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Voices from Academia

Developing a Holistic Process to Measure Assistive Technology Outcomes

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Abstract

Assistive technology (AT) outcomes research sits across different fields of practice and uses, diverse measures and methodologies. Instruments have been developed to measure AT outcomes, but data are not routinely collected nor published in most settings. This impedes the evaluation and development of policy in

the field and prevents the sharing of best practices across settings and countries. Aiming to summarize existing knowledge about assistive technology outcomes and propose directions for the future, we provide a broad narrative synthesis of existing literature about AT outcomes conceptualized through the people-centered 5P model of the WHO Global Cooperation on Assistive Technology initiative and the GAATO Assistive Technology Outcomes and Impacts Model. We conclude that the 5P system model operates as a viable, integrative framework which supports a holistic understanding of the challenges associated with measuring AT outcomes. The development of a process to measure AT outcomes is proposed.

Keywords: assistive technology, outcomes, 5P model, measurement

Developing a Holistic Process to Measure Assistive Technology Outcomes Context, Challenges and Complexities of Assistive Technology

The pressing need for evidence to support the complex and growing interventions in the field of assistive technology (AT) has long been articulated (DeRuyter, 1995, 1997; Scherer, 1996a, 1996b) and has become more urgent in the current context of the physical, digital and biological realms that are being merged through rapidly developing technology (Scherer et al., 2019). Every stakeholder within the AT industry has a need to see outcomes achieved, especially the users of AT and their families (Smith, 2021). There is a need for a common understanding of what these outcomes are, who defines them and how they are measured, so that the results can be compared.

The definition of outcomes depends on what stakeholder is being addressed. Clinicians may focus on an individual's functional gain, while clinic directors have their eye on cost containment and profit. Consumers are most interested in enhanced capabilities and well-being (Fuhrer et al., 2003; Jutai et al., 2005; Lenker et al., 2005; Scherer & Galvin, 1996; Scherer & Smith, 2021). While a good deal of emphasis today is on measures of specific outcomes with particular products or functional goals, the purpose of this paper is to discuss a more broad and global perspective.

To effectively compare outcomes, we must use a common understanding of what assistive technology is. The World Health Organization (WHO) defines assistive technology as the "application of organized knowledge and skills related to assistive products, including systems and services." Assistive products are further defined as "any external product (including devices, equipment, instruments or software), specially produced or generally available, the primary purpose of which is to maintain or improve an individual's functioning and independence, and thereby promote their well-being. Assistive products are also used to prevent impairments and secondary health conditions" (WHO, 2016). Assistive products are also defined by the International Organization of Standardization (ISO) as "any product (including devices, equipment, instruments and software), specially produced or generally available, used by or for persons with disability for participation; to protect, support, train, measure or substitute for body functions/structures and activities; or to prevent impairments, activity limitations or participation restrictions" (ISO, 2016). When considering outcomes, and how we measure them, we must therefore consider outcomes associated not only with the assistive products themselves, but also those associated with the broader systems and services used to deliver them to the people who need them. The WHO has identified 5 interrelated concepts which impact the delivery of assistive

products: people (the users of assistive products), products, personnel, provision, and policy. These are collectively known as the WHO-GATE 5P model (WHO, 2020) and will be referred to throughout this work.

The Global Alliance of Assistive Technology Organizations (GAATO) propose that “measuring outcomes and impact is necessary to understand the benefits of assistive technology and create evidence-based policies and systems to ensure universal access to it” (GAATO, 2022a). However, the proposal embodies several challenges to achieving this goal, such as the measurement of AT outcomes and impact at individual, community, local, national, and global levels; instruments for data collection and use; outcomes related to systems and their implementation; and the evaluation of good practices and policies (GAATO, 2022a).

Defining the outcomes of assistive technology interventions is complex, not least of all because of the current rate and scope of technological innovation. Firstly, it is essential to know what specific interventions are being examined and what outcomes to measure. Secondly, what Smith (2002, p. 240) described as “InGo”, must be clearly identified. However, specifying the variables that “go in” to the intervention to enable an “outcome” is challenging because AT systems are complex, personalized and highly diverse across population distributions (Smith, 2016). Thirdly, context is critical because AT is rarely used in isolation. Therefore, comprehending and managing simultaneous and analogous interventions is essential in order to examine the effectiveness of AT (Smith, 2005). Finally, multiple stakeholders are involved in the provision and use of AT and are likely to view outcomes from specific perspectives (Layton et al., 2020; Rist et al., 2008; Scherer, 2020).

The complexities discussed above are the result of a set of variables that are dependent on dynamic, interrelated factors in the environment or context, which indicates that, unless comprehended and managed, the general use and measurement of AT outcomes occurs in an open system. Recent conceptual thinking about assistive technology is that although assistive products can be thought of as a closed system where variables can be controlled and results or outcomes can be replicated, it is best to view service provision as an integral part of the AT bundle provided (MacLachlan et al., 2018). We argue in this paper that what is needed is not to view separate components as open or closed systems but to adopt a holistic view to develop a process that can be used to measure all critical aspects of AT systems and their outcomes.

Purpose Statement

The objective of this paper is to kickstart development of a process that could be used globally to measure the outcomes of AT interventions. We accomplish this by first summarising the research experience of key authors and networks of contributors. This broad pool of expertise is synthesized into a commentary connecting two contemporary models: the WHO-GATE 5P framework for strengthening access to AT (WHO, 2020), and the Global Alliance of Assistive Technology Organizations Outcomes and Impacts Model (GAATO, 2022b).

Target Audience and Relevance

Given the diversity of stakeholders in the AT ecosystem, the *Assistive Technology Outcomes and Benefits (ATOBS)* audience are essential players, part of developing a holistic process to measure assistive technology outcomes. More specifically, the stakeholders that could benefit most from this article include assistive technology providers, suppliers, manufacturers and developers, as well as consumer.

Methods

In order to achieve the primary objective of this paper, i.e., to contribute to the development of a process that could be used globally to measure the outcomes of AT interventions, the following steps were completed. Firstly, the state of science related to global AT outcomes and impact was summarized. Secondly, gaps in the 5Ps were identified by mapping existing data, frameworks, and techniques to the goals of the outcomes of the AT system. Thirdly, current outcome conceptions were identified and critically evaluated in the light of their potential use in various contexts, including high- and lower-middle-income countries. Finally, a model for a holistic understanding of AT outcomes was developed based on the 5P model and in the context of the GAATO AT Outcome and Impacts Model.

Results

Summary of Existing Body Knowledge on AT Outcomes

Major AT outcomes and research instruments over a number of decades were identified and summarized (Table 1). The examples in Table 1 represent the most cited and frequently mentioned technology-focused outcomes measures. The mid-1990s were the heyday of developments in AT outcomes (e.g., DeRuyter, 1995; Scherer, 1996a, 1996b; Scherer & Galvin, 1996), both theoretically and as the measures presented in Table 1 indicate, in the development of tools to measure outcomes. The tools were, for the most part, designed to be used across disability types, ages, and assistive products.

Table 1: Measuring particular outcome: Examples of available and validated technology focused instruments

OUTCOME	MEASURE/ APPROACH	FOCUS	FIELD OF RESEARCH / DISCIPLINE FROM WHICH MEASURES WERE DEVELOPED
Intention to use	UTAUT, TAM (Davis et al., 1989; Venkatesh et al., 2003)	Product <ul style="list-style-type: none"> Perceived usefulness and ease of use 	Business/ Commerce; Information Technology
Expectations of benefit from use	MPT measures/ATD PA initial (Scherer & Craddock, 2002; Scherer & McKee, 1990)	Person and Provision <ul style="list-style-type: none"> Motivation, readiness, subjective need, personal factors 	Behavioral science
Goal attainment	IPPA (Wessels et al., 2002)	Provision <ul style="list-style-type: none"> Goal identification and attainment 	Health sciences; Education
Satisfaction with Product and Service delivery	QUEST (Demers et al., 2002)	Product and Provision <ul style="list-style-type: none"> Device features, service delivery, usability 	Occupational therapy; Education
Realization of benefit from use	ATD PA follow-up (Scherer & Glueckauf, 2005)	Person and Provision <ul style="list-style-type: none"> Person-Product Match Performance Use worthiness 	Behavioral science

OUTCOME	MEASURE/ APPROACH	FOCUS	FIELD OF RESEARCH / DISCIPLINE FROM WHICH MEASURES WERE DEVELOPED
Psychosocial Impact	PIADS (Jutai & Day, 2002), MPT measures	Person <ul style="list-style-type: none"> Competence, adaptability, self-esteem 	Psychology
Functional Performance	OTFACT (R. O. Smith, 2002)	Person <ul style="list-style-type: none"> Function with and without the use of assistive technology 	Occupational therapy

(Scherer et al., 2019)

Abbreviations

ATD PA = Assistive Technology Device Predisposition Assessment

IPPA = Individually Prioritized Problem Assessment

MPT = Matching Person and Technology

OTFACT = OT Functional Assessment Compilation Tool

PIADS = Psychosocial Impact of Assistive Devices Scale

QUEST = Quebec User Evaluation of Satisfaction with Assistive Technology

TAM = Technology Acceptance Model

UTAUT = The unified theory of acceptance and use of technology

When two centers to study assistive technology outcomes were funded in 2001 by the U.S. National Institute for Disability and Rehabilitation Research, much of the focus through the early 2000s was on more general and conceptual contributions. Existing outcomes measures were reviewed in the context of meeting service provision needs. These instruments revealed a conundrum regarding the use of measurement tools that persists to this day. That is, instruments generally either measure contributing factors to AT outcomes or measure the effects of AT use (Fuhrer et al., 2003; Jutai et al., 2005; Lenker et al., 2005).

When *Assistive Technology Outcomes and Benefits* debuted in 2004, the issues reflected a blend of theoretical and practical. Starting in the mid-2010s, outcomes studies became more specific, focusing on a particular product or rehabilitation target (Bigras et al., 2020; Cruz et al., 2021; Subramanian et al., 2022). The literature demonstrated the importance of not only focusing on functional performance outcomes, but also recognizing underlying and alternate factors that might influence the use of AT, such as complexity of devices or lack of personnel training (Smith et al., 2018).

Recent global initiatives have once again brought conceptual issues to the forefront, but there has been little work in the development of additional outcomes measures unless designed for a specific population or purpose (Scherer et al., 2019; Scherer & Smith, 2021).

Contemporary Views Informing AT Outcomes

In the WHO/UNICEF Global Report on Assistive Technology (WHO & UNICEF, 2022) it was recognised that monitoring user outcomes is essential. Recommendation 6, *Invest in data and evidence-based policy*, called for “Outcomes in terms of human rights and quality of life for users, their families and the community or country” (p. 101).

This was closely related to Recommendation 8, Develop and invest in *enabling environments*, in which it was noted that, “The outcomes of assistive technology depend largely on the existence of enabling environments”

(p. 102). The recommendations and actions in the Global Report were operationalised according to the 5P Model shown in Figure 1.

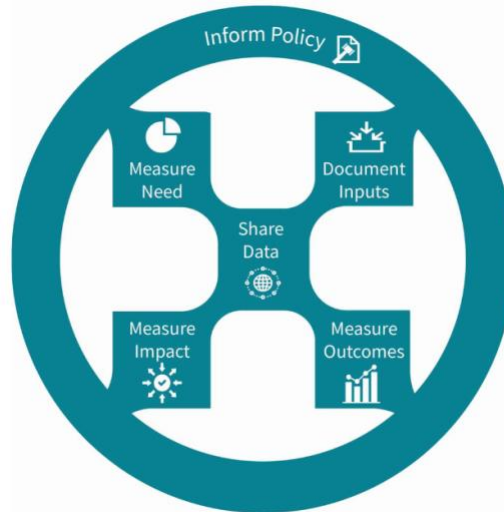
Figure 1: WHO’s GATE 5P People-Centered Assistive Technology



Note: Source - ©2022, World Health Organization and UNICEF. Used with permission.

The 5Ps Model is used to frame AT outcomes and integrate the additional P concepts in the discussion in the section on *Differential desires for outcomes* below. Additionally, during a recent global consultation that comprised over 300 AT stakeholder perspectives from all WHO global regions, six key challenges related to AT outcomes and impacts globally were identified as shown in Figure 2 (GAATO, 2022c).

Figure 2: GAATO AT Outcomes and Impacts Model



Note: Source - ©2022, GAATO. Used with permission.

Implications of Context for AT Outcomes

Currently, in high-resourced settings, service delivery and implementation are prioritized with little mandate or commitment toward documentation and data collection. This may be driven by the notion that manufacturers and providers are responsible to generate the evidence to promote their products. For example, pharmaceutical companies that develop new drugs are responsible to run clinical trials and capture

the evidence to obtain approvals from public regulators. This methodology works for large corporations but is not feasible for smaller companies such as those that support the AT industries.

Although WHO-GATE has activated the implementation of assistive technology programs globally, historically, little or no funding has been provided to new assistive technology programs to support outcomes documentation. Nevertheless, the emphasis on evidenced-based practice and person-centred service delivery has increased the significance of developing, utilizing, and disseminating systemic models for the outcomes of assistive technology (Scherer & Federici, 2018; Zapf, 2023). The requirement for evidence documentation to support the ongoing efficacy of assistive technology solutions is growing. It is argued that the idea of evidence-based funding will challenge and spread across the board for AT initiatives. Thus, for all populations of people who require assistive technology products and services, as well as the providers of those services, gathering evidence through reporting the outcomes of assistive technology will become crucial. Assistive technology programs must therefore take outcomes measurement systems for assistive technology into account. For example, in low-income settings, the development of information technology and the widespread use of mobile devices is enabling data collection regarding mobile-device related assistive technology outcomes to be captured (Savage et al., 2020). This is therefore an ideal time to incorporate outcomes documenting into programs for the provision of assistive technology. Leadership and/or partnership initiatives can support stakeholders within lower resourced settings to make this a reality (GSM Association, 2018; Holloway et al., 2018). Such initiatives can serve as fresh examples that demonstrate innovative and successful measurement of outcomes.

5Ps Differential Desires for Outcomes

In this section, AT outcomes are explored from the perspective of the WHO 5P, people-centred, assistive technology model. Which P is most related to each particular outcome measure is shown in Table 1.

Systems for assistive technology that are stand-alone or integrated contain connected components and dynamic processes. A simplified view of the assistive technology system is provided in Figure 1. According to this approach, the four inter-connected elements of the assistive technology system—products, provision, staff, and policy—determine how users experience the process for gaining access to assistive technology. Holistic solutions are more effective when all system components and their interactions are understood. Policy influences the range, quantity, quality, and cost of the items that are offered, including the design and implementation of the provision (procurement, delivery, and services), and the capability of the workforce (legislation, policy structures, information system, financing).

A discussion of the perspectives and influences of the 5Ps on the outcomes of the system follows, with examples of the questions that should be asked to obtain relevant data, and what should be documented. Each P is associated with unique stakeholders and leads to unique perspectives on the outcomes.

People (the User)

The perspectives of people who use assistive technology are central to our understanding of the need for and utility of assistive products themselves, as well as the experience of navigating assistive technology systems and policies (Desmond et al., 2018). In order for users to derive value from their AT, it must fulfil their requirements and be useful and valued, otherwise it might be abandoned and not used at all. This domain of outcomes includes subjective user perspectives, e.g. comfort, self-consciousness, etc. As a result, no single AT is likely to meet the needs of all the various stakeholders (see Table 2). Interestingly, consumers of

assistive technology might not even perceive the term “outcomes” as a word of choice when they are interested in product utility (Lenker et al., 2013).

Table 2: Examples of the influences upon the system related to People and how to document outcomes

Questions to examine influences on outcomes of the system	Documentation of statements of outcomes (examples of successful inclusion)
<p><i>Partnership</i></p> <ul style="list-style-type: none"> • What are the expectations of what will be gained from use of the device compared with what is currently being done or used? • What are the characteristics of others in the environments of use? Supportive, resistant, stigmatizing? • Are there cultural mores or beliefs that disavow use of the technology? • Has the need for additional supports and assistance been considered and are they available if needed? 	<ul style="list-style-type: none"> • Documentation of personal and contextual characteristics (functional needs, subjective needs, social and material support, personal preferences and priorities, well-being). • Identified expectations of benefit and follow-up documentation of the realization of benefit.

(Desmond et al., 2018 and Lenker et al., 2013)

Policy

The legislative, regulatory, structural, and environmental contexts of the other Ps are embraced by "Policy" (see Table 3) which serves to develop and record key outcomes such as laws or codes. As key role-players in the AT environment, policymakers have a vested interest in costs versus benefits (Scherer et al., 2019). Also, funders often play a role in establishing a need for outcomes documentation (Clayback et al., 2015). Further, there is an identified need to evaluate policy for its ability to contribute to the realization of human rights, and to enable equitable access to assistive technology (MacLachlan & Scherer, 2018).

Table 3: Examples of Influences on outcomes of the system related to Policy

Questions to examine influences on outcomes of the system	Documentation of statements of outcomes (examples of successful inclusion)
<p><i>Place</i></p> <ul style="list-style-type: none"> • Are all of the necessary architectural supports in place? • Is there adequate infrastructure for use? • Is there accessibility to equipment and facilities? • Is there adequate supply of electricity? • If assistance is required for student training and use of the technology, is it available? • Do classroom settings need to be re-organized? • Is there access to ancillary facilities, for example, classroom environments for training and learning? 	<p><i>Place</i></p> <ul style="list-style-type: none"> • Documentation of availability of facilities and accessibility to sufficient equipment, supplies, materials and other resources.

Questions to examine influences on outcomes of the system	Documentation of statements of outcomes (examples of successful inclusion)
<p><i>Legislative/Political/Regulatory</i></p> <ul style="list-style-type: none"> • Are there mandated services? Is there licensure of providers? • Are relevant community resources needed and are they available? 	<p><i>Legislative/Political/Regulatory</i></p> <ul style="list-style-type: none"> • Documentation of sufficient laws, regulations and codes. • Evidence of legal and regulatory compliance. • Evidence that products meet regulatory standards. • Proof that products have been safety-tested. • Documented guidelines for meeting and exceeding minimal requirements.
<p><i>Economic</i></p> <ul style="list-style-type: none"> • What are the costs of service provision? What are the costs Training? • What are the costs for repairs and maintenance? • Is funding available for products and services? • Can products be re-used, recycled? 	<p><i>Economic</i></p> <ul style="list-style-type: none"> • Information about funding available for programs and facilities. • Information about funding available for products. • Information about funding available for services. • Documentation to show that the program is economically viable.

(Scherer et al., 2019; Clayback et al., 2015; and MacLachlan et al., 2018)

Provision

The provision of AT programs is usually an administrative outcome that frequently involves examining the process of service delivery and often might include evaluations, such as surveys, of the users' satisfaction and realization of benefit from use (See Table 4). As previously mentioned, measuring outcomes depends on data collection, preferably post-intervention in addition to the baseline data. Provision also involves consideration of the composition of the AT team and how its members are incorporated into the services provided (Scherer et al., 2019). Previous research has identified the establishment of key quality indicators for assistive technology provision systems as key to decision making for efficient and effective services (De Witte et al., 2018).

Table 4: Examples of influences on outcomes of the system related to Provision

Questions to examine influences on outcomes of the system	Documentation of statements of outcomes (examples of successful inclusion)
<p><i>Selecting the technology or other support</i></p> <ul style="list-style-type: none"> • Has a comprehensive assessment been done to select what will best suit the user's needs and preferences (a technology, additional personal assistance, a combination)? • Have options been prioritized, and has it been decided why one product or feature is preferable to another? • Has the technology been assembled correctly? • Has a trial been undertaken in the settings of use? 	<p><i>Selecting the technology or other support</i></p> <ul style="list-style-type: none"> • Directories of local facilities and resources are available. • A process to guide AT selection and decision-making is available and used. • Documentation that a comprehensive assessment was done. • There is a satisfactory balance sheet. • Proof that Products meet regulatory standards. • Evidence that products have been safety-tested. • There is a satisfactory safety record. • Formal partnerships exist between users, manufacturers, suppliers, and vendors. Documentation of the results of consumer trials and locations of trials.

(Scherer et al., 2019 and De Witte et al., 2018)

Personnel

Individual experiences, viewpoints, and pre- and post-service training of AT personnel (including professionals and non-professional staff) all play a role in effective service delivery, i.e., delivering effective AT interventions. Key results, which are best captured using both qualitative and quantitative data, include adequate staffing (Scherer et al., 2019) and sustainability indicators (Smith et al., 2018; see Table 5). Assistive technology education and certification has been a focus for decades (Kanny et al., 1991) and remains an active and current area of concern (Goldberg et al., 2022).

Table 5: Examples of influences on outcomes of the system related to Personnel

Questions to examine influences on outcomes of the system	Documentation of statements of outcomes (examples of successful inclusion)
<ul style="list-style-type: none"> • Have providers received adequate training? • Are regular training opportunities provided to provide new and updated information? • Do providers have the essential certification or licence? • Do providers have the resources and support they need? 	<ul style="list-style-type: none"> ▪ Proof that providers meet all qualifications to practice. ▪ Evidence of satisfactory provider performance. ▪ Evidence of provider satisfaction.

(Scherer et al., 2019; Smith et al., 2018; Kenny et al., 1991; and Goldberg et al., 2022)

Products

The key role-players in this domain are the product designers (who focus on product appearance, costs, safety, usability, and mechanical aspects), manufacturers and suppliers. Thus, product outcomes refer essentially to the technical characteristics (Scherer et al., 2019; see Table 6). It is critical that outcomes data

which are relevant to all stakeholders in the product development and evaluation process be collected (Smith et al., 2018).

The key message from the 5Ps is that all are stakeholders' positions with unique contributions and interests pertaining to AT outcomes. Some Ps may have common interests between them, but often they are disparate. Consequently, considering all 5Ps is a necessary step in designing, creating, and implementing an AT outcomes system that ultimately successfully measures the impact of AT interventions (Scherer et al., 2019).

Table 6: Examples of influences on outcomes of the system related to Products

Questions to examine influences on outcomes of the system	Outcome Documentation Statements (examples of successful inclusion)
<p><i>Performance</i></p> <ul style="list-style-type: none"> • Is the product reliable? • Is the product stigmatizing, fatiguing, painful to use? • Is the product compatible with use of other supports, durable, portable, easily serviceable? • Does the technology require customizing or other adaptations? 	<ul style="list-style-type: none"> ▪ Evidence that available products are reliable are. ▪ Evidence that products are publicly accepted. ▪ Evidence of insights obtained from user experience (compatibility, useability, need for adaptation).
<p><i>Procurement</i></p> <ul style="list-style-type: none"> • Can products be purchased, fabricated, leased? 	<ul style="list-style-type: none"> ▪ Information about purchasing options is available.
<p><i>Pace</i></p> <ul style="list-style-type: none"> • Can products be obtained in a timely fashion? • How easily and quickly can servicing and repairs be done? • For those with rapid developmental changes, how easily and quickly can upgrades be obtained? 	<ul style="list-style-type: none"> ▪ Evidence that products are available in a timely manner. ▪ Evidence of timely turnaround in product provision. ▪ Evidence that services are available in a timely manner. ▪ Evidence that consumer-standards for servicing and repairs are met. ▪ Evidence that product updates and innovation are available in a timely manner.
<p><i>Promotion</i></p> <ul style="list-style-type: none"> • Are promotional materials attractive and credible? • Are promotional materials informative and understandable? • Are promotional materials available and easily accessible? 	<ul style="list-style-type: none"> ▪ Evidence that products have high customer satisfaction ratings. ▪ Specifications and manuals are easily accessible and understandable. ▪ Operations manuals are comprehensive and understandable, and available in accessible formats.

Discussion

Applications of the WHO and GAATO Frameworks

The broad global analysis of the 5Ps and GAATO Models creates a framework for understanding and addressing AT outcomes in a new way, particularly in how the AT outcomes and their impacts are collected and documented. Firstly, the way in which AT outcomes are documented and the methodologies used varies considerably across geography, types of assistive products, provision settings, the level of mandate for research, and funding sources. This vexing issue has challenged those working in the AT sector for many years. For example, at times, the outcomes and benefits of AT interventions are explicit and, thus, do not seem to require data about outcomes. Paradoxically, for people not working directly in the field as providers, e.g. funders or policymakers, measurement and documentation of AT outcomes are very important to be able to demonstrate evidence of the effectiveness of AT interventions (Clayback et al., 2015). Interestingly, the lack of evidence can also justify the limiting of funds (Smith, 2016). This is a conundrum of evidence-based funding. Funders can say they need evidence of outcomes to approve funding but, if policymakers do not require collection of data to measure outcomes when AT is provided, then this will not be documented, and funders will not have the evidence they need to support the provision of AT. From the perspective of the WHO Ps, this concept is clear and helps to understand the problem. The **People** need the Assistive **Products**. Trained **Personnel** develop and implement the **Provision** mechanisms to assess and document the needs, but, if no **Policymakers** mandate the collection of data to measure outcomes after the AT is provided, no evidence is available to advocate that **People** receive the **Products**. This is a frustrating situation where the barrier to **People** receiving needed **Products** is the lack of a system to measure outcomes.

A second example applies to the use of innovative research methodologies. While randomized clinical trials (RCTs) are the accepted standard for creating evidence to report the outcomes of interventions, innovative outcomes research methodologies are conducive to developing AT. For example, in the area of special education, the use of the single case study design (N = 1 study) has been used effectively to document AT outcomes. In epidemiological research, population-based research is primarily used, and registries have become more welcome as a method of intervention discovery (Blumenthal et al., 2018; Smith, 2016). Currently, in the field of computer science, the concepts of big data, data intensive science, the cloud, and artificial intelligence are popular because large intervention data sets can lead to better outcomes predictions. However, these new outcomes methodologies are poorly understood by most **People**, **Provision** programs, and **Personnel** in the field, and are mostly ignored by **Policymakers** and funding agencies. Therefore, these new methodologies for assessing outcomes are not often used. From the perspective of the GAATO framework (GAATO, 2022b), there is a **Need** for better **Measurement** to **Document Inputs**, and **Measure Outcomes** and **Impact** as a **Shared** system to **Inform Policy**.

Lastly, use of mobile phones is a particularly rich example of how the GAATO framework can be applied to AT outcomes. Specifically, to inform potential opportunities to develop outcomes policy across global regions, countries, and local differences. Beyond paper-based data collection methodologies, high mobile phone penetration rates in low- to middle-income countries might be an opportunity to harness the advantages of mobile technologies, not only to increase access to AT, but also to create, administer, aggregate, and report (real-time) AT outcomes. The global AT sector needs new methods to collect, document and analyse data about AT outcomes to move forward. Using the GAATO framework, accessing mobile phones can produce a method to **Measure** the **Need**, **Document** the **Inputs** of AT use and intervention, serve as a platform for **Measuring Outcomes**, and **Measure Impact** while Sharing the **Data** that are acquired electronically through

mobile phone networks. These broad data collection networks can compile and evaluate accumulated data to **Inform Policy**.

A number of challenges, gaps, and opportunities related to AT outcomes have also been identified from the literature and from expert data sources such as the WHO and GAATO Global Consultation. These include: (1) the lack of consistent terminology and concepts, which creates barriers to effective collaboration and knowledge translation; (2) existing structures which hamper innovation, e.g. responsibility for leading change, which can be addressed through high-level agreement regarding global priorities, such as the Sustainable Development Goals, the Convention on the Rights of Persons with Disabilities, and Rehabilitation 2030 (WHO, 2023); and (3) creating the infrastructure for a process to measure and document outcomes of the AT system, which is not a standard process for practitioners or researchers (refer to the Tasks listed in Table 7).

Table 7: Proposed process to develop a system to measure AT outcomes

STEP	
Step 1	Commit to creating a system to measure AT outcomes and articulate purpose
Tasks	<ul style="list-style-type: none"> • Draft and revise purpose. • Document audience(s) for reports generated by the system.
Step 2	Identify INGO(s) (what is to be measured in what contexts?)
Tasks	<ul style="list-style-type: none"> • Specify target Population(s) of users. • Specify target Population of secondary users and other people affected, e.g. co-workers. • Specify target Products of interest. • Specify exact features of target Products of interest. • Specify target product Performance areas of interest. • Specify target Situations and Environments.
Step 3	Identify outcome(s) of interest for each component of the AT system
Tasks	<p>PEOPLE, for example:</p> <ul style="list-style-type: none"> • Functional areas of interest fulfilled (quantitative or qualitative change); • Well-being; • Expected and realized benefit; • Goal attainment.
	<p>PRODUCT, for example:</p> <ul style="list-style-type: none"> • Durability; • Reliability; • Cost, safety and comfort; • Complexity of device usage; • Delivery and set-up time; • Need for maintenance and repairs.
	<p>POLICY, for example:</p> <ul style="list-style-type: none"> • Regulatory requirements met; • Compliance with voluntary standards; • Discretionary funding available for purchase by end-users or by third-party funders.

STEP	
	<p>PROVISION, for example:</p> <ul style="list-style-type: none"> • Waiting list, turnaround time acceptable; • Essential trained specialists available; • Essential validated assessments available; • Partnerships forged, e.g. vocational rehabilitation; • Discretionary funding available for purchase by end-users or by third-party funders.
	<p>PERSONNEL, for example:</p> <ul style="list-style-type: none"> • Appropriate qualifications obtained; • Feasible caseload with available time; • Resources available. • Continuing education provided. • Specify P's of interest (from the framework under Step 3). • Specify Measurement Domains within each P of interest.
Step 4	Review and identify measurement instruments for outcomes
Tasks	<ul style="list-style-type: none"> • Locate existing measurement instruments that measure the outcomes within relevant P's. If no instruments are available or found, consult experts to consider: <ul style="list-style-type: none"> ○ Using non-AT specific instruments as: <ul style="list-style-type: none"> ▪ Pre/Post AT intervention or ▪ With/Without AT intervention ○ Development of a new instrument. • Select outcomes measurement instrument(s).
Step 5	Decide on data collection mechanism.
Tasks	<ul style="list-style-type: none"> • Decide who will collect the data and how they will be found. • Identify or create incentives for data collectors. • Determine what privacy and data security protocols are needed. • Select technology or technologies for data collection, e.g. mobile phones, paper and pencil etc.
Step 6	Decide on data collection frequency (minimum)
Tasks	<ul style="list-style-type: none"> • Collect baseline data (before or without use of AT products). • Record result of intervention (after or without AT intervention). • Schedule ongoing data collection (follow-up).
Step 7	Create database infrastructure
Tasks	<ul style="list-style-type: none"> • Select where the data will be stored. • Determine how the data will be compiled, cleaned, managed and maintained.
Step 8	Design reports for outcomes data
Tasks	<ul style="list-style-type: none"> • Specify audience(s) for reports. • Specify content of reports. • Decide frequency of reports. • Select media for outcomes reports and methods of distribution to audience(s).
Step 9	Create sustainability plan for outcomes assessment
Tasks	<ul style="list-style-type: none"> • Identify ongoing funding for the outcomes measurement system.

(Clayback et al., 2015; Smith. R., 2016; Fitzgerald et al., 2007; Blumenthal et al., 2018; James et al., 2022; GAATO, 2022b; and WHO, n.d.)

Outcomes and Benefit

Consideration of the issues discussed in this paper is a priority for the AT sector and is essential for the implementation of new AT programs and for updating existing services, research, and development processes. The historical and current scientific status of AT outcomes were summarized and were mapped thoroughly against the GATE 5P model for strengthening access to AT. AT outcomes must be considered holistically from both the evidence-based practice and practice-based evidence perspectives to address the complex system of assistive technology adequately. Furthermore, this paper is a call to action and a beginning point for a knowledge translation process that has the potential to unite the AT sector around the globe in cooperative action. The 5Ps and GAATO Models provide excellent conceptual frameworks for such an undertaking, which has the potential to create real change and opportunities centred around AT, disability, and related health issues.

With the launch year of the WHO/UNICEF Global Report on Assistive Technology (2022) as well as the unprecedented development of international, mission-led, AT bodies (Layton et al., 2020), the time is right to establish new methods for collection and analysis of data to measure AT outcomes for documentation and discovery (Lenker et al., 2021). To be in a position to deliver a system which builds on the rich history described above, and to reach consensus of opinions to guide future actions and collaboration, a process to develop a system to measure AT outcomes is proposed in Table 1.

This perspective paper has reviewed the development of outcomes in assistive technology research and emphases over time. Looking forward, it will be important to work globally to achieve outcomes of technology benefit in multiple arenas. It is proposed that the 5P model serves as an integrative model to enhance and guide research on AT outcomes. The imperative to act is provided within the Global Report on Assistive Technology and documents by GAATO. Multiple points of measurement—from need through inputs and outputs, and the necessity for shared vocabulary, data systems and a link back to policy—are clearly required. It is hoped that the reflections provided in this paper contribute to a future direction.

This manuscript represents the perspective of the author and the work reported herein was not subject to IRB oversight.

Declarations

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