

Principles of universal design in teaching building construction

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ABSTRACT: It is the architect's duty to design universal buildings and public spaces, where the needs of each person are taken into account. In Poland, basic accessibility requirements are contained in the construction law, but this is only the minimum required for building handover. These basic requirements are rarely sufficient, considering the actual needs of people with different disabilities. The education of architects should not be limited to the compliance with the basic requirements. Knowledge should be continuously expanded to incorporate modern technologies for people with special needs, with emphasis on avoiding architectural barriers rather than combating them. In this article are presented various problems caused by implementing the universal design (UD) principles into a building construction module in a faculty of architecture in Poland. During two years of the building construction module, students prepare ten design assignments, five of which emphasise building accessibility and the avoidance of architectural barriers. The author argues that education in UD should be strengthened by implementing the UD principles in other classes, not only in architecture design.

INTRODUCTION

Universal design (UD) in architecture describes a method of the design of buildings and public spaces that are accessible and comfortable to use for the greatest possible number of users (to all). This approach was propagated by Ronald Mace at the start of the 1970s and later. In 1997, along with a team of architects, engineers and scientists, he formulated seven principles of UD at the North Carolina State University. The goal of their study was to identify the precepts to be followed by designers, so that the effects of their work could be used by the largest possible number of people, regardless of their ability, age, height, etc [1]. Contrary to legal provisions, this is not merely about adapting a building to persons with special needs, but to make it so that adaptation is not necessary in the first place. This aspect is already critical during the first stages of training designers. The matter of accessibility and utility of a product to the greatest possible user base should be discussed since the very start of training.

In 2019, the Polish Parliament passed the Act on Providing Accessibility to Persons with Special Needs [2]. It introduced obligations for public institutions concerning architectural, informational, circulatory and digital accessibility. The Act is to improve the living conditions and functioning of people with special needs (PwSNs), who are endangered by marginalisation, stigmatisation or discrimination. It is to promote a direction of design that shall not single out persons with disabilities in any way, and ensure that newly-built buildings and spaces shall be accessible to all. Despite a sizable body of literature concerning UD, senior- and disability-oriented design, as well as guidelines for design without barriers, there are only a few publications on educating architects.

DIFFERENCE BETWEEN A PERSON WITH DISABILITIES AND A PERSON WITH SPECIAL NEEDS

Upon investigating the Polish Construction Law (PCL) [3], it was observed that it does not fully apply to the group of people referred to in the Act on Providing Accessibility to Persons with Special Needs [2]. When the PCL mentions persons with disabilities, it refers to persons who:

...possess a permanent or temporary inability to fulfil social roles due to a permanent or long-term disruption of bodily capacity, particularly causing them to be unfit for employment [4].

A similar yet broader definition was provided by the World Health Organisation (WHO):

The International Classification of Functioning, Disability and Health (ICF) defines disability as an umbrella term for impairments, activity limitations and participation restrictions. Disability is the interaction between individuals with a health condition (e.g. cerebral palsy, Down syndrome and depression) and personal and environmental factors (e.g. negative attitudes, inaccessible transportation and public buildings, and limited social supports) [5].

According to the WHO, persons with disabilities are those who are either partially or completely unable to sustain themselves on their own as a result of physical or psychological disability. Health disorder consequences are divided into: damage, inability and role restriction. The PCL features several dozen paragraphs focused on such persons, which precisely regulate matters like: parameters for building entrances, parking spaces, their placement, the accessibility of green areas, accessibility to all storeys within a building, access ramp parameters, freely available sanitary facilities, equipping buildings with lifts. When analysing these regulations, it can be clearly seen that they refer primarily to persons with limited mobility, particularly wheelchair-bound persons. The problem is thus approached very narrowly.

Meanwhile, the Act [2] was written with PwSNs in mind. This term is not necessarily identical to the notion of persons with disabilities. According to the definition featured in the Act, a person with special needs is:

...any person that, due to their external or internal characteristics or due to the circumstances they find themselves in, must make an additional effort or use additional means to overcome barriers so as to participate in different spheres of life equally to others [2].

The Act [2] applies to both types of persons with disabilities as defined in the Professional Rehabilitation Act [4], and also to seniors and other persons with either permanent or temporary movement disabilities (e.g. persons who are weak, ill, convalescents or people with heavy luggage, strollers or children) or perceptual and other impairments (e.g. persons who have trouble hearing, seeing, experience manual and cognitive difficulties).

This means that not every PwSN is a person with a disability, but it can be assumed that all persons with disabilities are PwSNs.

Until recently, it had been merely recommended to apply the precepts of UD. At present, the Act on Providing Accessibility to Persons with Special Needs [2], obligates public institutions to adopt UD standards. However, architects are not obligated to apply these guidelines, as it is up to their clients to require this application. At present, the Act is not referenced in the PCL.

The scale of the problem that the regulations in question are to combat is evidenced by studies that report that over 15% of the world's population, which is over a billion people, has some form of disability [5]. According to the European Health Interview Survey (EHIS), in 2014, there were 7.7 million people who declared limited capacity for activities typically performed by people in that year. Around 2.5 million reported serious limitations in physical or mental ability, while over 5 million people have minor limitations [6].

It is a highly substantial number of people. This data illustrates the significant role that is currently played by all types of solutions that allow to overcome architectural barriers. Worth noting is the rapid aging of societies in developed countries. Sensitising architecture students to the needs of PwSNs and accentuating the continuing role of architectural solutions that make it easier to function in public spaces and buildings shall be of increasingly greater significance.

OBJECTIVES OF THE ARTICLE

- To highlight the need to implement UD principles in general construction assignments.
- Raising the awareness of academic teachers in UD education.

METHODOLOGY

Building construction is a design studio module taught during the first and second year of study of the Architecture and Landscape Architecture courses in the Faculty of Architecture at Cracow University of Technology (FA-CUT), Kraków, Poland. The module is comprised of lectures and design studio classes based on individual assessments.

The objective of the design studio classes, as per the syllabus, is to familiarise students with technical problems in construction and methods of graphical presentation used during the technical design stage. Familiarising students with the solutions of the PCL and the application of contemporary technologies is also essential. The syllabus does not feature guidelines that directly refer to the UD principles, apart from the requirements in the PCL.

It is worth mentioning that due to the high complexity of legal provisions, it is not possible to fully familiarise students with the PCL at one time. While working on various projects during their studies, they get to know them fragmentarily depending on the needs resulting from the subject of the project [7]. It is similar with educational outcomes - the requirements include knowledge about construction systems, materials and technologies. Students gain the ability to apply standards and regulations in practice. In addition, they should be able to prepare a complete set of technical architectural design documentation.

To gain a greater insight into the students' awareness and understanding of UD, a survey was conducted among architecture and landscape architecture students. It was performed on-line in the MS Office 365 application used to conduct classes during the COVID-19 pandemic. Only verified students with accounts set up by the FA-CUT were

allowed to participate. The survey was anonymous, participation not compulsory, and it did not affect any of the subject's grades. The survey consisted of seven questions (Tables 1-7). The first two questions (Q1 and Q2) related to personal details. The next three questions (Q3, Q4 and Q5) were to determine whether students had the opportunity to familiarise themselves with the issues of UD, and if so, where? The last two questions (Q6 and Q7) were to check whether the declared knowledge of the term and rules of UD means that students understand how to implement them in practice.

SURVEY AND ITS RESULTS

The survey was conducted in November and December 2020. First-year students had already completed the preliminary project, so they had the opportunity to familiarise themselves with the requirements and applicable scope of assignments. A total of 116 students of the FA-CUT, mainly from the first, second and fifth year, took part in the survey.

Table 1: Question 1 with responses.

Q1.	Which course do you study?	Number of answers	Percentage
A1.1.	Architecture	102	88%
A1.2.	Landscape Architecture	14	12%

Table 2: Question 2 with responses.

Q2.	Which year of study are you in?	Number of answers	Percentage
A2.1.	First	18	16%
A2.2.	Second	65	57%
A2.3.	Third	1	1%
A2.4.	Fourth	3	2%
A2.5.	Fifth	28	24%

Table 3: Question 3 with responses.

Q3.	Where primarily do you know the term universal design (UD) from?	Number of answers	Percentage
A3.1.	Classes in the Faculty of Architecture	49	42%
A3.2.	Other sources	41	36%
A3.3.	I do not know it	26	22%

In the case of answer A3.1, the respondents were redirected to question Q5. In the case of answer A3.2, they were redirected to question Q4. In the case of the answer A3.3, the respondents ended the survey (Figure 1).

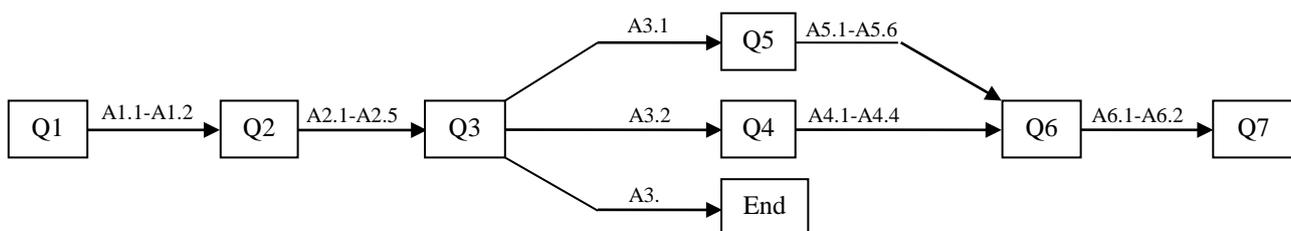


Figure 1: Survey diagram.

Table 4: Question 4 with responses.

Q4.	Specify where did you study the principles of UD?	Number of answers	Percentage
A4.1.	Courses and trainings outside the University	0	-
A4.2.	Internet	33	81%
A4.3.	Professional literature	6	15%
A4.4.	Other	2	4%

Table 5: Question 5 with responses.

Q5.	Specify during which classes did you study the principles of UD?	Number of answers	Percentage
A5.1.	Architecture design studio classes	17	35%
A5.2.	Architecture design lectures	31	63%
A5.3.	Building construction studio classes	0	-

A5.4.	Building construction lectures	1	2%
A5.5.	Contemporary architecture lectures	0	-
A5.6.	Other	0	-

Table 6: Question 6 with responses.

Q6.	UD means designing for whom?	Number of answers	Percentage
A6.1.	Only persons with disabilities	3	4%
A6.2.	Any potential user	87	96%

Table 7: Question 7 with responses.

Q7.	Does the fulfilment of the requirements in the PCL always means that the design complies with the principles of UD?	Number of answers	Percentage
A7.1.	Yes	10	11%
A7.2.	No	61	68%
A7.3.	I do not know	19	21%

ANALYSIS OF THE SURVEY RESULTS

Q1. The first question shows that the survey was mainly completed by students of the Architecture course (88%).

Q2. The greatest number of respondents were in the second and fifth year of study. This indicates the consistency between the level of UD knowledge in the later years of study and the expected familiarity with the principles of UD at that time.

Q3. Twenty two percent of the respondents declared that they did not know the term UD (A3.3). These students finished the survey at this stage. Among those who gave such an answer, 16 students (62%) were in their second year or higher, and four of them (15%) were in the fifth year, so just before graduation. Less than half (42%) declared that they had learned about UD during the FA-CUT classes. The rest (36%) admitted that in order to find out about the term UD, they had to look for information on their own.

Q4. Among the respondents who learned about the UD principles on their own, 81% mentioned the Internet as the main source of information. Only 15% of them turned to specialist literature.

Q5. For 49 (54%) respondents familiar with the term UD, the FA-CUT was the main source of knowledge about it. Architecture design lectures (63%) and architecture design studio classes (35%) were most often mentioned as the main source. The share of building construction (2%) is negligible, which indicates that the UD content is almost completely ignored during those classes or lectures.

Q6. Almost all respondents (96%) gave the correct answer. This means that they not only know the term UD, but also know the basic principles of UD.

Q7. Unfortunately, the situation looks different in the last question. Among the respondents who declared knowledge of UD principles (90 students) in the previous questions, 29 pointed to the incompatible answer (A7.1) or admitted that they did not know the answer (A7.3). Out of this group, as many as 88% of students were in the second year or higher, of which 15% were in the fifth year, so just before graduation.

Question Q7 was intended to check how the understanding of UD principles and the possibility of their implementation in the project look like in practice. Most of the students declared that they learned about UD during architecture design lectures and studio classes. It should be expected that during the development of projects, they had the opportunity to incorporate the UD principles into their projects and compare them with the PCL provisions contained. Thirty two percent of students did not draw correct conclusions.

Overall, the number of students who know the principles of UD and understand how they are applied in practice was only 61 (53%). The remaining 55 (47%) in question Q3 replied that they did not know the term UD or declared they knew it, but in the following questions it turned out that this knowledge was insufficient to give correct answers.

REQUIREMENTS ANALYSIS THROUGH THE LENS OF UNIVERSAL DESIGN

During their two first years of study, architecture students prepare ten design assignments on various themes and in various scopes. Some of these are purely technical and shall be ignored in this article. These are designs of footing, decks, walls and roof trusses. The single-family house design shall also be ignored as it is usually prepared following an individual commission by a client, who informs the architect of their needs and preferences. It is created for a specific user and not the largest possible group.

Table 8: Recommendations for the implementation of UD in building construction assignments.

No	Assignment	Year/ semester	Recommendations for the implementation of UD
1.	Initial design	1/I	<ul style="list-style-type: none"> - lift in every multi-family multi-storey apartment building* - lift accessible from the ground level* - easy adaptation of flats to the needs of PwSN*
2.	Stairwell design	1/II	<ul style="list-style-type: none"> - adding external stairs to the main entrance to the building** - adding a ramp to the main entrance to the building* - marking the steps in colour and contrast* - tactile pictograms on the handrails pointing to the evacuation direction or the room layout* - information about the rooms' layout in the building, at least visually and tactile or by voice in the entrance area [2] (tactile typhlographic plans and schemes)*
3.	Flat roof/ terrace design	2/III	<ul style="list-style-type: none"> - terrace available to every user on the same terms* - surface that cannot pose a problem for people using a walking stick or a wheelchair* - no thresholds or low - up to 2 cm
4.	Door and window design	2/III	<ul style="list-style-type: none"> - adequate clear door width - no thresholds or low - up to 2 cm - avoiding silvered and highly reflective glass in the entrance area* - marking glass surfaces and doors with two stripes at the appropriate heights* - additional contrast strip at the height of 10 - 30 cm [8]* - lower edge of the glazed entrance door protected against the impact of the wheels of a trolley up to a height of 40 cm* - door frames and their surfaces contrasted with the wall colour in which they are located* - sliding doors - require no maintenance and do not pose any danger to other users*
5.	Interior design	2/IV	<ul style="list-style-type: none"> - wall colours - properly contrasted* - no sharp edges* - floors without thresholds and steps and with an appropriate anti-slip surface - width of all passageways adapted to wheelchairs* - adequate interior lighting* - raised floor on a fragment of the space**

* Not required in the PCL

** If the design is fully compliant with UD, the student will not have the opportunity to face the problems that architects often encounter in practice. Removing an architectural barrier (e.g. external stairs) in this case, will reduce the educational outcome.

DISCUSSION

The survey among students showed that almost half of the respondents, including those who are finishing their education, did not have contact with or did not fully understand the principles of UD. Therefore, the assumption that education in this area should be intensified by implementing the UD principles in other classes, not only in architecture design, seems to be correct. However, it is critical to include architectural barriers in building construction assignments. One of the reasons is to familiarise students with certain elements in buildings. Another reason is the necessity to transfer knowledge about solutions used to overcome these barriers. In such cases, academic teachers should explain why the barriers are introduced into the design and explain that they should be eliminated wherever possible.

Students should be aware that the priority is not only the compliance with the PCL regulations, but also with the UD principles and that replacement solutions must always be sought. Students should know the direction the design is to follow, so that erroneous patterns are not ingrained into persons who are just starting their education. The students' mode of thinking is shaped right from their very first university classes. The teacher should teach design habits - so that the object of design can be accessible to all without the application of secondary solutions or accessible to merely a specific group. The application of proper design solutions does not always have to arise from familiarity with the PCL or UD principles, as common sense is often enough [9].

CONCLUSIONS

UD should be a feature of every design studio module, so as to sensitise students and change their mode of thinking. As Pusca and Northwood observed:

The main goal in the teaching and learning process during the first and second years is to guide the students in the engineering design process for product design, and the main goal for the students is to learn the basics of the engineering design process and engineering design tools [10].

A similar opinion was presented by Haupt:

Architecture reflects the contemporary needs of society which, experience shows, constantly change. No matter whether buildings, designs or visions are considered, they need to address up-to-date problems. Architectural education should provide tools for identifying and analysing such issues and encourage students' designs that address them [11].

UD is one such tool and has become an essential factor in designing a usable space. In the case of architectural design studio classes, one should always strive to meet the maximum possible number of requirements and recommendations. These matters should be kept in mind at every stage of design development - from the initial conceptual proposal to the construction-phase design [12].

Even when some furnishing elements are not required by the PCL, they can be required in student design assignments, so as to meet UD guidelines (e.g. passenger lifts). Other elements that could be eliminated in construction-phase designs (e.g. stairs accompanying building entrances), should nevertheless be trained during study, so that students become familiar with their structure and parameters. However, students should be made aware that UD requires the architect to avoid them as they can form a barrier, hindering accessibility to buildings for PwSNs.

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