The role of technical education in architectural studies

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ABSTRACT: Many practising professionals complain about the incompetence of the graduates entering the profession of architecture. It regards mainly the revealed deficiencies in their technical knowledge and skills. This situation could be improved by modifications in architecture schools' curricula by assigning more important roles in teaching to technical content. However, it seems that one of the main reasons for the graduates' inadequate technical preparedness is the circulating opinion among the candidates for architectural studies indicating falsely that this education is typically artistic only. The position of technical subjects in the curricula, measured and expressed in the assigned credit points in relation to all other subjects varies significantly in different schools. It means that some schools emphasise strongly the role of technical education in architectural studies, and others clearly underestimate this issue. The main purpose of this study was to analyse these relations across different schools. Through this study, a group of schools fostering technical knowledge and emphasising its role in their academic programmes has been identified. The findings indicate that there is a causal relationship between the high quality of technical education in architecture schools and the high quality of local architecture.

Keywords: Architectural education, technical subjects, technical education, architecture schools, technical competence

INTRODUCTION

Effective professional education giving the right to exercise many specialised professions is usually based on academic institutions. However, the quality of skills and knowledge acquired by the graduates is often subject to broad-scale criticism by practitioners who employ them. It applies to various disciplines. Architectural education systems frequently have been discussed, analysed and assessed in various countries. This critique comes from different sources and generally refers to the insufficient or defective knowledge, and poor professional skills of graduates from architecture schools. Unsatisfied with the newly employed young architects are the owners of architecture offices, who frequently complain about their incapacity to fulfil typical office work. As Duffy claims:

> *Older architects sometimes lament what they see as a decline in technical skill among their younger colleagues* [1].

The main reservation they have about the incompetence of graduates refers to the execution of technical documentation. But it concerns also some other aspects of the professional activity.

The incompetence of young professionals in the field of architecture is particularly revealed in the supervising activity on building sites, where technical knowledge is mostly verified, and where this compromises their communicative capacity with builders. This is also where the students experience for the first time their ignorance in this regard during their practical training periods.

> *The more the educational methods emphasize the issue of the competency of graduates on building sites, as far as professional communication is concerned, the more likely it is that the students will modify their attitude towards the technology-related building documentation and will be better prepared for their profession* [2].

According to Vitruvius, architecture should be durable, convenient and beautiful [3]. By default, it means that all three shaping guidelines should be more or less equally treated. However, many examples of designed and constructed buildings seem to neglect these rules. This comes about also in the case of durability, which is closely linked to the implemented building technology. The expected equilibrium seems unsatisfactory. It can be suggested, that it is the educational system, which in many cases can be considered responsible for this situation. The approach of various

architecture schools to this issue is vastly different. The goal of this research is to identify these differences and to define their scale. The author also analyses the reasons why the role of technical content and building technologies taught is significantly underestimated at some schools, which seems gradually increasing.

Speaking about technical aspects of architecture, it is important to know the precise meaning of the used terms. Instructors and publications in the architectural discipline use various terms in relation to academic courses dealing with this sphere of architectural design. They use the terms: technical or technological. Some authors use them alternatively and others claim their meaning is different. They explain this in various ways. One of them defines *technological* as basically referring to machines, processes and technology, also in the building industry; but *technical* can refer to any sort of specialised or complex knowledge or subjects [4]. In light of the above definition, it seems that all subjects this research deals with jointly and separately should be considered and named *technical*, as this term seems more suitable.

The issue of technical education gains in importance due to the pervasive paradigm of sustainable design, for which compulsory is a wide spectrum of multidisciplinary insights into design problems. *In architectural education, critical thinking represents one of the primary pillars, especially in the current time of dynamically developing trends, standards, and positions of sustainability* [5].

One can see the increasing input of technical knowledge in contemporary buildings featuring frequently the application of the newest innovations implemented in building solutions as details, technical equipment or building materials. Technical courses are inherently linked to STEM (science, technology, engineering, mathematics) subjects, which have played a relatively limited role in architecture in the past. Presently, this is rapidly changing, and this path should encompass architectural education, and it largely does in contemporary architecture schools. However, it is still seldom present in the awareness of the recruited candidates who have deep reasons for that ingrained in them.

CANDIDATES' EXPECTATIONS AND THE PROFESSIONAL REALITY

The attractiveness of architectural studies for young prospective students has always been seen in the case of individuals being sensitive to art and art-related issues. They usually constitute the majority of candidates for architecture schools. In the common imagination, artistic disciplines represent some higher abstract values, which are worth striving for or at least deserve special interest. This is particularly enticing for young people who picture related education as relatively undemanding, and even fascinating. Among various artistic studies included within is architecture. The conventional opinions of this kind are the basis of special attractivity ascribed to the education in this discipline. Successful creativity is a type of activity allowing one to verify and upgrade his or her values in society.

Artistic achievements are a relatively easy and spectacular way to satisfy these endeavours. This is basically why architectural study seems so attractive to prospective students. However, they are not aware that their expectations linked to this choice can be deceptive. For them, the profession of architecture has a purely artistic character, as it has been illustrated in the history of art. This instilled conviction creates a false image of the study and an untrue character of the profession of architecture.

Already the very beginning of the process of relevant education brings some unexpected disillusion for many, as besides designing and humanistic subjects appear also some technical ones. Their volume within curricula corresponds to differentiated approaches to the methods of teaching in various schools of architecture. Some of the students can accept them and modify their original vision of the profession, while others are disappointed, and even resign changing majors or schools. They begin to see both the educational process and further professional activity as unsuitable for them. The reasons for that seem to be worth of investigation.

RESEARCH METHODS

This research uses a comparative method for analysing selected academic institutions providing architecture curricula. The selection was based on the acknowledged position and reputation of the best-known schools of architecture. Many of them must have been excluded from this set due to the inaccessibility of their complete and extensive curricula on their Web sites. The overview of teaching programmes revealed substantial differences in various schools in terms of the number of years to obtain a degree giving graduates the right to exercise the profession, usually after finishing some compulsory architectural practice. These differences comprise, first of all, heavily differentiated curricula structures, making reliable comparisons difficult and sometimes equivocal. It seems that the most optimal method in this regard is the comparison of the bulk of time dedicated within curricula to relevant types of programme structures. Depending on the school, these appear as singular subjects or groups of akin subjects - that is modules.

The necessary time needed for knowledge acquisition within these subjects or modules is represented by the time measure used in European academic education in this regard; namely, credit points. It can be assumed that the relations between the modules or subjects expressed in credit points assigned to them testify to their role and position within the entire educational programme. Thus, the proportion of credit points assigned to the technical subjects in curricula in relation to those of the remaining non-technical subjects defines that role.

In this research, however, a few other problems have occurred. One of them is the issue of the graduates' degree giving the right to exercise the profession of architect, provided some defined professional traineeship in an architecture office is acknowledged, an application for registration in a professional organisation is accepted and the membership thereof is admitted. Depending on the country, this requires to have a Bachelor's or Master's degree completed. Therefore, the research is related to the curricula of both programmes. The second problem encountered refers to the proper classification of subjects or modules as clearly related to technical disciplines. The scope of relevant subjects turned out to be very wide. It should be said that technical problems can be found embedded in various design subjects and in different measures. For the purpose of this research, only fully technical subjects or modules have been taken into account. They have been incorporated into the curricula for the years 2022/23 or 2023/24. Given relatively frequent fluctuations in their content, they can be modified in the years to come.

TECHNICAL SUBJECTS IN THE ANALYSED CURRICULA - RESULTS

The technical subjects in educational programmes for architecture schools are named in various ways. But their scope relates basically to the core disciplines of building construction, building materials, statics, structures, building physics and building services. In some cases, one finds more complex modules like architectural technology, building engineering or simply technology.

A few more specialised subjects taught in some schools complete the technical spectrum of the analysed curricula. The knowledge comprised therein along with other non-technical subjects is usually considered adequate for a graduate in architecture, and proper for eligibility to further procedure towards becoming a licensed architect. There can also be some other more specialised technology-related subjects inherent within curricula in various schools, but they are not compulsory for prospective *regular architects*. For this reason, in this research, the conducted analyses will focus only on the subjects or modules specified above. Excluded have been other subjects by some considered marginal and neglected subject matters that occur in architectural education [6]. Diploma designs and the credits assigned to them are also omitted.

The tables presented below contain the data pertaining to particular schools of architecture allowing one to compare the relations between the scope of technical courses structured as mentioned above - expressed in credit points within their curricula, and the total amount of credit points for all subjects and modules contained within a study programme. Table 1 presents the final score for the entire educational programme of ten selected distinguished schools of architecture in Europe.

In the analysis, the Bachelor's programmes (Table 2) and Master's programmes (Table 3) have been considered separately as partial constitutive elements of the complete formation. Architectural education offers the acquisition of professional knowledge, thus giving the right to a further procedure leading towards the obtainment of the architect's license. It usually comprises these two phases and terminates with granting related degrees.

The presentation of data starts with Table 1, which is a summary of the following two tables (Table 2 and Table 3), and it displays the number of ECTS credits for technical subjects related to the final score necessary to obtain the skills suitable for a sufficiently educated prospective architect. To compare the European schools in this regard with an exemplary American one, a renowned Columbia University in New York was chosen, and the relevant data are indicated at the end of each table.

Table 1: Architecture schools and the technical subjects related to the total amount of credit points in the curricula of the Bachelor's and Master's degree programmes jointly.

	University	Faculty/Department	Final score		
			Technical subjects/modules credits	Total subjects/modules credits	Relation technical/ total (%)
1	Technical University of Berlin	Faculty VI Plannen, Bauen, Umwelt	114	258	44.2
2	Vienna University of Technology	Faculty of Architecture and Planning	85	240	35.4
3	Czech Technical University in Prague	Faculty of Architecture	69	249	27.7
4	European University of Madrid	School of Engineering, Architecture and Design	80	318	25.1
5	Politechnico di Milano	School of Architecture, Urban Planning, Construction, Engineering	52	270	19.3

6	Technical University of Delft	Architecture and the Built Environment	50	270	18.5
7	University College London	The Bartlett School of Architecture	75	480	15.6
8	Cracow University of Technology	Faculty of Architecture	40	269	14.9
9	Swiss Federal Institute of Technology Zurich	Department of Architecture and Civil Engineering	32	244	13.1
10	UTH Royal Institute of Technology, Stockholm	School of Architecture and Built Environment	25.5	240	10.6
	Columbia University in New York	1/Bernard College 2/School of Architecture, Planning and Preservation	22.5	127	17.7

The final ratio between technical courses and all others at the presented schools defines their position in the above ranking table. It can be clearly seen how dominating is the first position of the Technical University of Berlin over all others. The analysed relations indicated in Table 1 range from 10.6% to 44.2%. Such large discrepancies testify to a very differentiated approach to the issue of technical education in architecture schools. Only four of them forming the first group feature more than 20% of the technical courses within their curricula. The remaining six schools value technical education much lower. Characteristic for the first group is a high percentage of the analysed courses in both the Bachelor's (Table 2) and Master's programmes (Table 3).

The four schools are particularly important as educational institutions because they strongly foster technical aspects of architecture. These are the schools in Berlin, Vienna, Prague and Madrid.

Table 2: Architecture schools and the technical subjects related to the total amount of credit points in the curricula of the Bachelor's degree programmes.

	University	Faculty/Department	Bachelor's programme		
			Technical subjects/modules credits	Total subjects/modules credits	Relation technical/ total (%)
1	Technical University of Berlin	Faculty VI Plannen, Bauen, Umwelt	84	168	50.0
2	Vienna University of Technology	Faculty of Architecture and Planning	45	150	34.6
3	Czech Technical University in Prague	Faculty of Architecture	65	165	39.4
4	European University of Madrid	School of Engineering, Architecture and Design	72	288	25.0
5	Politechnico di Milano	School of Architecture, Urban Planning, Construction, Engineering	38	180	21.1
6	Technical University of Delft	Architecture and the Built Environment	40	150	26.6
7	University College London	The Bartlett School of Architecture	60	360	16.7
8	Cracow University of Technology	Faculty of Architecture	32	194	16.5
9	Swiss Federal Institute of Technology Zurich	Department of Architecture and Civil Engineering	20	160	12.5
10	UTH Royal Institute of Technology, Stockholm	School of Architecture and Built Environment	-	-	-
	Columbia University in New York	1/Bernard College 2/School of Architecture, Planning and Preservation	4.5	25	18.0

The range of the ratios in Table 2 is between 12.5% and 50%, which is more than in the summary presented in Table 1. As the table data show, Bachelor's programmes in the majority of schools provide much more technical courses than in the final scores in Table 1. This is because architectural education at this level is usually more oriented toward professional practical skills than later Master's programmes, which are intended to develop more research-stimulating capacity in students. The Swedish school that is missing this level of education has been excluded from Table 2.

Table 3: Architecture schools and the technical subjects related to the total amount of credit points in the curricula of the Master's degree programmes.

	University	Faculty/Department	Master's programme		
			Technical subjects/modules credits	Total subjects/modules credits	Relation technical/ total (%)
1	Technical University of Berlin	Faculty VI Plannen, Bauen, Umwelt	30	90	33.3
2	Vienna University of Technology	Faculty of Architecture and Planning	40	90	44.4
3	Czech Technical University in Prague	Faculty of Architecture	4	84	4.8
4	European University of Madrid	School of Engineering, Architecture and Design	8	30	26.6
5	Politechnico di Milano	School of Architecture, Urban Planning, Construction, Engineering	14	90	15.5
6	Technical University of Delft	Architecture and the Built Environment	10	120	8.3
7	University College London	The Bartlett School of Architecture	15	120	12.5
8	Cracow University of Technology	Faculty of Architecture	8	75	10.6
9	Swiss Federal Institute of Technology Zurich	Department of Architecture and Civil Engineering	12	84	14.3
10	UTH Royal Institute of Technology, Stockholm	School of Architecture and Built Environment	25.5	240	10.6
	Columbia University in New York	1/Bernard College 2/School of Architecture, Planning and Preservation	18	102	17.6

The technical contents of Master's programmes are even less similar among them than it is in the case of Bachelor's programmes. Here the range of the ratios is between 4.8% to 44.4%, which is about tenfold. Only one-third of them have the ratio of over 20%. This can be read that much less attention is given to technology at this advanced level.

In the case of schools with a higher appreciation of the role of technology in Master`s education, the scores are similar to those of Bachelor's programmes. These outcomes point to huge differences between the analysed schools at every level of academic education, and this can be indicative of the general picture of contemporary architecture schools with regard to their attention ascribed to technical courses. Also, the research outcomes conducted on some renowned American schools of architecture, represented by the school placed at the end of each table, indicate by comparison the numbers similar to the average level of European schools.

DISCUSSION AND CONCLUSIONS

This research can be used as a pretext and driver for an extensive debate about technical aspects of architectural education. A well-known statement that architecture is a unity of art and science, function and form is the reason to accentuate the importance of a tight connection between structure and architecture. Unity and context in architecture are goals, which good creators of architecture are trying to achieve [7]. Therefore, an ability to create architectural designs that satisfy both aesthetic and technical requirements with an understanding of the structural design, construction and engineering problems associated with building design [8] should be seen as essential in architectural education.

Architecture is also an engineering discipline. The technical way of seeing artifacts - often referred to as engineering aesthetics - is also a way of creation. Since engineering thinking in design is close to creativity, it is of interest to discover how engineering design ability develops during architectural education [9]. In order to create something with

technology the latter must be familiar to the designer. But this frequently poses a real problem in architecture schools. Technological literacy is significant for the innovation-driven economy. Students' attitudes towards technology were for a long time considered a measure of technological literacy, but evidence on interaction with technological literacy components is still lacking [10].

The development of building technologies includes the areas of renewable energy sources, heating and air conditioning [11]. Important are also such issues as building skin, intelligent buildings and emerging technologies. The general trend in construction is toward the usage of progressive building technologies [11].

The comparison of teaching programmes of architecture schools encounters many problems despite the uniform criteria set by the number of credits assigned to technical courses. The names of subjects, their content and methods of teaching vary substantially among schools. However, as was stipulated earlier, the assumed measures display reliably the credit values, and thereby the role of technical subjects within curricula. It is well known that students select the courses taught in the function of their personal propensities. There was frustration about the tendency of students to *compartmentalize knowledge, a kind of amnesia regarding concepts or principles learned* [12]. It seems that technical subjects are particularly susceptible to this attitude.

> *The architectural design of the present is no longer determined only by aesthetic questions. This is environmental comfort and the issue of sustainability that have increased the need for exact science and technology education* [13].

Designers of *green* buildings understand the importance of sustainability and techniques for achieving sustainable construction [14]. Therefore, the paradigm of sustainability in architecture is a factor that exerts pressure on designers, and also architecture school programmers to incorporate gradually more technology-related knowledge in curricula to make the graduates the competent partners of other involved professionals. This would enable them to participate effectively in collaborative multidisciplinary teams within the integrated design, as the realisation of an architectural project is always a collective effort and architects must be equipped with the appropriate tools and skills necessary to finalise their work successfully. The basics of these skills should be acquired during their academic education and developed in the subsequent stages of their careers [15].

While teamwork is a challenging part of education, as it requires combining different interests, gathering different opinions in order to make decisions and motivating all teams to deliver results, group co-operation provides for innovative and synergistically developed ideas [15].

> *The most decisive legislative document that indicates the necessary fields of knowledge and skills that a graduate should acquire in the process of architectural education is the European Directive 2005/36/EC on the recognition of professional qualifications. Among 11 fields of knowledge and skills specified in the European Directive, only a few may be seen as referring, very vaguely, to the competencies that would enable a graduate student to develop creative concepts focused on sustainability and the resilience of cities* [11].

This should be improved. Very suggestive and characteristic is the first position of the Berlin school in this research ranking. It is also highly ranked as 18th in the QS World University Ranking 2023 by Subject: Architecture and Built Environment [16]. But this classification relates to scientific achievements rather than education. The interesting fact is that it ranks first in the scientific assessment, but in light of this research, it is relatively low valued in the educational technological aspect. It is not the first time when the question arises, whether architecture schools should be more science-oriented or pedagogy-oriented; and in each case they should be research-oriented.

It is frequently claimed that architecture is not a science, however, this opinion gradually changes and architectural science gains in importance in architectural discourse and practice. In light of this, it seems that the scientific aspect of the profession is essential, and as a consequence this line in architectural education will prevail in the near future, hence the higher ratio of technical subjects in these schools can be to their advantage.

The findings of this research cast a new light on the role of technical subjects in architectural education, and indicate how differentiated and dynamic it appeared over time, especially in recent decades. It is worth noticing that a fairly clear association can be drawn between the schools from the German or the neighbouring geographical areas (Berlin, Vienna, Prague), and a well-known, very high technical level of buildings constructed there. This visible link leaves no doubts as to the close relations between the high quality of technical education in architecture schools and the high quality of local architecture, which forms a cause-and-effect relationship.

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BIOGRAPHY

Wacław Celadyn is a professor of architecture at Cracow University of Technology in Kraków, Poland. He is Chair of Construction and Building Systems, and a former Deputy Rector of the University. At present, he teaches construction, building technologies and architectural design. Between 1985 and 1987, he also taught in Algeria and later in California, USA. His scientific research covers ecological design, low-energy buildings, new technologies in architecture and problems of technical durability of buildings. He was a practising architect in Poland and Canada, between 1987 and 1992, where he worked with several architecture offices and established his own architecture office. His works were residential, institutional, sports and commercial facilities. He was a member of the Royal Architectural Institute of Canada, Ordre des Architectes du Québec and the Polish Chamber of Architects. From 2003 until 2010, he was President of the Municipal Committee for Architecture and Urban Planning in Kraków, Poland.