to accommodate all learners' needs regardless disability, language, gender, religion or ethnicity, based on the philosophy of differentiation and equality of education by providing accessibility in physical and learning environment (Booth & Ainscow, 1998; Symeonidou & Phtiaka, 2014).

Source: The ENTELIS+ Project glossary

Inclusion

A process that aims to ensure that the most vulnerable people are considered equally and that these people participate in and benefit from development and humanitarian programs. Inclusion is an organisational effort and practice in which different groups or individuals from different backgrounds are culturally and socially accepted, welcomed, and equally treated. The breadth and depth of inclusion of people with a disability varies according to history and culture.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Inclusive education

An approach that ensures that barriers to participation and learning are removed, and that teaching methodologies and curricula are accessible and appropriate for students with disabilities. All UNICEF state that Inclusive education is the most effective way to give all children a fair chance to go to school, learn and develop the skills they need through learning opportunities for groups who have traditionally been excluded – not only children with disabilities but speakers of minority languages too. Inclusive systems value the unique contributions students of all backgrounds bring to the classroom and allow diverse groups to grow side by side to the benefit of all.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Induction loops

An induction loop is a means of providing enhanced hearing assistance to hearing-aid users. Induction loops can be installed in a building or can be a portable device.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Joystick

A joystick can be an alternate input device. Joysticks are attached to the device via a USB port or can be connected wirelessly using Bluetooth. Such pointing devices can be used with phones and tablets as well as with computers.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Keyboard additions

Various peripherals are available to make keyboards more accessible to people with disabilities. Keyguards are hard plastic covers with holes for each key. Someone with tremors or a pointing device can avoid striking the wrong key using a keyguard. Moisture guards are thin sheets of plastic that protect keyboards. Increasingly these peripherals can be designed and printed using 3D printing technologies.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Mice alternatives

A mouse operates as a pointing device moved by hand to navigate and point to items on a screen. The buttons on a mouse are used to click on items. Various adaptations or alternative mice have been developed to address multiple access needs, accommodating different sizes of hands and dexterity.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Mobile app

A mobile application, often referred to as an app, is a type of software designed to run on a mobile device, such as a smartphone or tablet. They usually aim to provide similar services to those accessed on PCs. Most Apps are small, with more limited functions than on a PC. A mobile application may also be an app, web app, online app, or smartphone app.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

On-Screen keyboard

An On-screen keyboard replicates a physical keyboard as software. When combined with an access device such as a switch, mouse or touch, and with word prediction, it can offer a very accessible way of adding text to documents On-screen keyboards have a range of "scanning" options, such as row/column to make selecting a letter faster.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Open source

Open-source software is freely available for anyone to download, modify, build upon, and use in development and is governed by a license determining its use in commercial applications. Ideally, open-source software is developed 'in the open', meaning as changes are made, they are contributed directly to a shared repository with a history of changes made by specific contributors supervised partly by moderators. UNICEF supports and contributes to open-source projects where possible to further develop and adopt new technologies.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Screen magnifiers

Screen magnification enlarges what is viewable on screen and increases visibility for those with limited and low vision. Most have variable magnification levels, and some offer text-to-speech options, or the ability to see the text in high contrast. Screen magnifiers can mean that words become pixelated at high magnification, and pages can also become difficult to navigate. At high magnification, many people prefer text to speech.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Screen Reader

Screen readers use text-to-speech to read out all of the words and menus on a screen to allow access for people who are blind, have low vision, or have a print disability, such as dyslexia. Some use a screen reader in conjunction with magnification or Braille.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Speech/Voice Recognition

Speech recognition converts spoken words into text. Recognition can also be used to command and control a device. Speech recognition responds to a range of voices, although some may require the user to enroll and create a "voice model" for greater levels of recognition. Recognition solutions can be used to create written documents without the use of a keyboard, to control devices including phones, tablets and smartspeakers and are increasingly integrated into smart televisions and other consumer goods. Most major operating systems for computers, phones, and tablets have a form of speech recognition built-in. As well as tablets and smart speakers, recognition is increasingly integrated into smart televisions, other consumer goods, and productivity software such as Microsoft Office or Google Docs.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Switches

Switches are a device that offers a method of accessing a device when a standard keyboard or mouse is not an option. Switches come in various sizes, shapes, methods of activation, and placement options. Some software and apps are designed specifically for use with a switch and can employ scanning, where the device highlights options available to the user to select the desired action. Switches usually need an interface box to work on a device. Switches are often a low-cost option and can be set up to respond to most controlled voluntary movements of any body part.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Trackball

A trackball is an alternative to a mouse, where a ball sits on top of the device and can be manipulated to move a cursor on the screen. A trackball often has ergonomic benefits and may be more accessible to people with physical disabilities as it may require smaller movements than a mouse. Trackballs can be combined with a switch to provide easier access to mouse buttons for those with a physical disability. People with arthritis or age-related disabilities increasingly use them.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Trackpad

A trackpad or touchpad is a pointing device with a small flat area that detects touch and movement and is used to interact with a computer screen. It is often used as an alternative to a mouse, especially on laptops, where it usually sits below the keyboard. Large trackpads such as graphic tablets used with a stylus can also be used for access.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

UDL (universal design for learning)

Universal Design for Learning is an educational framework recognising that all children learn differently and benefit from differentiated learning techniques in the classroom. UDL uses practices, space, and materials that engage all learning strengths. UDL seeks to accommodate individual learning differences and styles by developing and using flexible learning environments. Such approaches particularly accommodate children with different types of disabilities and facilitate their inclusion in the classroom. Technology is widely used within UDL classrooms.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Universal design

The design of products, environments, programs, and services to be usable by all people, to the greatest extent possible, without needing adaptation or specialised design. UD does not exclude assistive devices for groups of persons with disabilities where required (UN, 2006). Seven universal design principles seek to guide the design of environments, products, and communications that allow users the flexibility to turn on and off features.

The seven principles are: Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Voice output communication aids (VOCA)

A VOCA is a device that generates spoken language for those who cannot use speech to express their needs and to communicate or interact with others. These devices are intended solely for communication purposes and are sometimes referred to as Speech generating devices. A VOCA may be combined with an access device. Many dedicated devices have now been replaced by apps and software on phones and tablets. These vary in price and complexity.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Wearable Technology

Wearables include clothing and accessories such as watches that incorporate technologies to operate as input or output devices. Many wearables can interact with other technologies to display content or control actions. Examples include Apple's iWatch, wearable GPS trackers, head-mounted displays or smart glasses, and a necklace with a personal amplifier. The growth of fitness trackers has made wearable technology very widely available. Other wearables include low-tech, such as spectacles, and very widely available technology, such as headsets.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Web Accessibility

Web accessibility defines the process of making a website accessible to all users with and without a disability. The W3C web accessibility initiative develops guidelines, and WCAG 2.1 guidelines primarily specify techniques to create a website accessible to people with a range of needs, notably those who are blind and have low vision but also include some methods to benefit users with intellectual, and developmental, or motor disabilities. The W3C leads web accessibility guidelines and standards. The standards provide the basis for audit, remediation, and design activities.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

Word/Text prediction

Word and Text prediction suggests words on the screen as letters are typed. The word is selected from the list and inserted into the text. Prediction can reduce key presses on phones and tablets and speed up text entry when used with a switch or other input device.

Source: The Glossary of the Accessible Digital Learning Portal (ADLP)

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