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Research Article

The Status of Sustainability in Architectural Education

Sürdürülebilirliğin Mimarlık Eğitimindeki Yeri

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Abstract: The discipline of architecture is a field that is influenced by current developments and integrated with changes, and architectural education must maintain its universality by updating in line with these changes. It is very important for students, who are the architects of the future, to be equipped for sustainability, which is one of the current topics of discussion, to achieve the targeted goals of sustainability. Developing solutions and implementing them to ensure the continuity of the global ecosystem consisting of people, living organisms, and inorganic elements are among the duties of architects. The purpose of this study is to make an analysis within the scope of sustainability-related courses and their contents in undergraduate and graduate education in the department of architecture. Within the scope of the study, information about state universities providing undergraduate and graduate education in the field of architecture in Turkey was obtained by examining the most recently published 2023 Higher Education Program Atlas. By analyzing the course information packages of the universities, the course contents in the context of sustainability, the semester in which the course was given, whether it was compulsory or elective, theoretical or application-oriented, and the use of computer programs in the courses were determined. As a result, many of the courses given at the undergraduate level in the context of sustainability are included in the programs as elective and theoretical courses. It has been concluded that in postgraduate education, courses on simulation programs, numerical calculations, or certificates are very few in number compared to the theoretical explanation and are generally included in master's programs.

Keywords: architectural education; awareness of sustainability; sustainability; ecology; architecture

Özet: Mimarlık disiplini güncel gelişmelerden etkilenerek değişimlere entegre olan bir alandır ve mimarlık eğitimi de bu değişimler doğrultusunda güncellenerek evrenselliğini korumak zorundadır. Geleceğin mimarları olan öğrencilerin güncel tartışma konularından biri olan sürdürülebilirliğe yönelik donanımlı olmaları, sürdürülebilirliğin hedeflenen amaçlarına ulaşmasında oldukça önemlidir. İnsanların, canlı organizmaların ve inorganik öğelerin meydana getirdiği küresel ekosistemin devamlılığını sürdürebilmesi için çözümler geliştirmek ve bunları uygulamaya koymak mimarların görevleri arasındadır. Bu çalışmanın amacı, mimarlık bölümü lisans ve lisansüstü eğitiminde yer alan sürdürülebilirlik konulu dersler ve derslerin içerikleri kapsamında bir analiz yapmaktır. Çalışma kapsamında, Türkiye'de mimarlık alanında lisans ve lisansüstü düzeyde eğitim veren devlet üniversitelerinin bilgisi, en son yayımlanan 2023 Yükseköğretim Program Atlası incelenerek elde edilmiştir. Üniversitelerin ders bilgi paketleri analiz edilerek sürdürülebilirlik bağlamında ders içerikleri, dersin hangi yarıyılda verildiği, zorunlu ya da seçmeli, teorik ya da uygulama ağırlıklı ders olması ve derslerde bilgisayar programının kullanılma durumu belirlenmiştir. Sonuç olarak lisans düzeyinde verilen derslerden sürdürülebilirlik bağlamında ele alınan derslerin pek çoğunun seçmeli ve teorik ders olarak programlarda yer aldığı; lisansüstü eğitimde ise simülasyon programı, sayısal hesaplama veya sertifika konulu derslerin teorik anlatıma göre oldukça az sayıda olduğu ve genellikle yüksek lisans programlarında yer aldığı sonucu elde edilmiştir.

Anahtar Kelimeler: mimarlık eğitimi; sürdürülebilirlik kültürü; sürdürülebilirlik; ekoloji; mimarlık

1. Introduction

The gradual disappearance of natural resources, which is a result of increased reproduction with the acceleration of consumption, contributed to the popularization of the concept of sustainability. Sustainability is associated with every desired area, not limited to environmental and social development. The concept originated in 1987 when it was articulated as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" in the report of the United Nations Commission on Environment and Development (WCED, 1987). With sustainability, it aims to protect and transfer

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the social and environmental values, basic resources, and existing values that people have (Oğuz and Ateş, 2018). In order to solve the problem of environmental degradation, the United Nations (UN) approved 17 sustainable development goals in 2015, which are divided into 169 tasks and grouped under three headings: social, economic, and environmental. Hawkes (2001), on the other hand, emphasizes the cultural dimension as the fourth pillar of sustainability as well as its social, environmental, and economic dimensions (Hawkes, 2001). In this context, it can be said that the economic, ecological, social, and cultural dimensions of sustainability affect, define and complement each other (Çelebi, 2007).

Sustainability is crucial in architecture, emphasizing the reuse of materials and efficient resource utilization. In economically constrained environments, it's essential to focus on resource-efficient construction. New buildings strain society both economically and ecologically, making it imperative to develop sustainable building designs that minimize harm to people and the environment throughout their lifecycle, from construction to demolition (Ateş Can ve Kurtoğlu, 2017; Erkan, 2022; Kaypak, 2012; Kokmaz vd. 2018). In addition, the reuse of existing structures without constructing a new building and using new resources will ensure the sustainability of both the life cycle of the building and the use of natural resources without using resources. In this context, architects, who have a great role in the building design process, should be made aware of and guided by sustainability.

Architecture is all knowledge and practices based on the design and production of human and space systems (Yücel, 2004). Vitruvius filtered out the factors that he saw as the conditions of an original architecture and formulated the architecture, whose roots go back to Antiquity, as follows: "Architecture = function + durability + aesthetics" (Vitruvius, 2017; Özer, 2018). On the other hand, Özer (2018) defines architecture as "the ability to create spatial layouts that can accommodate activities related to that society, within the framework of the real needs and possibilities of a particular society, by supporting them emotionally". Architecture (both as an architectural and architectural act) aims to change and transform nature (Yücel, 2004). The architect, on the other hand, transforms any place that exists on its own as a historical subject into a space with its ideas, thinking, and acquisition orientation (Çotuksöken, 2004: 18). Architectural design is the most important tool for an architect to express himself, his mind, and his thoughts (Lang and Moleski, 2016). The expertise of the architect consists of a wide variety of enriched knowledge (Vitruvius, 2017). Architecture is a dynamic, innovative and constantly changing profession, as it is a comprehensive science that has been equipped and enriched with a wide range of specializations (Lökçe, 2002).

The concept of sustainability, which has become a fundamental concern for architecture, entered the consciousness of architects at the end of the twentieth century. Sustainable architecture, on the other hand, can be seen as a revision of architecture in response to many contemporary concerns as a result of the effects of human activities. Buildings should be considered from an environmental, socio-cultural, and economic point of view, and therefore objectives, processes, and sources of information should be reviewed (Bennetts et al., 2003). Creating a better life stands as a primary objective for individuals in all their professional endeavors, with sustainable and environmentally friendly architecture being a key goal and ultimate model.

Therefore, greener architecture is the main goal of today's contemporary architecture (Mahdavinejad et al., 2014). The relationship between the building and the environment is important in sustainable design and aims to integrate with the environment (Ragheb et al., 2016).

Three criteria have been determined for a sustainable building. These are environmental, economic, and social-cultural sustainability. Environmental sustainability includes the use of resources and the protection of the ecosystem. Long-term resource efficiency and low operating costs are economic sustainability goals. In social and cultural sustainability, the goals are comfort, health, and the preservation of social-cultural values (Borrini and Buchan, 1997; Glavič and Lukman, 2007; Kohler, 1999; Murillo Camacho et al., 2022; Reza and Abdullah, 2011). In addition, although cultural sustainability has an effective role in society in the field of architecture, the studies are mostly within the scope of environmental sustainability (Lakot Alemdağ et al., 2022).

1.1. Architectural Education and Sustainability

For sustainable architecture, it's crucial to start educating future architects at the undergraduate level. Changes in society, the economy, and technology have shaped education over time, necessitating updates to architectural education to instill 21st-century values in graduates (Ng and Lin, 2022).

As students advance in formal architectural education, it becomes essential for them to encounter experiences and environments beyond the confines of the classroom. Consequently, architectural education should extend beyond traditional indoor settings and incorporate a balance between indoor and outdoor learning environments (Ummihusna and Zairul, 2020). Many researchers (Altomonte 2012; de Gaulmyn and Dupre 2019; Keumala et al. 2016; Khan et al. 2013; Taleghani et al. 2011; Wright, 2003) have studied architecture and urban design from the beginning to all its stages and continuing throughout life. Sustainability should be at the center of learning because it emphasizes that this is the only way to ensure that its principles are understood. Sustainability should be integrated into education holistically and should focus on students' knowledge, understanding, values, and attitudes. These constitute the foundations for sustainable behaviors and advanced problem-solving (Altomonte 2012; de Gaulyn and Dupre 2019; Pappas et al. 2013; Gucyeter 2016). To properly integrate sustainability into architectural educa-

tion, a broadly expanded vision of what it entails is not only the core of the course but also a one-year foundation course shared by students who want to become architects, urban designers, and interior designers (Buchanan, 2012). Recently, environmental design and low energy awareness have moved from being a technical concern to an agenda in architectural education. In addition, sustainable redesign of existing buildings has gained importance in both architectural practice and education (Alexandrou et al., 2022; Keumala et al., 2016).

Concentrating on the environmental facets of sustainable design, Kim and Rigdon (1998) present a notional framework aimed at educating architects. This framework comprises three levels (principles, strategies, and methods), aligning with the three objectives of architectural environmental education: fostering environmental awareness, elucidating the building ecosystem and its relationship with the environment, and instructing on sustainable building design. Domenica Iulo et al. (2013) emphasized that there are four principles for integrating sustainability into courses in architectural education: core value, technology area, choice, and specialist knowledge. All course contents in architectural education should be organized based on sustainable design, which should be taken as a basic value. Sustainable design should be taught from the perspective of technology, and environmental system lessons should be added. In addition, students should be able to choose the sustainability-related courses they want to take, and there should be expert harmony between centers and institutes that work on sustainability, especially at the graduate level.

In recent years, awareness of the connection between architecture and the urban environment has grown, leading to curriculum adjustments in undergraduate and graduate programs. While these courses emphasize examining the urban environment, they often prioritize its social and visual aspects (Oktay, 2011).

Another study conducted a thorough literature review to assess how environmental sustainability is incorporated into higher education architecture curricula. To cultivate graduates who prioritize environmental sustainability, active engagement in architectural education courses and assessments of student learning must be enhanced (Boarin and Martinez, 2022). In another study aiming to compare architectural education in Iran with other countries in Asia and Australia, it was seen that the following objectives should be achieved in order to integrate sustainability into architectural education (Taleghani et al., 2011):

- Giving courses on energy economy and energy policies to engineering and architecture students,
- Giving renewable energy courses related to other engineering fields,
- To provide education in faculties of science, education faculties and even high schools in order to overcome the critical deficiency of educated professionals,
- Opening postgraduate courses in order to provide continuous vocational education opportunities for engineering and architecture students on sustainability and renewable energy principles,
- Obtaining software that will contribute to sustainable design in cooperation with institutions and providing training.

Educators should prioritize integrating sustainability into building design courses. A case study found that architecture students' design work often lacked holistic sustainability due to rigid architectural guidelines. To enhance sustainability awareness, it's essential to assign projects and provide real-world experiences focused on sustainability to the students (Grover, 2020).

When teaching a simulation tool that measures performance for sustainability and how it contributes to students in sustainable design education, it has been seen that although individual students cannot achieve success satisfactorily, group studies have shown that learning is successful (Gaulmyn and Dupre, 2019). In this direction, it can be said that, in addition to theoretical teaching, tools such as simulation programs and group work will be effective in strengthening students' perceptions of sustainability. Studies have shown that, in addition to theoretical teaching in architectural education, using different educational methods such as simulation and experiment tools are factors that strengthen the perception of sustainability. In this respect, the contents of the courses on sustainability given in architectural education and the methods by which they are given are important.

In order to improve the impact of architectural education, it is trying to stimulate discussions on the potential of architectural education curricula. In particular, the interests and relationships between design and technical knowledge courses are constantly being reviewed and are developing with criticism. In this context, architectural programs should be reviewed in order to meet the increasing demands that arise with the development of vocational education. This study's primary goal is to investigate the topics and teaching strategies of sustainability courses offered by Turkish universities that provide architecture majors. In this context, the existence and content of sustainability courses in the architecture undergraduate and graduate education programs of state universities in Turkey were examined, and their place and importance in education programs were evaluated.

2. Method

In order to strengthen the impact of the perception of sustainability on architecture students and graduates, the courses to be given at the undergraduate and graduate levels and the contents of these courses are important. The main purpose of this study, which carries out

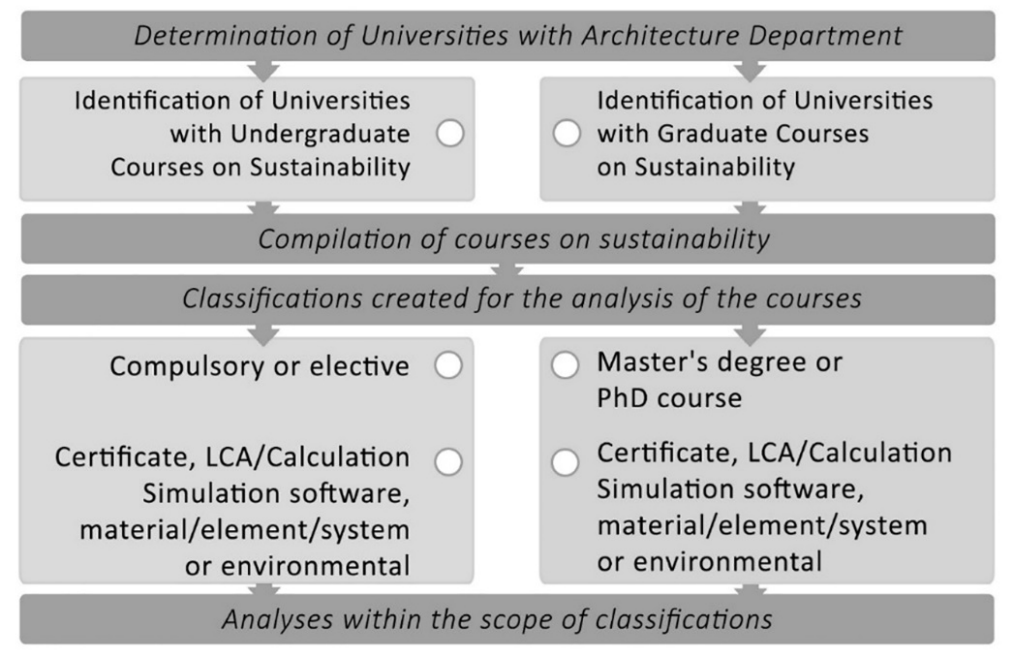


Figure 1. Working Flow Chart

research within the scope of universities with architecture programs in Turkey, is to examine the contents and methods of the courses on sustainability. In this regard, 59 state universities with architecture programs in 2023 were determined from the website of the Turkish Council of Higher Education (Yükseköğretim Kurulu) (Url-1). The sustainability courses offered through the course content packages and websites of these universities were compiled, and their contents were categorized based on the classifications created within the scope of this study. Sustainability courses were obtained at the undergraduate level in 25 of 59 universities and at the graduate level in 31 of them. These courses were first identified with the help of headings. Then, the content information of the courses was examined and classifications were created according to these examinations. Figure 1 shows the flow diagram of the study.

In the study, the classifications made within the scope of the undergraduate program were created by taking into account whether the courses were compulsory or elective. Postgraduate courses, on the other hand, are classified according to whether they are master's or doctoral courses, as they are usually electives, and also according to the content of both undergraduate and graduate courses:

- Certificate (C): Courses given to teach green building certification systems such as LEED, BREEAM
- LCA/Numerical Computing (LCA): Lectures on Life Cycle Analysis (LCA) or numerical calculations of this analysis
- Simulation Software (SS): Courses that introduce and teach programs used to calculate the energy performance of buildings
- Material/ Element/ System (M): Courses that teach the concept of sustainability theoretically on materials, building elements and building systems.
- Environment(E): Lessons that examine sustainability at a wider scale (urban/regional/environmental)

The topics under which the graduate course contents were categorized were obtained as a result of the analysis of the course contents. General analyses were made with the help of Microsoft Excel and word count analyses with the help of AntConc 3.4.0 software and are given under the heading findings. AntConc is a tool enabling users to alphabetically sort or arrange words based on their frequency of occurrence, identify keywords, generate concordances and phrases from a plain text file, and differentiate between lowercase and uppercase characters.

3. Results

It is seen that only 27 of the 59 state universities providing undergraduate architecture education, obtained from the Turkish Council of Higher Education (Yükseköğretim Kurulu-YÖK) website in order to analyse within the scope of the study, have sustainability courses in their course contents. A total of 48 sustainability courses were obtained from 27 universities. Considering that only 2 of these courses are compulsory and 46 of them are elective, it is noteworthy that the subject of sustainability in undergraduate education is limited only within the scope of elective courses (Figure 2).

As seen in the literature review under the title of studies conducted, the methods used in the courses given in architectural education are effective for learning. In this direction, it is seen that the methods used in undergrad-

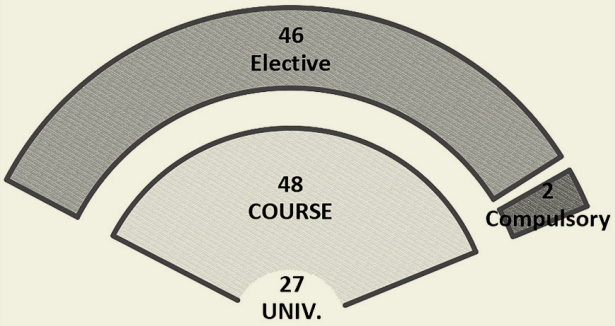


Figure 2. Compulsory-Elective status of undergraduate courses on sustainability

uate courses within the scope of this study are generally on theoretical information. Of the theoretical courses, 39 (85,3%) are on the environment and 2 (12,5%) are on materials. In addition, the number of courses that provide support with computer programmes is 2 (4,2%) and the number of courses on life cycle is 1 (1,2%). No courses with content within the scope of certificates were encountered. Within the scope of undergraduate education, the weakness of the courses that teach the concept of sustainability by supporting it with different methods draws attention (Figure 3).

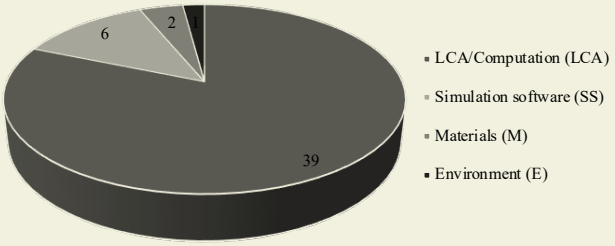


Figure 3. Content Analysis of Undergraduate Courses on Sustainability

When the words used in the titles of the courses obtained are analysed, it is seen that the first three most used words are within the scope of the concepts of "Architecture", "Sustainability" and "Building".

It is noticeable that the use of words within the scope of "Energy", "Environment" and "Renewable" concepts is lagging. In this direction, it is noteworthy that the theoretical education given within the scope of the course contents is generally within the framework of the building and generalised under the title of architecture. It is seen that holistic and environmental education is weak (Table 1).

When the universities that offer courses on sustainability in their undergraduate curricula are analysed, Bursa Uludağ University, Çukurova University, Istanbul Technical University and Yozgat Bozok University are ranked first with 4 courses on sustainability in their curricula. Dicle University and Trakya University are in second place

Table 1. Counting the words used in the titles of undergraduate courses

Rank	Number	Words Used in Course Titles
1	23	Architecture/Architectural/In architecture/In architectural
2	23	Sustainable/Sustainability
3	16	Structure/Residence/Building/In the building
4	12	Ecology/Ecologic
5	10	Energy
6	10	Design/In design
7	6	Environment/Urban
8	4	Technology
9	3	Relationship
10	3	Renewable

with 3 courses. These universities are followed by Dokuz Eylül University, Eskişehir Technical University, İzmir Institute of Technology, Karadeniz Technical University and Mimar Sinan Fine Arts University with 2 courses. The universities that have an undergraduate education in architecture but do not have a course on sustainability in their graduate education or graduate curriculum are Adana Alparslan Türkeş University of Science and Technology, Bolu Abant İzzet Baysal University, Düzce University, Necmettin Erbakan University, Niğde Ömer Halisdemir University and Süleyman Demirel University. Although there are 31 universities in total, it is seen that the number of sustainability courses in the postgraduate curricula of these universities is 123. Of these courses, 85 are master's courses and 69 are doctoral courses. 31 courses are offered in both master's and doctoral programmes (Figure 4).

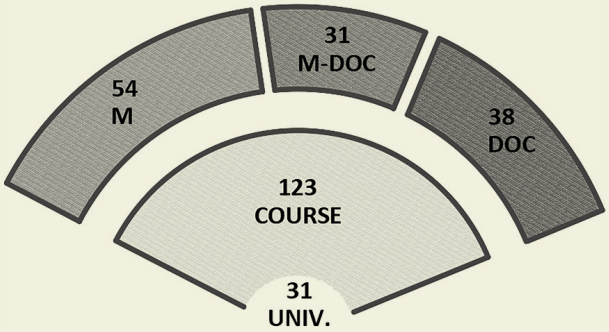


Figure 4. Status of Sustainability Courses as Master's or Doctorate Courses

Within the scope of the study, the titles of the certificate (C), LCA/Computational (LCA), simulation software (SS), material-element-system (M) and environment (E) were determined in the classification based on the content and methodology of the sustainability-related master courses. When the courses were analysed within the scope of these classification headings, it was seen that

5,69% (7) of the 123 courses were on certificates, 8,94% (11) were within the framework of Life Cycle Analysis and computational methods (LCA), 7,32% (9) were on the introduction and use of simulation software, 43,09% (53) focused on materials, elements or building systems and finally, 58,54% (72) created a sustainability perception within the scope of the environment (Figure 5).

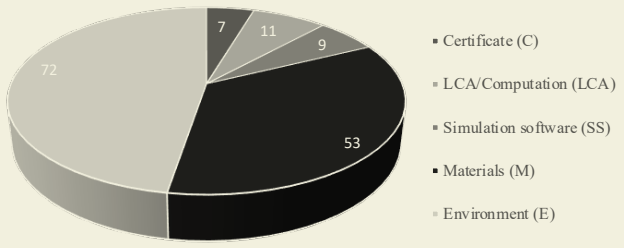


Figure 5. Content Analysis of Sustainable Graduate Courses

When the status of the courses evaluated under the classification headings as master's and/or doctoral courses are analysed (Figure 6);

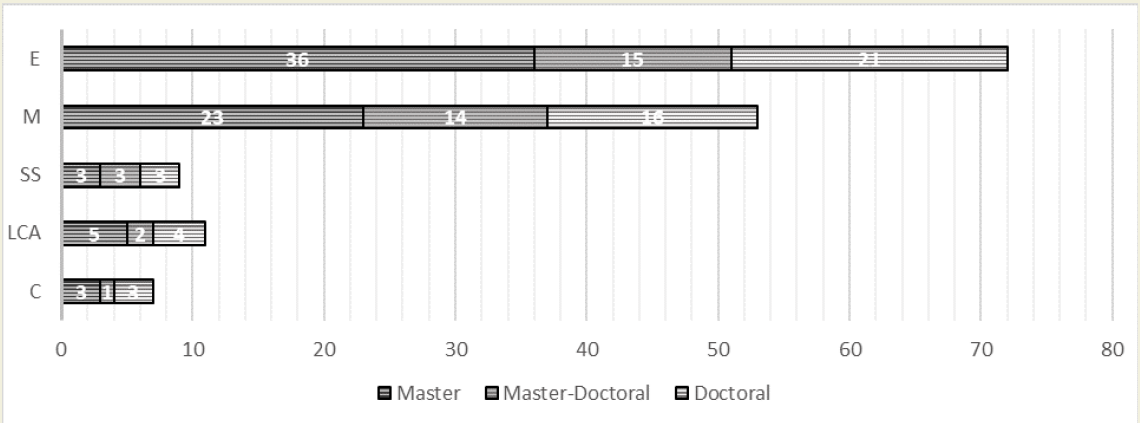
- 42.85% of the certificate (C) courses are master's courses, 42.85% are doctoral courses, and 14.29% of these courses are both master's and doctoral courses.
- 45.46% of the courses on LCA/Numerical Computation (LCA) are within the scope of the master's programme and 18.18% are within the scope of the doctoral programme. It is seen that 36,36% of the courses are given in both programmes.
- It was found that 33% of the courses in which simulation programme (SS) training was given in the master's programme, 33% in the doctoral programme; 33% of the courses given in both master's and doctoral programmes.

Table 2. Preferred words in graduate course titles

Rank	Number	Words Used in Course Titles
1	49	Sustainability
2	44	Architecture
3	36	Design
4	28	Structure
5	27	Energy
6	24	Ecology
7	19	Building
8	16	Material
9	14	Efficiently
10	9	Environment

- When the courses focused on Material/Element/System (M) topics are examined, it is seen that 43.40% of the courses are given in the master's programme, 26.42% in the doctoral programme and 30.19% in both programmes.
- As for the courses within the scope of Environment (E), the rate is 50% in the master's programme, 20.83% in the doctorate programme, and 29.17% in both the doctorate and the master's programmes.

As a result of the numerical analysis, it was seen that the courses in the other course content titles, except for the certificate and simulation programme training, were predominant in the master's programme, while the certificate and simulation programme training were given equally in both master's and doctoral programmes. While the environment was the course content with the highest rate in the master's programme, the certificate was the course content with the highest rate in the doctoral programme. When the words found in the titles of the courses on sustainability in postgraduate education are



	C	LCA	SS	M	E
Master	3	5	3	23	36
Master-Doctoral	1	2	3	14	15
Doctoral	3	4	3	16	21

Figure 6. Classification of Sustainability Courses Given in Master's and Doctorate Programmes According to Course Content

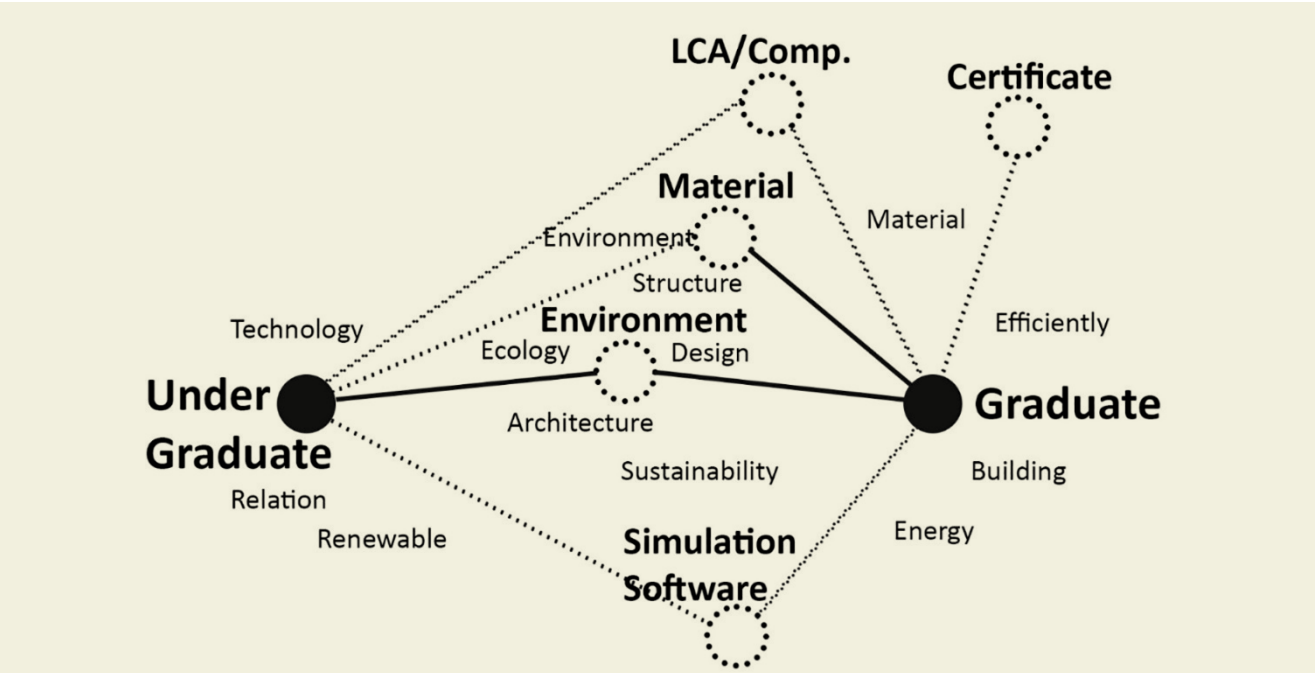


Figure 7. Map of undergraduate and graduate course contents and words used in titles

analysed, it is seen that the first three words are "sustainability", "architecture" and "design". This is followed by the words "structure", "energy", "ecology", "building", "material", "efficiently" and "environment" respectively. In this direction, it is noteworthy that the words sustainability and architecture are preferred in the titles of the courses. In addition, the topics of ecology and energy efficiency are less reflected in the titles (Table 2).

4. Discussion

Developing technology and increasing opportunities have enabled the development of education and training techniques. However, it has been observed that the effect of these new techniques on students has positive results; the subject can be better perceived and maintained. Architectural education also has to transfer the field required by the profession and the methods within the framework of other necessary field studies to the students who are the architects of the future. For architects responsible for our world's future, the courses to be given in this direction and the methods of giving these courses are important.

Sustainability is a general concept but can be divided into many sub-headings. When the contents of undergraduate and graduate courses on sustainability are analysed, it is seen that the subject of sustainability is generally given in a theoretical context. In addition, it is noteworthy that the concept of sustainability taught within the architecture framework has very few more specific courses on simulation programmes, life cycle and numerical calculation methods or certificates. It is also noteworthy that in architecture undergraduate and postgraduate education, students generally address architecture, building, design, sustainability, ecology and environment under the general title of sustainability (Figure 7).

When the contents of the courses on sustainability are analysed within the scope of the study, it is seen that undergraduate courses are concentrated on the environment (85.3%), while graduate courses are concentrated on the environment (58.5%) and materials (43.1%). It was concluded that the life cycle and simulation programme usage course contents were higher in postgraduate courses than in undergraduate courses and that certificate courses were only given at the postgraduate level.

While it is seen that the words technology, renewable and relationship are common in the course titles within the scope of undergraduate education, the words material, effective, building and energy are common in the courses within the scope of graduate education. In this direction, it has been concluded that the effective use of energy under the subject of sustainability in postgraduate education is examined in more detail and the course methods are increased in this direction, albeit in small numbers.

As a result of the findings and analysis, the concept of sustainability is generally treated superficially in undergraduate and postgraduate courses. In addition, its integration into architectural studies is minimal and its environmental impact is emphasised.

5. Conclusion

As a result of the study, it has been observed that most architecture schools add sustainability-related courses to their curricula at both undergraduate and graduate levels. However, discussions on the inclusion of sustainability in the architectural design programme should be supported by all architecture faculties/departments and options to improve the presentation and quality of technology in technically oriented faculties/departments should be

reconsidered. It should not be forgotten that more such discussions and an emphasis on valid links between the various parts of programmes will improve the quality and importance of the programmes. Resisting change and keeping architectural thought separate from various fields is synonymous with injuring architectural education. For better learning and adoption of a more holistic sustainable design approach, it is felt that sustainability courses should be supported by different methods such as application or simulation programmes. In future accreditation processes, the scope of undergraduate and postgraduate courses may be reconsidered in the context of sustainability.

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