THE NEED FOR UNIVERSAL DESIGN OF EDUCATIONAL FACILITIES AND LEARNING ENVIRONMENTS

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ABSTRACT

The architectural design of educational facilities plays a critical role in the teaching and learning process. As a leading principle, the philosophy of architecture should be compatible with the philosophy of education in order to generate expected outcomes. If the architecture doesn't allow educators to employ the best instructional strategies, this situation will create a serious constrain on their teaching preferences and they will eventually choose less effective strategies. Of course, such choices will influence the effectiveness, appeal and efficiency of learning environments negatively. Considering that student demographics have changed considerably in recent years and individual differences of learners have demonstrated greater variability, accommodating their needs has become much more difficult compared to previous decades. Instructional decisions may be relatively easier to make or modify according to learning needs but physical alterations in the architectural design of educational facilities are often hard, if not impossible. Thus, educational facilities and learning environments should be designed and constructed from the very beginning based on the essential principles of universal design to make them more accessible, safer, and more usable for all people. These principles were developed in 1997 by a working group of architects, product designers, engineers, and environmental design researchers as: equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use. Almost two decades have passed since the identification of universal design principles, educational institutions have not been very sensitive to the requirements and implications of these principles. This paper will elaborate on the essential principles of universal design as they are applied to the design of educational facilities, discuss the common restraining factors, and suggest solutions to make educational facilities and learning environments more accessible and usable. It is assumed that universal design of educational facilities will be beneficial to learners, schools and society at large.

Keywords: *Universal Design, Educational Facilities, Learning Environments, Design Principles, Educational Ergonomics.*

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1. Introduction

The concept of universal design has usually been discussed within the contexts of architecture and engineering. It was claimed that universal design promotes diversity, access, equity, inclusion, and safety. Thus, it has been largely applied to the design of streets, airports, stations, buses, museums, kitchens, machines, olympics, hospitals, web pages etc. In recent years, schools have joined this wave and educators have advocated universal design. Of course, this is not without reasons.

Student demographics have changed dramatically for the last several decades all around the world. Schools have evolved from being privileged institutions serving elite only to common grounds for all learners exemplifying various segments of the society. It appears that schools at any level of education have highly diverse groups of individuals demanding greater accessibility to proper learning opportunities regardless of their own conditions. The audience of a typical school includes children and adults, handicapped and non-handicapped, majority and minority, rich and poor, male and female, visual learners and verbal learners, digital natives and digital immigrants etc. In other words, student population in today's schools represents a heterogeneous body of learners with a number of social and individual differences.

All these learner characteristics, which are virtually unprecedented in the history of education, require greater accessibility, more safety and better usability in educational environments. This situation has certain implications for the design of educational facilities and environments, ranging from the macro-level architecture of buildings to micro-level learning activities implemented in the classroom. For example, the main gate of the school building should make entrance easier for all students, particularly the handicapped. Similarly, there should be a multimedia learning center in the school complex for students with different learning styles, especially for visual learners.

It is a challenging task to accommodate a wide variety of learner characteristics in designing and managing educational facilities. However, it seems to be an obligation for today's educators to find appropriate ways to accomplish this task. It has become a public issue and almost all learners demand that they are provided with easier and safer access to educational opportunities. Educators show either insensitivity to these demands or they do not know how to meet such needs.

Universal design provides both a general framework and a practical approach to make educational facilities and learning environments more accessible, safer and more usable for all people with regard to their wide spectrum of conditions, characteristics, and abilities. This paper discusses why, to what extent, and how this should be done within the context of educational ergonomics.

2. Background of Universal Design

In the early years, the concept of universal design has been interpreted in reference to rights of the handicapped. The reason for this was that the *handicapped people* had difficulty in accessing or using public facilities. Therefore, public buildings and their amenities have been designed in such a way that the handicapped people do not feel left out or disadvantaged. For example, many schools had built wheelchair ramps and installed elevators to make the life easier for the handicapped learners. Similarly, many elevators in public buildings were built in and installed with special codes for the visually impaired people.

Later on, the rights of *the elderly* people were considered another important issue in designing and constructing public facilities. Their needs and using habits differed from those of the majority of users. Revolving doors at the main entrance of the buildings were not appropriate for them because they were slower than the expected speed of an average user, stairs were not appropriate for them because the elderly people usually had difficulty in climbing the floors, steps inside the buildings

created additional hurdles for the old people because many of them had neck and skeleton discomforts. Considering these kinds of challenges, architects and engineers collaborated in constructing buildings with sensored/sliced doors, smart/sensitive lifts, and smooth/flat floors. These innovations have had certain implications for training centers and schools because adults have attended tertiary education in massive numbers. Naturally, educators needed to improve educational facilities and learning environments by adding new components to make them more accessible, safer, and usable for adult learners.

Another big wave has emerged particularly in recent years that *social traits* of users have become important for the design of public facilities. The variables appearing as crucial in this wave include but are not limited to being male-female, tall-short, heavy-light, large-skinny, right handed-left handed, literate-illiterate, urban-rural background, picky-butterfingered, fast-slow, strong-emaciated etc. These traits were important for many reasons. For example, when gates/doors are heavy and require considerable force to open, emaciated people cannot push or open them. Similarly, butterfingered or slow people often experience difficulty with revolving doors which are made of glass. Social traits of learners are particularly important for institutions with heterogeneous populations. Educational institutions should make it absolutely clear that nobody is left out for any reason.

Multiculturalism has also affected the design of products and environments for common use. Public buildings including schools were designed/constructed in such a way that members of various cultural groups should be able to use them without any constraints due to their differences. Considering that many countries around the world have a variety of subcultures, their public spheres need to reflect and accommodate subsequent demands. For example, United States has a large population that consists of Anglo-Americans, Hispanic-Americans, African Americans, Indian Americans, and Asian-Americans. Similarly, some European countries have a multicultural population due to ethnic diversity and constant immigration. Particularly immigrants speak different languages, have difficulty with the official language and show resistance against cultural assimilation. Thus, schools provide them multicultural or multilingual education that will allow them to benefit from proper learning opportunities and (Simsek, Simsek, & Yildiz, 2014).

Today, we have a more complicated situation in terms of having access to public facilities, particularly in educational institutions. Students come to schools with a wide variety of *individual differences*. These differences may be about intelligence, ability, personality, prior knowledge, cognitive style, motivation, epistemological beliefs, self-efficacy etc. No doubt, all these differences have certain implications for the design of educational facilities and learning environments. It is also true that it is a daunting task to accommodate all these differences in a typical learning environment. When educators design their materials with an average student in mind, this does not help much and leave many students outside their spectrum of reach.

3. Definition of Universal Design

Over the years, various definitions of universal design have been proposed. The most popular definition is probably the one suggested by the Centre for Excellence in Universal Design at North

Carolina State University, which states that "universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Centre for Excellence in Universal Design, 2016). More or less, the other definitions in the literature consist of the same elements.

When this definition is further analyzed, one can identify several dimensions. First, universal design principles can be applied to the design of products and environments in a variety of areas. Second, outcomes of universal design should be usable by all people regardless of their traits or characteristics. Third, there should be no need for adaptation on the products and environments that are designed based on the principles of universal design. In other words, outcomes of universal design should meet the needs of all people when they are in use. This requires that design, production, and usage of these products and environments should be in harmony without additional interventions or adjustments.

Of course, such a harmony involves the consideration of many factors including but not limited to aesthetics, engineering, safety, standards, quality, cost, usability etc. Thus, designers should have leading data about the characteristics of the assumed and/or identified universe of potential users. They make all the design decisions based on such data and develop the products and environments to meet the expectations to the greatest extent possible. They test their products and environments to find out whether they really work as intended. Based on the findings of the trials, they revise the outcomes (sometimes prototypes) and finalize them. Following all these stages and making necessary improvements, desired products and environments can be completed and put in actual use.

The finalized products and environments of universal design are expected to meet the needs of all potential users with a wide variety of characteristics that they may possess such as age, gender, disability, ethnicity, language, daily routines/habits, educational level, height, weight, physical load etc. In this respect, universal design plays a crucial role in democratization of services by making them appropriate for all possible users.

4. The Process of Universal Design

Functional design of any product or environment requires a systematic process in which a number of sequential or iterative steps are carried out. The designers first consider important issues and key variables that have effects or implications for design decisions. Relevant data, along with intuitions of the designers, guide the decisions regarding features of the products or environments. The decisions are then converted into qualities of the application while developing the archetype or prototype. Implementation provides useful feedback about appropriateness of the design. Finally, universal design standards are employed for evaluating the final outcome. The process of universal design requires a macro view of the application as well as a micro view of subcomponents (Burgstahler, 2016).

The process of universal design typically includes the phases of analysis, design, development, implementation, and evaluation. Certain tasks are carried out in these stages. Outcomes of each stage serve as inputs of the proceeding stage and this makes the course of design a systematic process. The following is a descriptive summary of the universal design process.

In the *analysis* stage, needs assessment is conducted and the target audience is defined. The designers try to assess the needs for the products or environments and identify important characteristics of potential users. The critical task here is to find out the needs and make decisions based on the characteristics of the target audience. In other words, the designers start with specifying the product or environment to which they wish to apply universal design and then define the universe by describing the diverse characteristics of potential members of the population for which the application is designed. The target audience may be students, faculty, staff etc. and their important characteristics may include gender, age, size, ethnicity, language, daily routines/habits, learning style, abilities to perceive and communicate.

In the *design* stage, fundamental features or crucial dimensions of the products and environments are decided, which eventually establishes functionality and usefulness of the product or environment. This includes both external (physical-structural) and internal (functional-operational) properties. Basically, the designers in this stage determine features of the products and environments based on data gathered in the analysis phase. In doing so, they consider the principles of universal design and integrate the best practices in the field of specific application.

In the *development* stage, prototypes or archetypes of the proposed products and environments are created. They are considered samples or exemplars. The models of to-be-completed outcomes are produced. For example, if the final outcome is a school building, the mock-up of the building with its all elements and amenities are created so that the builders can get a complete grasp of the school. At this stage, the relevant guidelines or standards are applied to overall design, subcomponents, and ongoing operations to maximize the benefits. The designers also develop solutions to address special requests (i.e. assistive technology, visual indicators, sign language interpreters, multilingual translations) of individuals for whom the design of the application does not automatically provide access.

In the *implementation* stage, the application process is carried out and the products or environments are constructed. Through this stage, we can see the proposed outcome as a physical entity in its visible form. This may be, for example, a school building that consists of classrooms, laboratories, workshops, library, computing facility, exhibition hall, ballrooms, gymnasium, conference center, cafeteria etc. However, we cannot only see major building blocks of facilities but also itemized elements such as doors, windows, corridors, walls, directions, signs, color, air conditioning, lighting, steps, elevators, seating arrangement etc. that affect both the processes and outcomes of teaching and learning. In this stage, it is important to train and support stakeholders to ensure welcoming of accessible and inclusive experiences for everyone such as students, instructors, administrators, staff, parents, and volunteers.

In the *evaluation* stage, formative and summative assessment are completed. Pilot tests provide feedback for error corrections or improvements for better performance, while summative evaluation produces final decisions about actual use and diffusion. Designers try to evaluate the

application with a diverse group of users based on universal design measures and make modifications by taking the feedback into account. The designers eventually complete their tasks/responsibilities, and submits proper documentation including the details of the design so that one can understand particularities of the product or environment.

Universal design sometimes produces a fully original product or environment. If this is the case, the final outcome is unique and the design process is probably sequential. On the other hand, sometimes universal design produces a modified product or environment that replaces an existing application. In this case, the design efforts can start from any point in the design process, which runs relatively interactive. However, the choice of design approach alone affects neither the content nor the output because universal design is always sensitive to the needs and characteristics of the target audience without any discrimination.

5. Principles of Universal Design

Over the years, a number of principles have been suggested for effective and efficient universal design. Most of these principles are generic in nature; that is, they can be applied to all kinds of products and environments. The most commonly known principles of universal design were developed in 1997 by a working group of architects, designers, engineers, and environmental researchers in the North Carolina State University. These principles can be summarized as follows (Centre for Excellence in Universal Design, 2016):

5.1 Equitable Use

The design is useful and marketable to people with diverse abilities. Therefore, the designers should provide the same means of use for all users. If possible, the means should be identical for everyone; if not, they should be equivalent. In doing so, segregation or stigmatization should be avoided. Also, provisions for privacy, security and safety should be equally available for all users. Needless to say that, the design should be appealing for everybody. For example, direction signs in a multicultural school are written in different languages so that everyone can benefit from them. Similarly, power doors with sensors at entrances of school buildings are convenient for all users.

5.2 Flexibility in Use

The design accommodates a wide range of individual preferences and abilities. In order to meet this expectation, the designers should provide choice in methods of use, accommodate right-handed or left-handed access/use, facilitate the user's accuracy and precision, and provide adaptability to the user's pace. For example, it is common in US schools that door handles are long enough so that both right-handed and left-handed people can push the doors to open. Another example may be a museum that allows a visitor to listen to description of the displays in a language that he/she chooses.

5.3 Simple and Intuitive Use

The use of design is easy to understand, regardless of the user's prior experience, knowledge, language skills, or current concentration level. Thus, the designers should eliminate unnecessary complexity, be consistent with user expectations and intuition, accommodate a wide range of literacy/language skills, arrange information consistent with its importance, and provide effective feedback for task completion. One should keep in mind that, as common saying goes, "simplicity is the ultimate sophistication." A well-designed product usually consists of the same elements but it is easier to use compared to complicated designs. Simple designs also make users feel that they can successfully use such products or environments. For example, moving sidewalks or automatic lights may provide convenience for handicapped students.

5.4 Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or user's sensory abilities. In applying this principle into product and environment development, the designers should use different modes (verbal, pictorial, tactile) for redundant presentation of essential information, provide adequate contrast between essential information and its surroundings, maximize "legibility" of essential information, differentiate elements in ways that can be described, provide compatibility with a variety of techniques or devices used by people with sensory limitations. It appears that the essence of this principle is to help the user identify the basic and supporting information. The design should particularly highlight the critical information needed by the user. It is natural that some users will not be able to locate critical information when needed, while it will be easy for others to identify what they need. For example, besides visual signs, voice communication is used in airports and subway stations in order to help passengers. Similarly, a multimedia-based manual with visual, auditory, and tactile instructions may help students understand what they need to do in order to complete a learning task.

5.5 Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions. The designers should follow several guidelines for assuring this feature such as arranging elements to minimize hazards and errors, provide warnings of hazards/errors, provide fail safe features, and discourage unconscious action in tasks that require vigilance. It should be noted that the sense of danger is twofold: Some users are over-sensitive and tend to exaggerate potential risks, whereas other users are not capable of sensing or perceiving the hazards. Considering both situations, the design should have embedded components to encourage the safe-use for hesitant users and warn those who are not able to perceive the hazards. Practically, hazardous elements should be totally eliminated or shielded when possible. This will build trust in reluctant users and protect those who are not aware of dangers. A good example may be that the computer asks the user whether he/she

wants to save information before exit. Similar example may be “Undo” feature in computer software that allows the user to correct mistakes without penalty.

5.6 Low Physical Efforts

The design can be used efficiently and comfortably and with minimum of fatigue. In this direction, the designers should allow the user to maintain a neutral body position, use reasonable operating forces, minimize repetitive actions, and minimize sustained physical effort. In other words, the use of a product or environment should require minimum power without making people tired. This applies cognitively, affectively, and physically. Considering that educational institutions have students from all ages (children to elderly), one can assume that most students will have limited physical power to use or operate educational facilities and learning environments so that the designers can support students by minimizing the efforts. For example, automatic doors, faucets with sensors, user-friendly websites, and electronic toothbrushes may help in this respect.

5.7 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. Thus, the designers should provide a clear line of sight to important elements for any seated or standing user, make reach to all components comfortable, accommodate variations in hand and grip size, and provide adequate space for the use of personal assistance. A number of applications may be considered in line of this principle. For example, low-floor school buses, wide interior doors, large light switches, touch buttons on equipment, and flat ramps make educational facilities and learning environments more accessible or usable for many students.

Additional principles of universal design for learning were suggested. These are: (a) *Representation* (What of learning): For resourceful, knowledgeable learners, present information and content in different ways; (b) *Expression* (The How of learning): For strategic, goal-directed learners, differentiate the ways that students can express what they know; and (c) *Engagement* (The Why of learning): For purposeful, motivated learners, stimulate interest and motivation (Novak, 2014). However, these principles are suggested more specifically for facilitating individual learning. They have indirect implications for the design of architectural components of educational establishments. Therefore, they are not discussed further in this paper.

6. Potential Benefits of Universal Design in Education

The principles of universal design may be applied to a number of situations such as evaluating existing designs, developing new products or environments, improving previously-designed materials, and educating designers and consumers about the characteristics of more accessible/usable products or environments from the point of ergonomics. In other words, the

principles of universal design may guide the design and improvements of products/environments for better access and usability.

Benefits of universal design in educational settings can be discussed from the points of the learner, the school, and the society at large. Potential benefits do not have to be in conflict with each other. For example, students can enjoy the school because it makes their life easier, the school can achieve its mission effectively, and the society can have citizens with higher sense of self-fulfillment.

Universal design respects human rights; thus, it is human-centered and user-friendly. Access will be convenient and usage will be easy. Students will enjoy opportunities designed by keeping all users in mind. Obstacles will be avoided, difficulties will be at minimum, dangers will be eliminated, privacy will be assured, and assistance will be available if needed. No individual student will be disregarded or left out for the sake of serving the majority or mainstream users. All learners will be dignified and provided with appropriate opportunities that suit their needs and expectations. They all will be beneficiaries, regardless of who they are or what characteristics they have (Meyer, Rose, & Gordon, 2014).

Universal design will make the environment more enjoyable and engaging because more users will be able to have access to opportunities provided. The school will be a common ground for all learners. Every aspect of the school will be accessible for those who need to use them. Learners will feel themselves comfortable in every corner of the educational facilities and learning environments. The school will be used more effectively and efficiently. The number of users will increase and their level of satisfaction will go up. People, both educators and students, will be happy with the school, and their performance will improve as a consequence of this positive climate and inclusive approach (Clarkson, Coleman, Keates, & Lebbon, 2003).

Universal design helps people attend societal life more and better. Contemporary society requires or needs meaningful contributions and active participation of all individuals. However, this is not possible or easy in many cases due to visible and invisible obstacles, although people have ability and wisdom to get involve. By eliminating potential barriers (at least some of them), universal design facilitates participation of all individuals in societal life. By recognizing the rights of its citizens, clearing the likely barriers, providing access, encouraging usage, and recognizing their accomplishments as well as contributions, the contemporary society becomes much more democratic. This is probably an indirect but escalating benefit of universal design from the point of social-utility perspective. In other words, when individuals are empowered through applications of universal design, they may become more capable for contributing to the society in which they live so that social investment in this area certainly pays off.

7. Conclusion

Universal design promotes equality among individuals and makes life easier and safer for everyone regardless of their social and personal characteristics. Being a human right and public service by nature, education should be accessible for all individuals. In order for this to happen, educational facilities and learning environments should be designed based on the principles of universal design.

This will provide more elbow room for educators in their instructional decisions and practices. Furthermore, key stakeholders including policy makers, administrators, instructors, supporting staff, parents, and learners should be trained about universal design.

Despite the popularity among educators and advocates of human rights, very little research has been conducted to validate the principles and evaluate the effectiveness of universal design. Although universal design as a fascinating concept has been popular for the last two decades, empirical studies have appeared only in recent years. These studies generally provide supporting evidence for this approach (Roberts, Park, Brown, and Cook, 2011). However, more research should be conducted about the effectiveness, appeal, and efficiency of universal design regarding various elements of educational settings and/or systems.

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