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Universal design in diabetes: An idea whose time has come

Ann S. Williams, PhD, RN, CDE
Frances Payne Bolton School of Nursing, Case Western Reserve University, Cleveland, Ohio 44106, Telephone: 216-368-2147, Fax: 216-368-3542

Ann S. Williams: asw13@cwru.edu

Abstract

Purpose—The purpose of this article is to introduce diabetes educators to the emerging concept of Universal Design (UD): the design of products, environments, and services to be used by persons with a wide range of abilities, without needing adaptation or specialized design.

Method—Drawing from the use of the term "Universal Design" in a variety of types of writing, this article covers: definition of UD, contrast of "average person design" with UD, and implications for diabetes self-management education (DSME).

Summary—Implications for DSME are: (1) Diabetes consumer medical devices (such as blood glucose meters and insulin pumps) can be designed using UD principles, with a goal of successful use by the largest number of persons possible; and (2) Diabetes educators can use UD principles in the design of diabetes education programs to reach the largest number of learners possible without the need for special accommodations.

Conclusions—Adoption of UD principles by designers of diabetes medical devices could benefit persons with disabilities, increase the potential market for the manufacturer, and have unexpected benefits for people of average abilities. Adoption of UD principles for DSME programs would not require a paradigm change, since diabetes educators already do many activities that could contribute to UD of an education program. By replacing "average person design" of DSME programs with UD, diabetes educators can promote full participation in DSME for individuals with the wide range of abilities normally present in target populations, without the need for added adaptations or specialized design.

Following the passage of the Americans with Disabilities Act in 1990,[1] persons with disabilities in the United States (US) have experienced greatly improved access to public spaces and services. In conjunction with this substantial progress in accessibility, there have been corresponding advances in the development of concepts related to inclusion of people with disabilities in mainstream society. A major concept that has received much attention in recent years is "universal design" (UD).[2] The purpose of this article is to introduce diabetes educators to the emerging concept of UD.

Definition

UD is defined as the design of products, environments, and services to be effectively and efficiently used by persons with a wide range of abilities to the greatest extent possible, without adaptation or specialized design.[3–6] Other terms commonly used around the world to mean the same thing include: design for all, inclusive design, and barrier-free design.[7]

The definition of UD is intentionally ambiguous, to provoke discussion.[2] UD is considered a process, not an end point, in the spirit of continuous quality improvement (CQI). Because the concept is in early stages of development, no one knows yet what "the greatest extent possible" is for use of any particular product or service. Our understanding of and standards for UD in the future are likely to be quite different from our understanding and standards today.

Contrast: "Average Person" Design vs. Universal Design

A typical philosophy of design, used by many industries throughout the U.S., is known as "average person design" (APD). The core concept of APD is to design products and services for an average person – a person whose abilities fall approximately in the middle 90% of a typical bell curve describing that ability in a target population.[8, 9] Designers using this philosophy consider design for the people in the upper and lower 5% to be a specialized market that should be served by small, specialty companies.

APD originated as a concept in the military during World War 2, with applications to design of military machines (e.g., airplanes, tanks, ships, and submarines). Following the war, extensive data about average soldiers was available. The pent-up demand for housing and consumer goods stimulated a mass-production market that used the existing military data as "average person" parameters for the design of civilian goods.[8, 10]

In retrospect, it is easy to see some major problems with this early "average person" application. The average soldier – a young, able-bodied male – does not represent the average person in a general population. Furthermore, when a design assumes that the user has the abilities of typical young, able-bodied males, the product can be unsafe or inaccessible for other people in a typical population of users.

As an illustration, consider housing standards based on WW2 "average person" data. Two typical housing features –electrical plugs in baseboards near the floor, and stairs at the entrance of the house – present no difficulties to young, able-bodied men. However, electrical plugs in baseboards can be dangerous for very young children; and they are out of reach for many older persons who cannot easily bend down. Furthermore, stairs at the entrance can make an entire house inaccessible for anyone who has mobility problems.[10]

In contrast, the core concept of UD is to create designs that can be used by as many individuals as possible in typical populations. UD shifts the focus of the design from an individual *average user* to a typical *population of users* who have a wide range of abilities. This shift of focus is based on the non-negotiable reality that a broad range of human abilities within a given target population is normal and ordinary, not abnormal or "special." In the examples mentioned above concerning standard housing design, it is normal and ordinary that houses are occupied not only by young, able-bodied men, but also by very young children and older people with limited flexibility and mobility, even though very young children and older people are not "average persons."

Through considering the human factors that may limit the usefulness of particular products and services, UD includes more individuals in the group that can easily use that design. Instead of designing for the middle 90% of people with a particular ability, UD principles encourage designs for as close to 100% as designers can imagine. Persons with a wide range of abilities can use the resulting products without needing special adaptations. So, for example, in housing design, installation of electrical plugs up a few feet from the floor is safer for young children and also easy to reach for adults who have difficulty reaching baseboards. Creating stair-free entrances for houses makes them accessible for people with mobility problems.

As an added unintended benefit, products with universal designs are often easier and more convenient to use for average persons. For example, electrical plugs located above the floor are easier for all adults to reach, and stair-free entrances enable people using strollers or wheeled luggage to move in and out easily.

Principles of Universal Design

Connel and nine colleagues, a working group of individuals who shared the goal of promoting UD in a variety of disciplines, collaborated in 1997 to produce "The Principles of Universal Design."[3] Purposes for publishing these principles included: evaluation of existing designs; guiding new designs; and educating consumers and designers about making products and environments more usable. The seven principles have become foundational. They are widely quoted in writings about UD.

The "The Principles of Universal Design." are listed below, with a brief explanatory statement for each one.

1. **"Equitable use: The design is useful and marketable to people with diverse abilities."**

   To avoid segregation and stigma, the same design should be usable by all persons, regardless of ability or disability. The design should be appealing to everyone, and have provisions that ensure privacy, security, and safety for all users.

2. **"Flexibility in use: The design accommodates a wide range of individual preferences and abilities."**

   Users should have choice of a variety of methods to use the design, including left or right-handed use, and adaptability in pace of use.

3. **"Simple and intuitive use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level."**

   The design is simple, intuitive, consistent with user expectations, and not dependent on literacy or a high level of language skills. The order in which information is presented reflects its importance. Prompting and feedback for partial and full task completion is incorporated into the design.

4. **"Perceptible information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities."**

   Redundant sensory input (auditory, tactile, and visual) presents essential information in a variety of ways, perceptible by people with a variety of abilities. Adequate contrast between the information and the surroundings, and maximum clarity or "legibility" of the information facilitates use. Essential elements of the design can be clearly described in multisensory ways. The design is compatible with tools and techniques commonly used by people with sensory limitations.

5. **"Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions."**

   The arrangement of the design should make hazards and errors unlikely by and making usable elements most prominent and eliminating predictable mistakes. Hazardous elements and those likely to lead to error should be eliminated, isolated, or shielded. Hazards and errors have warnings built in, along with fail-safe features. The design allows the user to undo mistakes whenever possible.

6. **"Low physical effort: The design can be used efficiently and comfortably with a minimum of fatigue."**

   The user can maintain a natural, neutral body position in all phases of use. The design uses reasonable forces for operation, and minimizes repetitive actions and sustained physical effort.

7. **"Size and space for approach and use: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility."**

   A seated or standing user has a clear line of visual and tactile approach, with all essential components for operation easily reached. The design is easy to use for persons with a wide variety of hand size, dexterity, and grip strength. The design has enough space for commonly used assistive devices or personal assistance.

Examples of well-known universal designs using these principles are abundant. Oxo® Good Grips® kitchen tools were originally designed for persons with limited manual dexterity and grip strength. Curb cuts were originally intended to provide accessibility for persons in wheelchairs. Television captioning was originally intended to make the audio portion of television accessible for people with hearing impairment. Recorded (or "talking") books were originally created to provide access to print for people with visual impairment. Collectively, these universal designs incorporate all of the principles listed above.

Taken together, these examples illustrate an additional principle: Unanticipated benefits. When adaptability is an integral part of a design, people of varied abilities often prefer it and find numerous uses for it.[11] Oxo® Good Grips® tools have become quite popular among persons with no manual problems, and have won many design awards because they are comfortable and easy to use for everyone.[12] Curb cuts benefit many people with high levels of mobility, such as skateboarders, bicyclists, people pushing strollers or shopping carts, and people pulling wagons.[11] Television captioning is used by many hearing people, such as exercisers in health clubs, diners in noisy restaurants, people learning English as a second language, and people who have a sleeping family member.[13] Recorded versions of many commercial books are now released along with the print versions, and are used by many fully sighted persons to listen to books while driving, exercising, or doing other tasks. As Rose and Meyer stated, "Addressing the divergent needs of special populations increases usability for everyone."[13]

DSME and Universal Design

In Diabetes Self-Management Education (DSME), there are two important applications of the basic concept of UD. First, diabetes consumer medical devices (such as blood glucose meters and insulin pumps) can be designed using UD principles, with a goal of successful use by the largest number of persons possible. Secondly, diabetes educators can use UD principles to design diabetes education programs that can reach the largest number of learners possible without the need for special accommodations.

Universal Design of Consumer Medical Devices for Diabetes

UD of consumer medical devices for diabetes would require planning in the design phase for a wide range of user abilities. Simple design changes often greatly increase usability for persons with limited abilities, broadening the potential customer base and increasing usability for everyone. Such changes could include: provision of redundant visual, tactile, and auditory information for both processes and outputs; simplifying procedures to a minimum number of steps for the user; increasing the size, spacing, color, and tactile contrast of control buttons or labels; and making all actions reversible if the person has made a mistake.[4]

Some of these changes have already made their way into the designs of some diabetes devices. For example, simplified procedures with large control buttons are now common in blood glucose meters. Insulin pens provide redundant visual, tactile, and auditory feedback as users dial a dose. Most insulin pumps have a procedure that allows the user to receive visual, tactile (vibration), and audio feedback to confirm a bolus amount and to cancel it if it has been wrongly programmed. And both blood glucose meters and insulin pumps commonly make actions reversible if the user makes a mistake.

In addition, because the process of UD of diabetes products is still in early stages, many more changes are possible that could make such products more widely usable and more convenient for everyone. For example, differently colored and tactile distinguishing marks for different types of insulin have been discussed for years, and are not yet a reality. Additionally, no one has yet explored ways that the audible or tactile feedback needed by visually impaired users of blood glucose meters and insulin pumps might also benefit sighted users. Therefore, as of this writing, most meters and pumps do not include redundant sensory feedback for all of their functions. The market for audible meters is still considered a specialized market; and no insulin pump yet exists that has all features fully accessible through audio and tactile redundant feedback.

Universal Design of Diabetes Education Programs

Like products and environments, services such as education programs can be designed for effective and efficient use by persons with a wide range of abilities to the greatest extent possible, without adaptation or specialized design. Rather than planning a curriculum for “average” learners and adapting or retrofitting the curriculum for “non-average” learners, an educator who uses UD principles can plan the education process for the broad spectrum of abilities present in a typical population of learners.[14] For example, it is predictable that a typical population served by a diabetes education program will include people with sensory disabilities (especially in hearing, seeing, and touching) and motor impairments (especially in manual dexterity and mobility). In addition, people who have learning disabilities, attention deficit disorder (ADD), and decreased cognition associated with early dementia or mental illness are also common.

In general, education theorists approach discussions of universal design by emphasizing the need for flexibility in four major areas of the educational process: facts about the students, content of instruction, educational process, and demonstration of student success. These areas are equivalent to processes familiar to diabetes educators: assessment of individuals, setting learning goals, planning educational activities, and evaluating progress. In educational programs based on UD, individual learners are offered a rich variety of methods and settings for learning essential information. Flexibility is needed in recognizing student strengths as well as deficits; in individualizing educational goals; in using a wide variety of instruction techniques that take advantage of student strengths and give access to content through a variety of media; and in using multiple and multilevel criteria for assessing learning outcomes.[13, 15]

As an illustration, consider a DSME class that contains persons with hearing loss, visual impairment, and ADD, as well as those without current disability. If essential material is simultaneously presented in both audible and visual formats – for example, using colorful illustrations in a slide presentation with detailed verbal description from the instructor – persons with hearing loss, visual impairments, and ADD will be better able to perceive, attend, and understand it. Adding a lively participatory game will enhance the attention of the person with ADD. Making all classroom materials available in printed handouts, and also in audio-recordings or digital format ensures that persons with visual impairment or ADD can review the information at their own pace and in their own way.

Just as UD has unexpected benefits for non-disabled users of products and environments, the use of UD principles in designing educational programs produces an enriched learning environment that benefits all learners. Non-disabled persons with a variety of learning styles, as well as persons with low literacy or English as a second language, can all benefit from multisensory, participatory learning activities. In the example described above, the presentation of essential materials in multiple formats can help to make the education more comfortable for learners from diverse ethnic backgrounds; more convenient for learners with time pressures; and more effective for non-disabled learners with a variety of learning styles (such as auditory, visual, or kinesthetic).[16]

Other examples of a variety of methods and settings that can benefit persons with diverse abilities include, but are not limited to: both individual and group settings for learning; both in-person and distance learning formats; use of a consistent, predictable class structure with repetition of major points to make learning easier for persons who have difficulty focusing attention; environments that accommodate both wheelchair users and persons on foot; and locations for classes that are accessible to persons who drive, walk, ride bicycles, and take public transportation.[16] For a more thorough discussion of universal design in education, please see the reference list.[13–17]

Conclusions

Some basic principles of UD are already incorporated into the designs of some consumer medical devices for diabetes. Many more UD changes are possible that would make use of diabetes devices even more effective and efficient for persons with a wide range of abilities without the need for adaptations or special design. Adoption of UD principles by designers of medical devices for diabetes would not only benefit people of varying abilities. It would increase the potential market for the manufacturer, and is likely to have unexpected benefits for people of average abilities.

Similarly, adoption of UD principles for DSME programs would not require a paradigm change, since diabetes educators already do many activities that could contribute to UD of an education program. In fact, flexibility in assessment, goal setting, planning, and evaluation is familiar as a standard for high-quality DSME. AADE's "Scope of Practice, Standards of Practice, and Standards of Professional Performance" require diabetes educators to conduct detailed individual assessments of patients, set individual learning goals, plan and implement appropriate learning activities for the individual, and evaluate individual and group behavior change outcomnes.[18] Funnell, Anderson, Austin, and Gillespie, in the AADE Position Statement, "Individualization of Diabetes Self-management Education," provide in-depth detail about what it means to deliver high-quality DSME to the wide variety of individuals with greatly divergent learning needs who are present in a typical target population.[19] Most diabetes educators are familiar with these concepts, and most diabetes education programs have structures intended to implement them, at least to some extent. UD principles could readily be incorporated into the existing foundation described in the Standards of Practice and Position Statement on Individualization.

However, most DSME programs still assume average abilities in program participants, and accomplish inclusion of persons with disabilities through accommodations added to the APD of the program – analogous to "retrofitting" a non-inclusive design of a device so that it can be used by someone with a disability. Inclusion through retrofitting is inherently less efficient and effective than designing for inclusion from the beginning, or UD. Furthermore, UD is likely to produce unexpected benefits for people with "average" abilities.

In summary, by replacing APD of DSME programs with UD, diabetes educators can promote full participation in DSME for individuals with the wide range of abilities normally present in target populations, without the need for added adaptations or specialized design.

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