

# Environmental Evaluation of a Rehabilitation Aid Interaction under the Framework of the Ideal Model of Assistive Technology Assessment Process

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**Abstract.** Recently Federici and Scherer [1] proposed an ideal model of an Assistive Technology Assessment (ATA) process that provides reference guidelines for professionals of a multidisciplinary team of assistive technology (AT) service delivery centers to compare, evaluate, and improve their own matching models. The ATA process borrows a user-driven working methodology from the Matching Person and Technology Model [2] and it embraces the biopsychosocial model [3] aiming at the best combination of AT to promote customers' personal well-being. As Federici and Scherer [1] suggest, the multidisciplinary team, by applying the ATA process, may provide for users not only a device, but much more an assistive solution, which is the real outcome of a match process. An assistive solution is provided for the user only when the interaction dialogue between user, device, and environments of use improves the users' performances in participating in their everyday contexts. In this theoretical framework, the evaluation of the users' interaction with the AT in different kinds of environments is a key factor for the success of the ATA process, because, as Mirza, Gossett Zakrajsek, and Borsci [4] claim, the environment is antecedent to the AT and crucial for identifying how the AT works in relation to the users' needs. In the ATA process a specific Environmental Assessment (EA) model for testing the interaction of the user with the environments of use, through the AT, has been defined. The aim of this paper is to describe the EA model steps and discuss the dimensions that a practitioner has to consider for this assessment. Accessibility, universal design, and sustainability are used in the EA model as the dimensions for measuring the relationship between the AT and the environment [4]. The EA model steps and the trade-off among these dimensions are presented through a case example in which practitioners analyze the relationship between a communication aid used by a child and her classroom and home environments.

**Keywords:** accessibility, assistive technologies, sustainability, universal design, user-centered delivery process.

# 1 Theoretical Background

The term “assistive technology” (AT) is “an umbrella term for any device or system that allows individuals to perform tasks they would otherwise be unable to do or increases the ease and safety with which tasks can be performed” [5]. Moreover, an AT can be considered as “any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities” [6, 7]. In the light of these definitions, it is quite evident why in the last few years many researchers have studied the processes of AT assignment, by aiming to rate the success (in terms of increasing the people’s well-being) and failure (in terms of AT non-use) of the AT delivered to the people.

In the AT industry, the term “service delivery” is used to identify the set of procedures and processes that act as intermediaries between the AT manufacturers and AT end-users [8]. The AT delivery process, carried out by a team of professionals with different areas of expertise [1, 2, 9, 10], is articulated in activities which include the physical delivery of the technical aid to the disabled person, the user’s training, and the setting up of the technology. The overall process of an AT delivery system is oriented to obtain, through a well-designed and researched sequential set of assessments, the best match between the AT and the user (i.e., matching process).

A well-designed system of AT delivery in which the matching process is iteratively supported by the effort of a team of professionals in order to identify and adapt an AT to the user’s needs is a central topic. In fact, many studies have clearly shown that a wrong or a not-user-centered process of matching, assignment, and delivery results in a high percentage of AT non-use (estimated from 30% to 33%) after the delivery [11-13].

As the United States Assistive Technology Act [6] indicates, the matching process differs from any other process of system delivery, because the professionals of an AT service have to provide not only the technology, but a set of services that directly assists an individual with a disability in the selection, acquisition, or use of an AT device. In tune with this complexity, as Federici and Scherer suggest, the team of professionals of an AT service delivery have to aim to deliver not the technology per se, but much more an assistive solution that acts “as a mediator of quality of life and well-being in a specific context of use. [...] An assistive solution does not coincide with assistive technology, since the first one is a complex system in which psychosocio-environmental factors and assistive technology interact in a non-linear way by reducing activity limitations and participation restrictions by means of one or more technologies” [1].

Finally, the assistive solution is the outcome of a user-driven process, called by Federici and Scherer [1] the Assistive Technology Assessment (ATA) process, aimed at the improvement of individual functioning.

## 2 The Model of the Assistive Technology Assessment Process

The ATA process model is “a user-driven process through which the selection of one or more technological aids for an assistive solution is facilitated by the comprehensive utilization of clinical measures, functional analysis, and psycho-socio-environmental evaluations that address, in a specific context of use, the personal well-being of the user through the best matching of user/client and assistive solution” [1]. This process is usually represented as a flow chart that can be read either from the perspective of the user or from the perspective of an AT service delivery. For our aims we report here only a descriptive sketch of the user’s and AT service delivery center’s actions.

The user’s actions in the ATA process can be grouped into three phases: (i) The user seeks a solution; (ii) The user checks the solution provided by the professionals; (iii) The user adopts the solution, and receives training and follow-up.

The actions of the AT service delivery center can be grouped into four phases: (i) Initial meeting with user and interviewer focused on gathering the user’s background information and psycho-socio-environmental data; (ii) The multidisciplinary team evaluates the data and user’s request and arranges a suitable setting for the matching assessment; (iii) The multidisciplinary team, along with the user, assesses the assistive solution proposed, tries the solution and gathers outcome data. When the assistive solution proposed requires an environmental evaluation, the team initiates a parallel assessment called the Environmental Assessment (EA) process. The multidisciplinary team evaluates the outcome of the matching assessment, then proposes the assistive solution to the user; (iv) When the technological aid is delivered to the user, a follow-up and ongoing user support are activated and the assistive solution is verified in the daily-life context of the user.

The ATA process model has placed the user at the center of the evaluation process, and it acknowledges that the environment is antecedent to the AT and crucial for determining an assistive solution [4]. In light of this, the evaluation of the environment is a key factor for identifying the best assistive solution “intended as individualized interventions providing users with appropriate environmental facilitators (AT products, personalized environmental modifications, personal assistance) to overcome disability and enable participation in all aspects of life” [14].

### 2.1 Assessing Environmental Factors

The World Report on Disability has recently confirmed an assumption in the field of disability studies: “Data on all aspects of disability and contextual factors are important for constructing a complete picture of disability and functioning. Without information on how particular health conditions in interaction with environmental barriers and facilitators affect people in their everyday lives, it is hard to determine the scope of disability” [7]. According to the ICF biopsychosocial model of disability [3], Environmental Factors (products and technology, the natural and constructed environment, support and relationships, attitudes and services, systems and policies) and Personal Factors (e.g., age, sex, race, motivation, and self-esteem) belong to the Contextual Factors. Therefore, we define the environment in the ATA process as any context in

which the AT is used by a person, according to the World Health Organization's description of the environment as "the world in which people with different levels of functioning must live and act" [7].

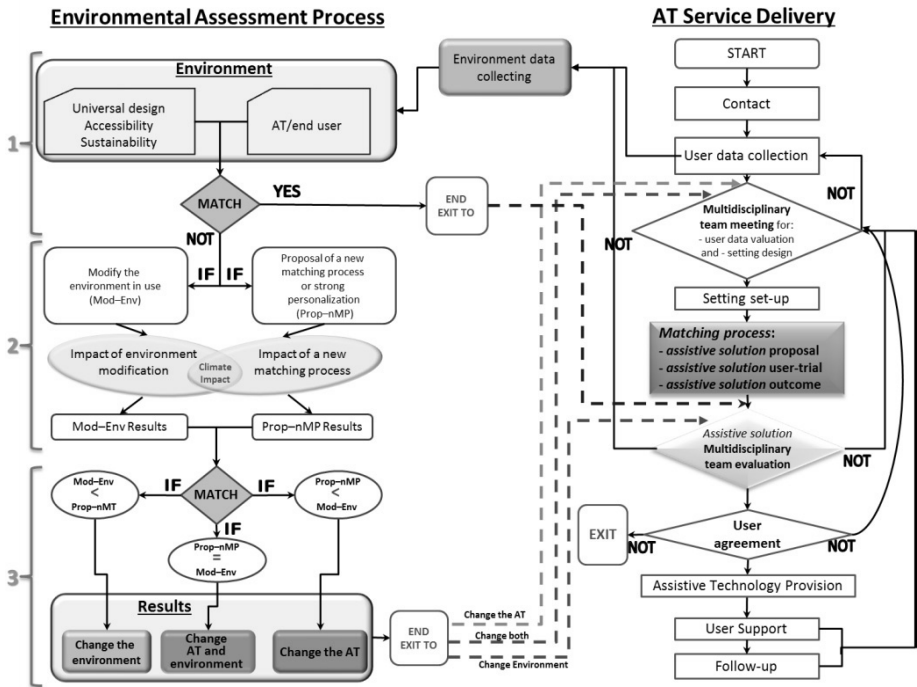
The EA process aims to analyze the cost-benefit balance with regard to the impact of the AT on the environment to lead the multidisciplinary team and the user to either modify the environment, or change the AT, or both. This decision in the EA process is supported by measuring three dimensions of environment and AT impact on the user's performances [4]:

1. Accessibility (Access): This measures the level of environmental characteristics to permit entrance, exit, and internal movements. This measure also predicts how many changes are needed for rendering accessible the environment in use;
2. Universal design and usability (Use): This measures how much an environment and a human product are designed for all;
3. Sustainability (Sustainable): This measures to what extent an environment and AT are adaptable over time to a person's changing needs, with minimal impact on the natural environment and economic maintenance.

The dimensions of accessibility, sustainability, and universal design all exist along their own continuum and each decision about the environment or about the AT (or both) can be evaluated in terms of universal design, accessibility, and sustainability, falling into various places on the three continua. The evaluation of the three continua can help to focus a decision on a critical deciding factor for improving the person's performance.

As displayed in Fig. 1, we can identify three main phases in the EA process:

1. Checking the match (Fig. 1, point 1). The practitioners (such as engineers, architects and experts of human factors) assess the environmental impact on supporting or obstructing the full participation of the user. If there is a match between the environment, the user, and the AT, the assistive solution is achieved and the environment assessment process ends. However, if a match does not occur, it is necessary to estimate the impact of any possible modification to the environment or to the AT.
2. Checking the impact (Fig. 1, point 2). Practitioners have to check the economical and socio-cultural impact of the modifications to the climate.
3. Making a decision (Fig. 1, point 3). On the basis of the impact analysis, practitioners can make one of the following decisions: (i) Modify the environment: In this case, the ATA process restarts from the multidisciplinary team's evaluation for a new or the modified assistive technology. The match between the AT and the user only requires a minimal environmental adaptation. (ii) Modify the AT: In this case, the ATA process restarts with a new multidisciplinary team meeting in order to discuss: (a) The cost benefit of AT modifications; (b) The cost benefit of identifying another AT. In this case the process restarts from the beginning of the ATA process. (iii) Modify both the AT and the environment. In this case, the ATA process needs to restart with a new multidisciplinary team meeting in order to discuss the cost benefits of the proposed modifications.



**Fig. 1.** Flow chart of the Environmental Assessment Process in the ATA process model. The phases of the environmental assessment (1, 2, and 3 on the right) are linked to the procedures of the AT Service Delivery process.

The environmental assessment, when needed, supports and integrates the ATA process driven by two main actors: the user and the multidisciplinary team.

### 3 Evaluation of the AT Interaction in the Environment: An Evaluation Case

For the aim of our paper we will report only a sketch of the subject profile as follows: Roberto (Rob) is 7 years old with a diagnosis of severe spastic quadriplegia with a dystonic component. His individual functioning can be summarized as follows:

- He attempts to grasp, but he has significant dystonia;
- He has standard visual performance (field of vision, visual acuity, sensitivity to contrast etc.). Moreover, he perceives and locates objects in both the proximal and distal distance, with good ability to fix and track;
- He has excellent cognitive resources and he is very communicative and participatory with the environment. He appears to understand any request about tasks ;
- He moves voluntarily within the room using a motorized wheelchair;
- He uses augmentative communications adequately.

The multidisciplinary team, after the evaluation of match with different kinds of ATs, suggests that Rob's performances could be significantly improved by using, together with his current AT, a writing and multimedia Clicker tool and a Junior postural system. Nevertheless, some concerns about the use of these new ATs in the classroom environment are outlined by professionals in their report. In fact, while these ATs could be a main factor for the integration of Rob within the class, at the same time the main concern of the team is that a too fast changeover to the most advanced technological tools could require an excessive effort from Rob for the training in the ATs use, and at the same, as a novice in the use of these ATs, he may experience initially a decrease in his communication performances. These difficulties in the use of the ATs could be perceived negatively by Rob and impact negatively his daily life in the classroom.

Taking into consideration these concerns, the multidisciplinary team requests an environmental evaluation to test the interaction between Rob and the new ATs in his classroom environment. The professionals run the EA process by using the environmental codes of the International Classification of Functioning, Disability and Health – Children and Youth Version (ICF-CY: [15]) to codify the assessment. The analysis of the use of the ATs in the environment (universal design) is designed as a test of Rob's performance in interaction with (i) the Clicker tool (ICF-CY code=e1251) by using it as a postural system in the classroom (ii) his electric wheelchair (ICF-CY code=e1201). Moreover, by considering the physical requirements for the use of the Clicker tool in terms of accessibility and sustainability, professionals arrange the test with Rob sitting (i) at his usual desk in a central position, and (ii) in a new desk position. The new position of the desk was selected by professionals for the following reasons: (i) it was more peripheral from the center of the classroom and closer to the wall (but still not isolated) than Rob's usual desk, reducing the possibility that his schoolmates accidentally damage the AT device; (ii) it had a higher level of illumination than the usual position (ICF-CY code=e2400); and (iii) it was close to an electrical outlet (ICF-CY code=e1501). Rob's performance time was assessed by using three different tasks for each trial; the performance time measured in the laboratory of the AT service delivery center ( $M=13.26$  s;  $DS=4.02$  s) was used by professionals as a comparative index of performances. The findings obtained were as follows:

- When the Clicker tool was tested in a central position, Rob's interaction was very slow ( $M=25.01$  s,  $DS=5.73$  s). The AT in this position decreased Rob's performance compared to the laboratory testing. In this context of use, the Clicker was not as good a facilitator (ICF-CY code=e1251.+0) as the electric wheelchair (ICF-CY code=e1201.+0). Moreover, the low illumination and the distance from the socket unit acted as severe environmental barriers (ICF-CY codes=e2400.3 and e1501.3). Finally, the test showed that the use of these ATs in the classroom environment caused problems in the dimensions of accessibility and universal design, while, from the sustainability point of view, the electric wheelchair did not support Rob's movements during the interaction.
- When the Clicker tool was tested in a peripheral position, Rob seemed more comfortable, due to the optimal level of illumination. Nevertheless, he was not driven

to control his hand movements by the electric wheelchair ( $M=19.55$  s;  $DS=3.22$  s). In that case, the illumination and the access to the sockets acted as facilitators (ICF-CY codes=e2400.8 and e1501.8), whereas the electric wheelchair and the Clicker tool had still not properly supported Rob in his movements (ICF-CY codes=e1251.+0 and e1201.+0). Therefore, although the accessibility problems were solved, and Rob's performances were slightly improved, his movements were still affected by the electric wheelchair.

Finally, Rob was invited to test the Clicker tool sitting in the Junior postural system previously tested in the laboratory of the AT service delivery center. This test was only run with the desk in the new peripheral position. With the use of this kind of postural system, the times of Rob's performances were very close to his performances at the center ( $M=14.05$  s;  $DS=1.57$  s).

At the end of their report, the professionals proposed that the Clicker tool could be used as a complete facilitator (ICF-CY code=e1251.+4) only when associated with the Junior postural system tested at the AT service delivery center (ICF-CY code=e1151.+3), also recommending that the position of the desk in the classroom should be modified in order to optimize Rob's performance in its use.

On the basis of this analysis, the multidisciplinary team decided to introduce gradually the new ATs in Rob's contexts of use and concurrently to modify the environment (his position in the classroom) as proposed by the environmental report.

## 4 Conclusion

An AT can be considered an assistive solution only when all the possible nuances of the user's interaction experience have been carefully analyzed under the lens of accessibility, universal design, and sustainability. When a trade-off among these three dimensions is identified by professionals, it is possible to match the needs of the users, the functioning of the AT, and the context of use by allowing users an efficient, effective, and satisfactory interaction with the technology in their environment. Nevertheless, the trade-off of the accessibility, universal design, and sustainability dimensions often requires one of the components to be modified in interaction with the user (the AT or the environment). In light of this, the EA process consists in the decision-making flow that could lead professionals to modify the environment, the AT or both for a successful matching between user and technology.

This decision process is carried out relying on measurements and methods that pertain to the interaction assessment, as shown in the evaluation case. Finally, in line with the AAATE/EASTIN indication [14], the EA process represents a new way to improve the efficiency and the effectiveness of the AT system delivery process that brings from the interaction framework a set of evidence-based practices and concepts to support professionals in taking critical decisions for the relationship between the users and the AT.



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