

TEACHING DESIGN AND CONSTRUCTION SUBJECTS FOR SUSTAINABLE EDUCATION AND DEVELOPMENT OF CONSTRUCTION INDUSTRY

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Abstract. In the process of development and life of the cities, a big amount of created waste highlights the importance of sustainability aspects in the construction sector. The construction sector contributes also to the development of infrastructure and building environment in general. Imparted education in the area influences the upcoming generation of design and construction professionals and quality of their work, and it differs in various countries. The aim of the article is to investigate the actual issues related to teaching design and construction subjects for the sustainable education and sustainable development of the construction industry. The literature overview, comparative and statistical analysis, logical access and other methods have been used in the course of elaboration of the research. The research includes examples and actual tendencies within education in general and for teaching design and construction. The research includes the international overview and a case of Latvia. The research includes examples and actual tendencies within education that could help achieve positive results. The research provides also several recommendations for the professionals working in design and construction area. The research results may help identify some possible improvement opportunities related to the research topic which could contribute also to the sustainable development of the construction industry.

Keywords: design and construction, education, international overview, statistical analysis, sustainability, teaching.

Introduction

Education is an important factor for the sustainable development of societies and is a defining factor in the progress and development of societies [1]. Sustainable development of the construction industry includes social, economic and environmental issues that determine the relevance from economic, environmental and social points of view.

Education in construction, engineering and architectural sectors is of great importance for the future development of the industry. The main professions related to the research topic or stakeholders are, for example, architects, engineers, and designers. Growth of population has contributed to climate impact and it is one of the reasons for the importance of the concept of sustainable management – sustainable management has become an integral part of the business environment and of the processes of decision-making [2]. Also, the construction sector is one of the main polluters [2]. As several stakeholders are involved in the management of construction projects, there are many factors that affect the reduction and recycling of construction waste [3]. Based on the analysis of 412 projects, prefabrication could reduce construction waste by 25.85% [4]. For instance, the production of construction industry's resource use and emissions in Australia particularly in the building sector had a significant effect on the environment, which also highlighted the growing importance for increasing sustainability in the sector [5]. At the same time, in the last decade a big number of Schools of Architecture in Europe reconsidered and reformed the structure of their curricula according to the actual need of profession [6]. At the beginning of 2020, due to the rapid global spread of the Covid-19 pandemic, educational institutions were forced to switch to a distance learning, which has had a big effect on all the structural elements of the education system [7], and, according to the conducted survey of 111 students [7], noticeable positive trends have appeared over six months of observations. Teaching design and construction is one of the most important professions which could contribute to changing the future of cities and the standard of living of the people. Education for sustainable development enables every human being to acquire the knowledge, skills, attitudes and values which are necessary for a sustainable future [8].

The aim of the article is to investigate the actual issues related to teaching design and construction subjects for the sustainable education and sustainable development of the construction industry. The research includes the international overview and case of Latvia. The literature overview, comparative and statistical analysis, logical access and other methods have been used in the course of elaboration of the research.

The novelty of the article is the current analysis and overview of issues related to teaching construction and design subjects, related current educational issues in Latvia, and highlighting of the interconnection between educational issues and sustainable development of construction industry.

Materials and methods

The methodological framework of the current research is based on the materials and methods that are presented in this part. The methodological framework of the research includes the issues mentioned in Figure 1.

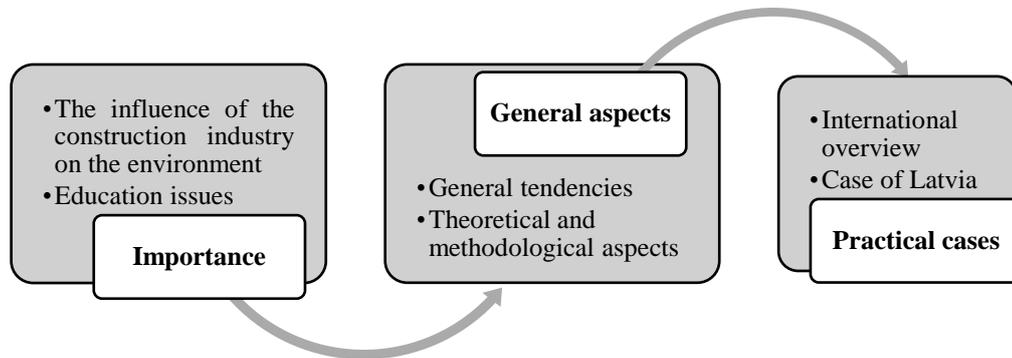


Fig.1. Methodological framework of the research (developed by the authors)

Architecture is “the creative industry that makes up the living space of a person, which includes the artistic, functional, technological, social, economic and ecological aspects of the spatial environment on a large scale - from urban planning and spatial planning alongside industry buildings and their external and internal design, improvement and structure” [9]. The concept of architecture includes both the profession of architect and construction. Design is often included in the educational architecture programs. Architectural design, based on “form”, “function”, and “construction” is a process of finding and regulating the functional components for creating a built environment, and the construction is a necessary and inseparable part of the design process, and thus construction education is important also in architectural curriculum [10]. Design always needs functionality. It should have to solve problems, while art should provoke thought and emotions [11]. Teaching functionality of building in design and construction is more related to practicality of the design. Starting from the essence of the material and coming back to the overall design through detailed design could create unexpected results [12]. “The parallel execution of construction and design courses made the students gain a good experience by combining the acquired knowledge in these two separate courses” [10]. For instance, according to Jaime Jiménez, Eugenio Pellicer, and Víctor Yepes [13], in courses of project management, business management in the construction industry, construction site management, projects scheduling techniques, health and safety management in construction, and strategic quality management in construction was a strong necessity to do a case study.

Construction management courses are increasingly teaching automation and digital technologies [14]. Ongoing discussion and research on the role of 3D virtual learning environments in teaching and learning was analysed also by Rui Wang, Russell Lowe, Sidney Newton, and Tuba Kocaturk [15]. “When BIM is integrated with the teaching of basic construction courses within architecture degree programs, the students understood the building system principles simply and effectively” [16, p.940]. According to Alexander Ishkov and Mikhail Leontiev [17], during the remote studies students almost always took an active part in the ongoing activities of small groups, even if such work had not been assessed. The majority of the surveyed students (62%) highlighted that the best option of direct communication with a professor during online consultations was via Zoom or MS Teams platform [18, p. 295]. According to the conducted research of the authors Natalia Popova, Leonas Tolvaisis, Baiba Briede, and Aleksandr Ponomarev [19], the most of students within analysed universities and programs do not combine their university studies with work. Accidents resulting from poorly planned or set up work environments were the main concern within the construction industry [20]. According to [21], it was found that “environmental and design elements of school infrastructure together explained 16

percent of variation in primary students' academic progress". Many universities are looking for new, creative approaches to integrate sustainable development in their strategies, and also there is a demand from the student side for a collaborative and flexible learning environment, as well as housing choices that also could contribute to sustainability [22].

Results and discussion

In this subpart, several creative management and technical subjects and modules in the chosen universities, actual education issues in Latvia in the sectors of engineering, manufacturing and construction, and humanities and arts have been identified and analysed. Several examples of management, creative and technical subjects and modules in universities are shown in Table 1. As it is shown in Table 2, there is a variety of subjects and areas that cover topics of design and construction.

Table 1

Creative, management and technical subjects and modules in universities (developed by the authors, based on [23-25])

University	Subjects/Modules
Msc in Construction and Management, University of London [23]	Project Funding & Finance International Construction Contracts and Arbitration Leadership and the Advance Practice of Management Corporate Governance and Operations Management Information Management and BIM in Construction Project Planning and Management People Management and Human Behaviour
Msc Construction Project Management, Waterford Institute of Technology, Ireland [24]	Sustainability and the built environment Construction law Economics and the construction sector Management of people Financial management Strategic management Professional development and ethics
Msc Architecture, Lund University, Sweden [25]	Aligned theory course Dwelling and Space Design studio Urban Dynamics or Spatial Experiments Materials and Details – I Degree project

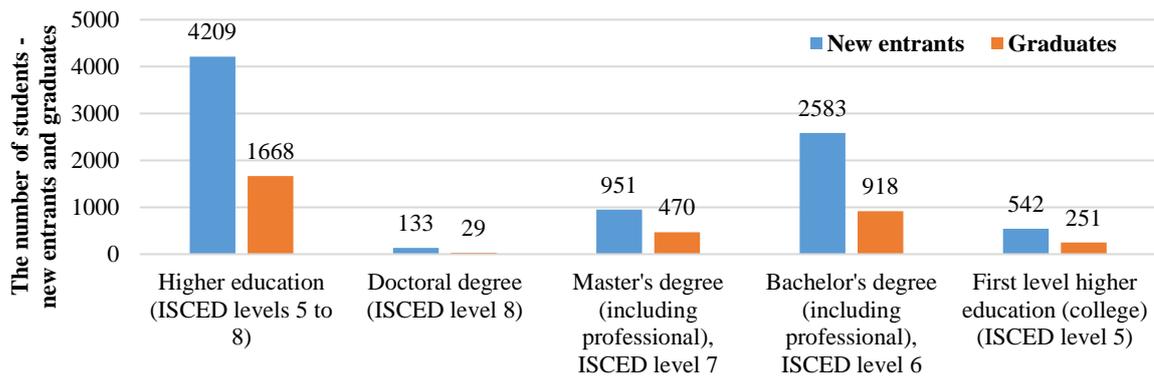
International Standard Classification of Education includes different levels. ISCED (International Standard Classification of Education) is "the reference international classification for organising education programmes and related qualifications by levels and fields" [26].

Construction subjects in Latvia are taught on different levels at the Daugavpils Construction Technical School, Latvia University of Life Sciences and Technologies, Rezekne Academy of Technologies, Riga Building College and the Riga Technical University. Architecture and programs related to architecture are offered at the Riga Technical University (academic bachelor, professional master and doctor programmes), RISEBA University of Applied Sciences (academic bachelor study program), Latvia University of Life Sciences and Technologies (program "Landscape architecture" at bachelor, master and doctor programmes), University of Latvia (Professional Master's Study Program "Spatial Development Planning") [27]. In 2021, more than the third (35.9%) part of students (or 5.3 thousand), obtained degrees in Social sciences, business and law, and 18.5% (or 2.7 thousand), in Health and social welfare; 1.7 thousand (or 11.3% of the total number of graduates) studied Engineering, manufacturing and construction [28].

According to the Central Statistical Bureau of Latvia [28], the number of graduates in 2021/2022 decreased in many fields in comparison to 2012/2013. For instance, the enrolment of students in Social Sciences, Business and Law has decreased in 2021/2022 in comparison to 2012/2013 with 26.1 thousand of students enrolled in 2021/2022. The enrolment of students in Engineering, Manufacturing and Construction, and Humanities and Arts has also decreased in this period, 11.1 and 8.7 thousand of students were enrolled in 2021/2022 respectively [28].

According to the Central Statistical Bureau of Latvia [29], the population of 15 years of age and over by the highest educational level attained at the beginning of 2020 had the highest indicators in Riga and Pieriga regions, and the biggest number of respondents obtained Master's Degree (137 690 students) in the beginning of 2020 in Riga. The number of respondents, who obtained Bachelor's degree in Riga and Pieriga regions at the beginning of 2020 was more than twice less than students that obtained the Master's degree for 37.4% and 44.1% respectively [29].

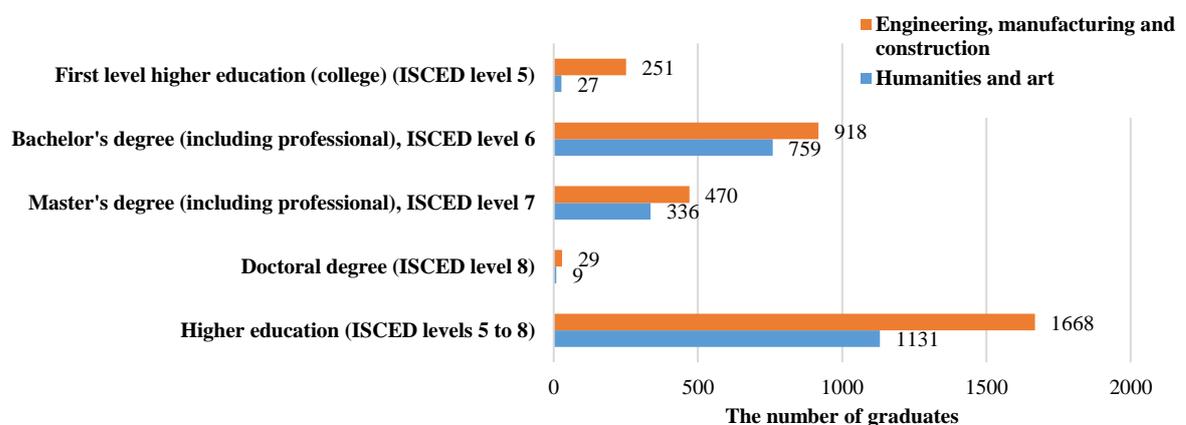
The number of new entrants and graduates in higher education institutions and colleges in 2021 in Latvia (engineering, manufacturing and construction) is shown in Figure 2. According to Figure 2, the total number of new entrants and graduates in higher education institutions and colleges (in the following sectors: Engineering, Manufacturing and Construction) in 2021 was 4209 and 1668 respectively, and the largest number of new entrants and graduates in higher education institutions and colleges in Engineering, Manufacturing and Construction sectors was observed for Bachelor's degree.



ISCED level 7: Master's degree (including professional) and second level professional higher education with length of studies 5 years; ISCED level 6: Bachelor's degree (including professional); second level professional higher education with length of studies 3-4 years

Fig. 2. New entrants and graduates in higher education institutions and colleges in 2021 in Latvia (sector: engineering, manufacturing and construction) (developed by the authors, based on [29])

The number of graduates in higher education institutions and colleges by sectors in 2021 in Latvia is shown in Figure 3. According to Figure 3, in 2021 the number of graduates of higher education institutions and colleges in general in Latvia for ISCED levels 5-8 in Engineering, Manufacturing and Construction sectors was higher than in humanities and arts; the largest number of graduates in higher education institutions and colleges in 2021 in Engineering, Manufacturing and Construction and Humanities and Arts was for Bachelor's degree (918 students and 759 students respectively); the total number of graduates in 2021 in Latvia in Engineering, Manufacturing and Construction was higher than in Humanities and Arts by 47.48% or 537 students.



ISCED level 7: Master's degree (including professional) and second level professional higher education with length of studies 5 years; ISCED level 6: Bachelor's degree (including professional); second level professional higher education with length of studies 3-4 years

Fig. 3. Number of graduates in higher education institutions and colleges by sectors in 2021 in Latvia (sectors: engineering, manufacturing and construction, humanities and arts) (developed by the authors, based on [29])

The industry of Humanities and Arts includes the subsector - Music, Visual Arts and Architecture, which consists of sub-sectors: Theory and History of Architecture, Urban Planning, Rural Construction, Building Architecture, Landscape Architecture, Other Visual Arts and Architecture [30]. According to [10], the coordination of construction courses and courses of architectural design make the students consider construction and design as associated concepts, and in the design process it is important to promote the design and construction coordination in architectural education [10]. At the same time, the process evaluation plays the main role in determining the results of summary evaluation [31]. For instance, the framework and indicator system for evaluation of ecological civilization education in colleges and universities was developed by Anna Vintere, Eve Aruvee and Daiva Rimkuviene [32]. Taking into account the growing importance of sustainability issues, there could be a big importance, for instance, for highly qualified engineers in the future. Also, a “regular research of the problems of motivation for learning and adaptation to a future profession at the university is a prerequisite for the formation of a highly qualified specialist in the field of engineering” [19, p.1284].

Conclusions

1. There is a variety of subjects and areas that are related to design and construction, and the universities can have different opportunities on how to achieve good results in the process of education. Education in construction, engineering and architectural sectors is of great importance for the sustainable development of industry.
2. Each year there is a different number of students and graduates that enter the education and construction sector, respectively, which highlights the relevance of the topic. The number of graduates in 2021/2022 in many fields of education had decreased in comparison to 2012/2013. The largest number of graduates in higher education institutions and colleges in 2021 in the sectors Engineering, Manufacturing and Construction and Humanities and Arts was for Bachelor’s degree (918 students and 759 students respectively).
3. The integration of sustainability principles in education could contribute also to the sustainable development of the construction industry. Implementation of the principles of sustainability could be useful and recommended also for the specialists working in design and construction area, and it could be recommended to follow the actual tendencies in practice and education. Future research direction could be related to more detailed analysis of the scientific and practical issues of the current topic.

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Conceptualization, L.K. and A.A.; methodology, L.K.; software, L.K.; validation, L.K., A.A. and J.Z.; formal analysis, L.K. and A.A.; investigation, L.K and A.A.; data curation, L.K., J.Z.; writing – original draft preparation, L.K. and J.Z.; writing – review and editing, L.K. and J.Z.; visualization, L.K.; project administration, J.Z. All authors have read and agreed to the published version of the manuscript.

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