ATATÜRK ÜNİVERSİTESİ YAYINLARI
ATATURK UNIVERSITY PUBLICATIONS

Research Article *Araştırma Makalesi* DOI:10.54864/planarch.1554347

Evaluation of Building Materials Course in Architectural Education

Mimarlık Eğitiminde Yapı Malzemesi Dersinin Değerlendirilmesi

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Received / Geliş Tarihi	23.09.2024
Revision Requested / Revizyon Talebi	28.11.2024
Last Revision / Son Revizyon	10.02.2025
Accepted / Kabul Tarihi	11.02.2025
Publication Date / Yayın Tarihi	15.03.2025

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Cite this article: Beyaztaş, H. & Tekin, Ç. (2025). Evaluation of Building Materials Course in Architectural Education. *PLANARCH - Design and Planning Research*, 9(1), 43-54. DOI:10.54864/planarch.1554347

ABSTRACT

In architecture, many fundamental topics—such as construction, comfort, health, safety, durability, lifecycle, environment, climate change, cost, reuse, and recycling—are rooted in "building materials." Despite this, it can be observed that the current architectural field lacks sufficient competence in building materials, both in education and professional practice. In architectural education, where the goal is to develop abstract and concrete thinking skills, the course that lays the foundation for abstract thinking is "basic design," while the course that explores the possibilities of translating abstract ideas into concrete forms is "building materials." Although these courses are complementary, their teaching methods and outcomes differ. This study aims to identify the quality of building materials courses, defining existing issues of building materials courses in contemporary architectural education and propose solutions. The scope of the research includes the curricula of "Building Materials" and "Basic Design" courses in the architecture departments of 33 state universities in Turkey, selected based on various criteria. The research design combines quantitative and qualitative analysis methods.In the quantitative analysis, factors such as the mandatory status of courses, their inclusion of practical components, class hours, and the adequacy of practical training hours were evaluated. The qualitative analysis involved interviews with instructors of building materials courses, which are delivered as a combination of theory and practice, to gain insights into the content and methods of practical training. The findings highlight a major issue: building materials courses lack a contemporary learning approach and method, instead relying on a traditional model where the instructor is active and the student remains passive.

Keywords: Architectural education, building materials, applied learning, learning methodology.

ÖZ

Mimarlıkta; inşa edebilme, konfor, sağlık, güvenlik, dayanıklılık, yaşam ömrü, çevre, iklim değişikliği, maliyet, yeniden kullanım, geri dönüşüm gibi birçok temel tartışma konusunun temeli; "yapı malzemesi"dir. Bu nedenle; mimarlık eğitiminde yapı malzemesi dersinin önemi, verilme şekli, öğrencinin ilgisi, öğrenebilme düzeyi tartışılması gereken oldukça önemli konulardır. Soyut ve somut düşünebilme davranışının geliştirilmeye çalışıldığı mimarlık eğitiminde; soyut düşüncenin temellerinin atıldığı ders; "temel tasarım", soyut bir düşüncenin somut hale getirilebilmesi olanaklarının tartışıldığı ders ise; "yapı malzemesi"dir. Eğitim süreci içinde birbirini tamamlaması gereken bu derslerin öğretim yöntemleri ve çıktıları aynı değildir. Bu çalışmada; mevcut mimarlık eğitiminde yapı malzemesi dersinin niteliğinin belirlenmesi, var olan problemlerin ortaya çıkarılması ve bunlara öneriler geliştirilmesi amaçlanmaktadır. Çalışmanın kapsamı; Türkiye'deki çeşitli ölçütlere göre belirlenmiş 33 (otuzüç) devlet üniversitesinin mimarlık bölümlerinin ders programlarında yer alan yapı malzemesi ve temel Tasarım dersleridir. Araştırmanın deseni; nicel ve nitel analiz yönteminden oluşmaktadır. Nicel analiz ile; derslerin zorunlu olma durumu, uygulamalı olma durumu, ders saatleri ve uygulamalı eğitim saatlerinin yeterlilikleri değerlendirilirken, nitel analiz kapsamında; yapı malzemesi dersini teori+uygulama şeklinde veren Mimarlık bölümü yapı malzemesi ders yürütücüleri ile mülakat yapılarak, uygulama içerik ve yöntemleri hakkında bilgi alınmıştır. Bulgular içinde en önemli sorun; yapı malzemesi dersinin güncel bir öğrenme yaklaşım ve yöntemine sahip olmaması, öğretmenin aktif, öğrencinin pasif olduğu geleneksel bir yönteme sahip olmasıdır. Çalışma ile yapı malzemesi dersine ilişkin değişim gereklilik ve yöntemleri konusunda önemli veriler elde edilmiştir.

Anahtar Kelimeler: Mimarlık eğitimi, yapı malzemesi, uygulamalı öğrenme, öğrenme yöntemi.

Introduction

Architecture is a field closely affected by the evolving and changing industrial environment although architecture is a low-tech profession itself. Even if the pace of change is not driven by technology, architecture remains a discipline with a very high rate of change due to shifting consumer demands (Ratti & Claudel, 2015).

Neoliberalism, while altering competitive conditions globally, has also changed production conditions and consumer demands (Harvey, 2005). This changing environment necessitates taking different demands into account and constantly renewing itself. The field of architecture is influenced by this dynamic restructuring.

The most important determinants of the architectural production environment are technology and building materials. The influence of technology in the field of architecture is seen in building material production and system design based on those materials.

Materials enable the realization of ideas. Architecture, on the other hand, is a comprehensive system formed with building materials. Although an architectural product requires a technical infrastructure, the result also has an emotional dimension, such as pleasure, enjoyment, and a sense of belonging. This emotional dimension is achieved successfully by thoroughly understanding the material both technically and sensorially.

Onaran (1995) emphasized the importance of material science by stating, "For an engineer, Material Science is as important as Anatomy is for a doctor" (Onaran, 1995). This is a valid analogy for architecture, where the primary medium is building material. Even though we live in a world of materials, we rarely think about them (Soyupak, 2015). Consequently, because we do not often think about materials, our interest and knowledge in them are quite limited. With the advancement of construction technology, a performance-oriented design approach has become widespread. As a result, the fundamental requirement for building materials has become their compliance with regulations and standards. The development of simulation technologies has further supported the performance-oriented design approach in sustainability-focused designs (Oxman, 2008; Shi, 2010).

The approach of focusing on the physical performance of building materials has also been reflected in education. In today's educational system, the information sources for material education predominantly emphasize technical properties (Pedgley, 2010). Building material education is provided primarily within the framework of engineering knowledge, stripping away sensory characteristics. Although material science appears to be an engineering-based field, aesthetic and sensory properties are equally important within the design discipline.

Additionally, building material courses are mainly taught theoretically. However, materials in architecture are directly related to practice, production, and communication with the user. Therefore, its education should be structured around this content. Material knowledge is also placed in between theory and practice in some studies (Figure 1).

Architectural material courses, which are engineering-focused and taught theoretically, aim to provide important information about production techniques and technologies; however, students cannot learn about building materials adequately because courses lack direct experience with material itself.

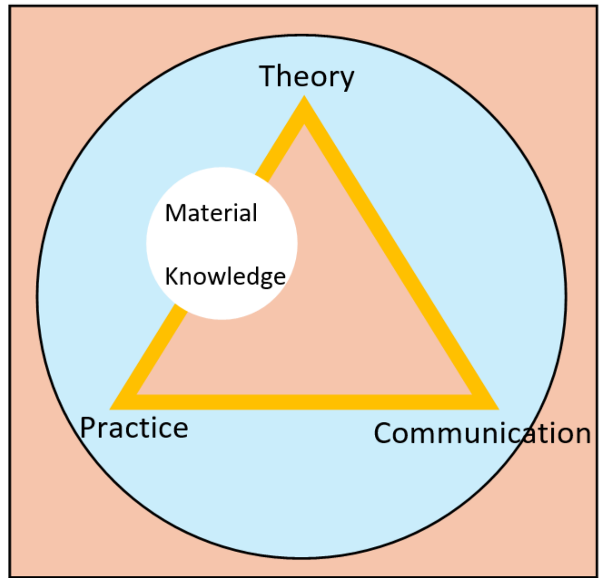

Figure 1. "Material Knowledge" on the axis of the Theory - Communication -Practice triangle (Er et al., 1998)

Lawson explains that material courses initially started in workplace and eventually transitioned to universities. In contemporary university design education, these courses are technology centered. Students concentrate more on new technologies instead of traditional craftsmanship (Lawson, 1997). This reminds the foundation purpose of Bauhaus. Rognoli and Levi (2004), in their research on material education, propose that Bauhaus's approach to materials was the first effective and contemporary teaching methodology (Rognoli & Levi, 2004). At Bauhaus, materials were learned through experimentation in separate laboratories during the basic design period. Apprentices worked with materials in a project-based manner. The research also indicates that the characteristics and differences of materials were learned not only by seeing but also by feeling them. Materials were identified through sensory organs, fostering creativity.

Examining modern building material education, it is observed that education keeps pace with technology. On the other hand, a different study has shown that using factory tours as an educational tool is an effective method (Perker, 2011). However, this educational practice is not a method that can be applied widely and continuously, and it also focuses more on the technical aspects of building materials. In summary, with the highly advanced production technologies and the increasing number of new material discoveries, it is seen that learning by seeing has replaced learning by doing in building material courses.

Today, the gap between theory and practice has been recognized, and as a solution, design-build workshops have been developed. The implementation of these workshops in different schools and countries indicates that this issue is a widespread problem in architectural education (Stonorov, 2017). Although design-build workshops are important for identifying the problem, they are insufficient for solving it, as only a limited number of students can participate (Toy & Gökmen, 2023). Additionally, the 'design-build' method is not yet a viable approach in many countries. Therefore, the method is being gradually implemented in architectural education through techniques like 'hands-on learning' and 'learning by doing'. This method aims for students to learn by doing, in which building materials and related details are intertwined. Therefore, the final product differs from the outputs of traditional learning models.

In a study investigating the primary criteria architects use in building material selection, Wastiels & Woulters (2008) identified four key elements: material (technical) properties, experience, manufacturing process, and context (Wastiels & Woulters, 2008). Material courses in collage of architectures generally focus on the technical properties of materials. For the manufacturing process, the factory production process is typically introduced. Context can be partially determined within the scope of architectural project courses, while experience is one of the most significant missing components in building materials education. Here, experience encompasses the perception, associations, and emotions related to the material (Karana & van Kesteren, 2006; Wastiels et al., 2007).

The selection of building materials is generally accepted to follow a hierarchical relationship between space, building elements, and materials. In this context, various scientific methods for material selection have been developed (Jahan et al., 2010). However, architects focus less on hierarchical thinking between materials, elements, and space and more on bringing together the qualities needed to create the experience they wish to provide for the user. This requires an iterative cycle. In the iterative cycle between the evolving design concept and the intended outcome, the properties of building materials and the experience of the space converge (Wastiels et al., 2007). For this reason, it is crucial for students to understand and control not only the technical and production aspects of materials but also the sensory experience they provide to users. This can only be achieved through direct interaction with building materials.

Hegger et al. (2023) state that in architectural practice, two common approaches are typically applied when selecting and using building materials: either the building material is considered the starting point of the design, or it is completely disregarded (Hegger et al., 2023). In projects where building materials and design are considered together, the design is developed based on the properties and potential uses of the material. However, in projects developed independently of the building material, the design is later adapted to the language of the material.

Cross (1997) states that expert designers work with a focus on results, concentrating more on outcomes than on the problem itself (Cross, 1997). Cross emphasizes that establishing a relationship between the problem and the solution can lead to a creative perception breakthrough. Supporting this view, Kesteren (2008) states that the material selection process is one of the tools that can bridge the gap between the problem and the solution (Kesteren, 2008).

Material education is expected to teach how to understand materials in all dimensions—technical, aesthetic, and perceptual—and how to select materials that suit design requirements. The material is expected to first establish an emotional connection with the designer, which then transfers its strength and effect to the user. Thus, the relationship between the designer and the material is crucial. The better the designer knows the material, the more effectively they can create the desired impact. This principle also applies to sculpture. Sculptors with a craft background are more skilled in using, shaping, and conveying emotions through the material (Bakkal, 2019).

Building materials are not confined to a single course in architectural education but are included in varying degrees across the entire curriculum. However, the most fundamental issue is that students fail to establish a connection between materials and a design problem and lack any hands-on experience with building materials. Additionally, with changing generations, students' learning methods also change. In this context, Mayuk and Coşkun (2020) applied the learning-by-doing method in a structural course and observed that students preferred this hands-on approach over the traditional method of listening to the lesson and then understanding it through drawing (Mayuk & Coşgun, 2020).

Working on real structures has a significant impact on the development of students' sense of space, place, and perception (Leurs et al., 2013). Therefore, it is important not only to have hands-on experience but also to work with real structures and spaces. Working within a physical structure is also an important tool for enhancing students' collaborative performance and peer learning (Doorley & Witthoft, 2012).

Hands-on experience is crucial in architectural education for teaching technical subjects such as structural systems (Emami & Buelow, 2016; Karadag & Canakcioglu, 2023; Voutetaki, 2024; Voutetaki & Thomoglou, 2023), in construction courses (Mayuk & Coşgun, 2020), and in interior architecture education (Doğan & Noraslı, 2019).

In creating the Bauhaus Vorkurs atmosphere, Itten placed great emphasis on material and texture studies. Because, material and texture studies will provide valuable support to help students more easily choose their area of specialization. In this way, every student identified the material that appeals to them, and this chosen material inspired them towards creative endeavors (Siebenbrodt & Schöbe, 2012).

Building materials education should be structured around the integration of design and building materials, allowing students to develop behaviors such as inquiry, problem identification, solution finding, risk-taking, and openness to innovation through hands-on experience.

Problem Statement

Architectural education consists of courses that teach both abstract and concrete thinking. Through different courses, architectural students are guided to develop learning behaviors, including imagining, generating ideas, representing ideas, assessing feasibility of those ideas, and construction ways. The process of abstract thinking typically begins with the basic design course. The practical aspects of an abstract idea—its feasibility, applicability, and constructability—are taught through contruction courses. However, the most important tool in transforming an idea into a concrete form is building material. In other words, building materials are the key actor in transforming abstract thought into reality. These two courses yield totally different outcomes; therefore, they should complement each other throughout the educational process.

The role of the building materials course in architectural education, how it is taught, students’ interest level to this course, and the learning outcomes are crucial issues that need to be discussed. Therefore, this study aims to analyze the proportions of basic design and building materials courses in the curriculum, as well as their teaching methods in Türkiye, using both quantitative and qualitative approaches.

Material and Methods

In Turkey, building materials courses and basic design courses in undergraduate architecture have been examined and compared. The examination method for building materials and basic design courses includes: a) Selection of sample undergraduate programs, b) Quantitative Analysis: Teaching methods of the courses, c) Qualitative Analysis: Comparison of course objectives, content, and 14-week syllabus. Qualitative analysis also includes the determination and evaluation of the application content in materials courses. Qualitative analysis includes interviews with the instructors. For this, the ethics committee approval was received for this study from the ethics committee of Mimar Sinan Fine Arts University on March 07, 2024 with the number of E-15207191-050.99-156017. These methodological steps and their implementations are detailed in the subheadings below.

Implementation of the Method

The study focuses on the architecture departments of state universities. State universities are chosen because they have a long and established history, more extensive educational and teaching experience, a larger faculty and staff, the ability to offer scientific diversity through various departments, opportunities for interdisciplinary collaboration, and a higher likelihood of possessing physical resources such as laboratories.

The number of students admitted in 2023 was obtained from the YÖK Atlas website, a government database. The distribution of student admissions was analyzed, revealing a significant decline after a quota of 60 students (Figure 2). It was found that architecture programs below this cutoff were relatively newly established departments. Initially, 38 universities were identified; however, this number was later reduced to 36 as Yıldız Technical University and Istanbul Technical University offer separate programs in Turkish and English.

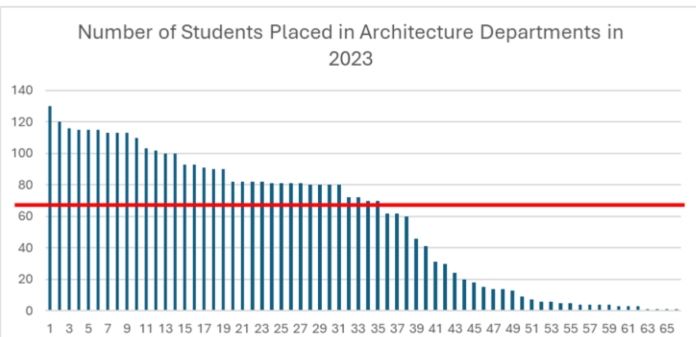

Figure 2. The number of accepted students in 2023 (URL-1).

In the review, Bolu Abant İzzet Baysal University and Muğla Sıtkı Koçman University were not evaluated because course contents could not be accessed online. İzmir Democracy University was also excluded from the study list due to the unavailability of course schedules or contents. As a result, a total of 33 architecture programs of state universities are studied.

Quantitative Analysis

A five-question examination matrix was created for quantiatative analisis in order to objectively examine the delivery methods of basic design and building materials courses, which are expected to develop abstract and concrete design skills at selected universities. The undergraduate architecture courses from the websites of the listed universities were then reviewed to find answers to these questions. The matrix questions are:

- Is there a mandatory building materials course?
- If there is no mandatory building materials course, how is building materials knowledge provided?
- In which semester(s) is the mandatory building materials course offered?
- How many hours is the mandatory building materials course?
- Are there practical(application) hours in the mandatory building materials course?

This matrix was also applied to the basic design courses. The results of the examination are shown in Figures 3, 4, 5 ve 6. To determine the differences between the structure of a building materials course and a design course, the analysis begins with the materials course, followed by the basic design course.

Building Materials Course

Is there a core (required) building materials course? If there is no mandatory materials course, how is building materials course content provided?

It is found that, in some universities, the materials course is offered as an independent mandatory course, while in others, it is integrated with the construction courses. Among the 33 architecture departments examined, it was found that 28 of them have a mandatory course specifically focused on building materials, with the word "materials" in the course title. 24 out of 33 are offered in a single semester (Figure 3 – orange color). In 4 universities, the building materials courses are taught over two separate semesters (Figure 3 – green color).

In 5 universities, there is no mandatory building materials course; instead, the content is integrated into construction courses (Figure 3 – blue color). In these universities, courses are given under names such as "Building Information and Technologies," "Building Elements and Materials," and "Construction Techniques and Materials," spanning multiple semesters. At Mersin University, although the building materials content is included within the construction course, there is also a separate mandatory course titled "Mechanics of Materials."

In which semester(s) is the core(required) building materials course offered?

It is found that building materials courses are offered in different semesters. Core material courses are taught from the first to the fifth semester (Figure 5). Mimar Sinan Fine Arts University (MSGSÜ) is the only university offering the building materials course in the first semester. The course is offered in the second semester at 7 universities, the third semester at 16 universities, the fourth semester at 5 universities, and the fifth semester at 3 universities. Additionally, 4 universities (shown in green) offer the course across two separate semesters.

Therefore, mandatory building materials courses are predominantly offered in the second and third semesters. On the other hand, building materials content which integrated with construction courses follow a similar pattern. Although they are offered between the second and fifth semesters, they are mainly concentrated in the third and fourth semesters.

How many hours is the mandatory building materials course? Are there application hours in the core building materials course?

It has been observed that building materials courses are predominantly taught with practical applications. Building materials courses are taught with practical sessions at 14 universities, on the other hand, they are offered as theoretical-only courses at 13 universities (Figure 3). At 5 universities building materials content is integrated with construction courses and they are taught practically; however, it is assumed that the practical aspects focus on construction in that type of courses.

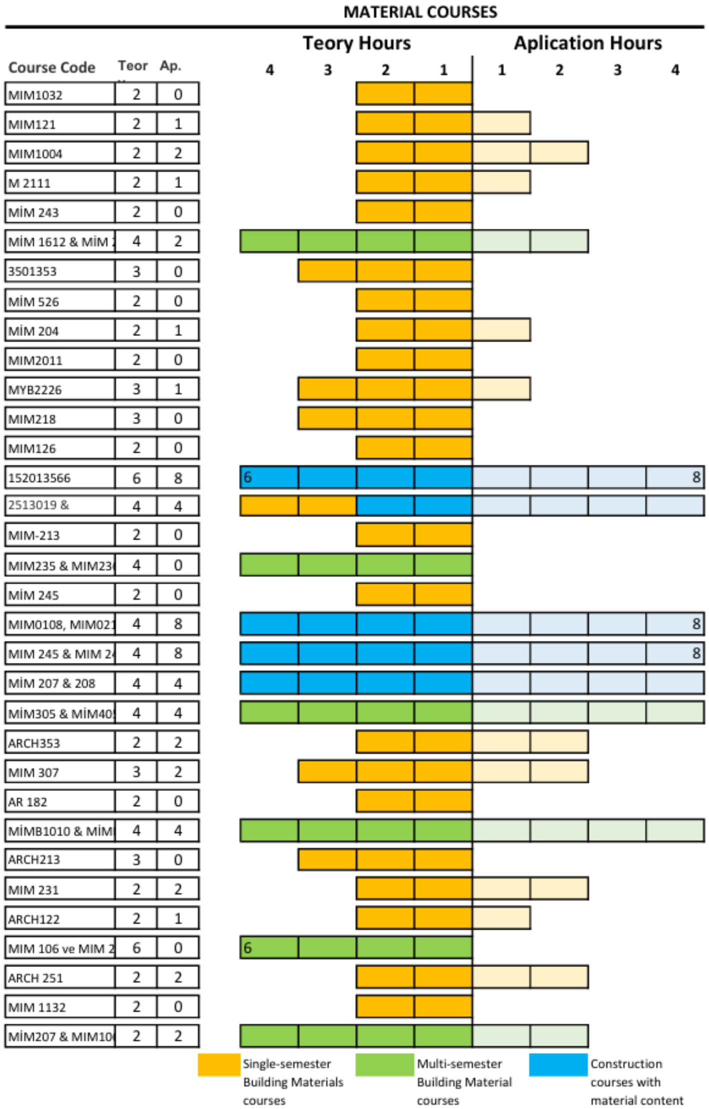

Figure 3. Theory and practice hours of core building materials courses.

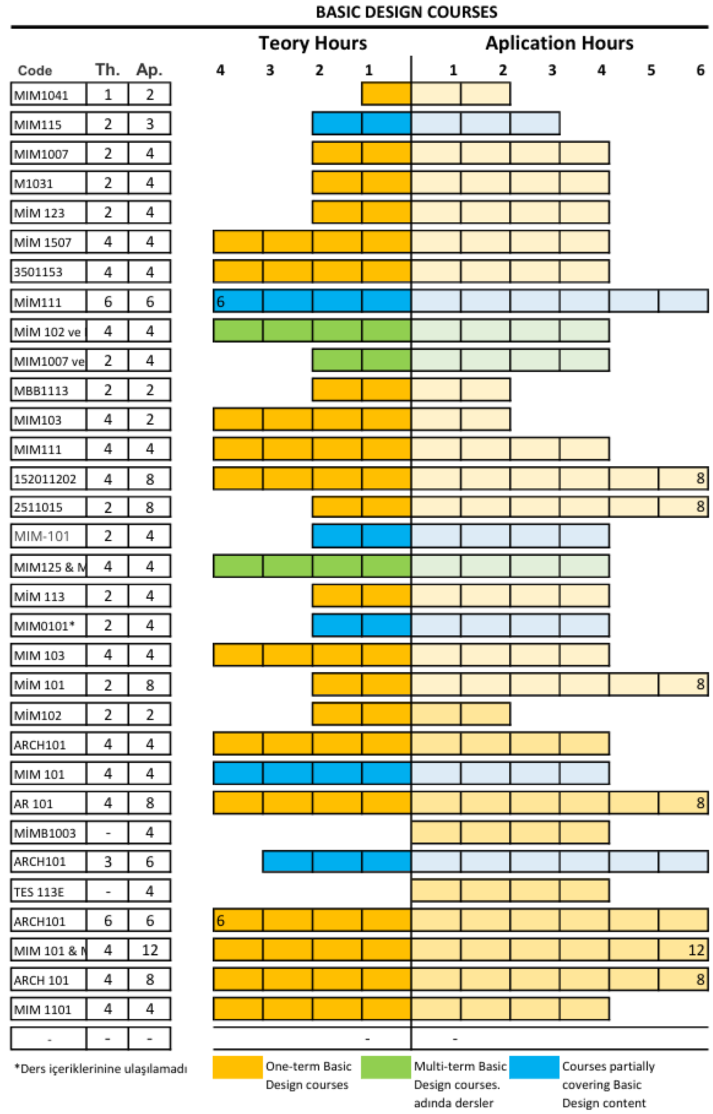

Figure 4. Theory and practice hours of core basic design courses.

The time distribution of building materials courses is detailed in Figure 3. Throughout the undergraduate program, 2-hour theoretical-only materials courses are offered at 8 universities, 2-hour theoretical and 1-hour practical courses are offered at 5 universities, and 2-hour theoretical and 2-hour practical courses are offered at 8 universities. Courses taught over two semesters can extend up to 8 hours. The average theoretical course duration for building materials courses is 2.66 hours, while the average practical duration is 0.96 hours. The combined average for theoretical and practical courses is 3.59 hours.

Basic Design Course

The prepared five-question evaluation matrix was also applied to the basic design course. The undergraduate architecture course programs from the listed universities' websites were reviewed to find answers to these questions. The matrix questions are: 1. Is there a core(required) basic design course? 2. If there is no core(required) basic design course, how is the basic design content provided? 3. In which semester(s) is the required basic design course offered? 4. How many hours are the required basic design courses? 5. Are there practical hours in the required basic design course? The results of the examination are shown in Figures 4 and 6.

Is there a mandatory basic design course? If there is not, how is the basic design content provided?

As a result of the curriculum reviews, it has been observed that the basic design course is offered as an independent mandatory course named 'basic design' in most universities, while in some universities, it is integrated with different courses or partially given under 'introduction to architectural design' courses (Figure 6). It has been determined that 28 out of 33 architecture departments have a mandatory course with the name 'basic design.' As an exception, the basic design course could not be found in the course lists of Samsun University, and this university was excluded from the evaluation because the course contents were not accessible.

In 24 out of 28 universities offering 'basic design' courses, the course is given in a single semester (Figure 6-orange). In the remaining 4 universities, the basic design courses are given in two separate semesters (Figure 6-green). It has been determined that there is no mandatory basic design course in 5 universities. In these universities, it has been observed that the basic design contents are integrated into different courses.

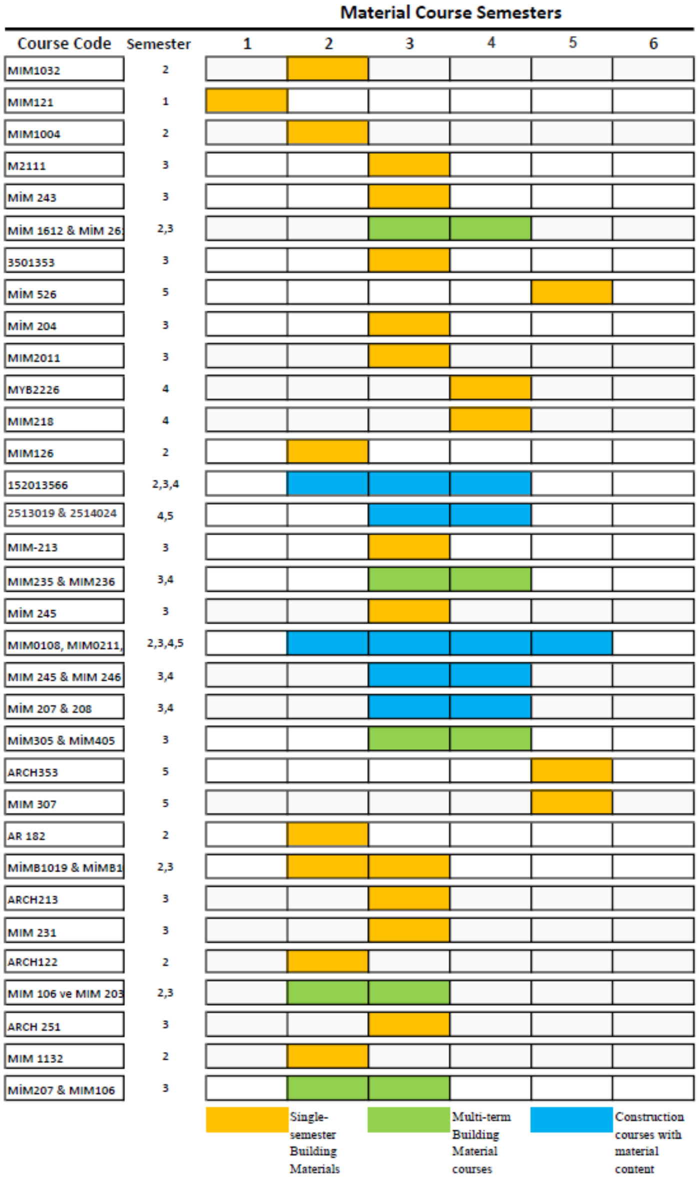

Figure 5. The semesters of building materials courses.

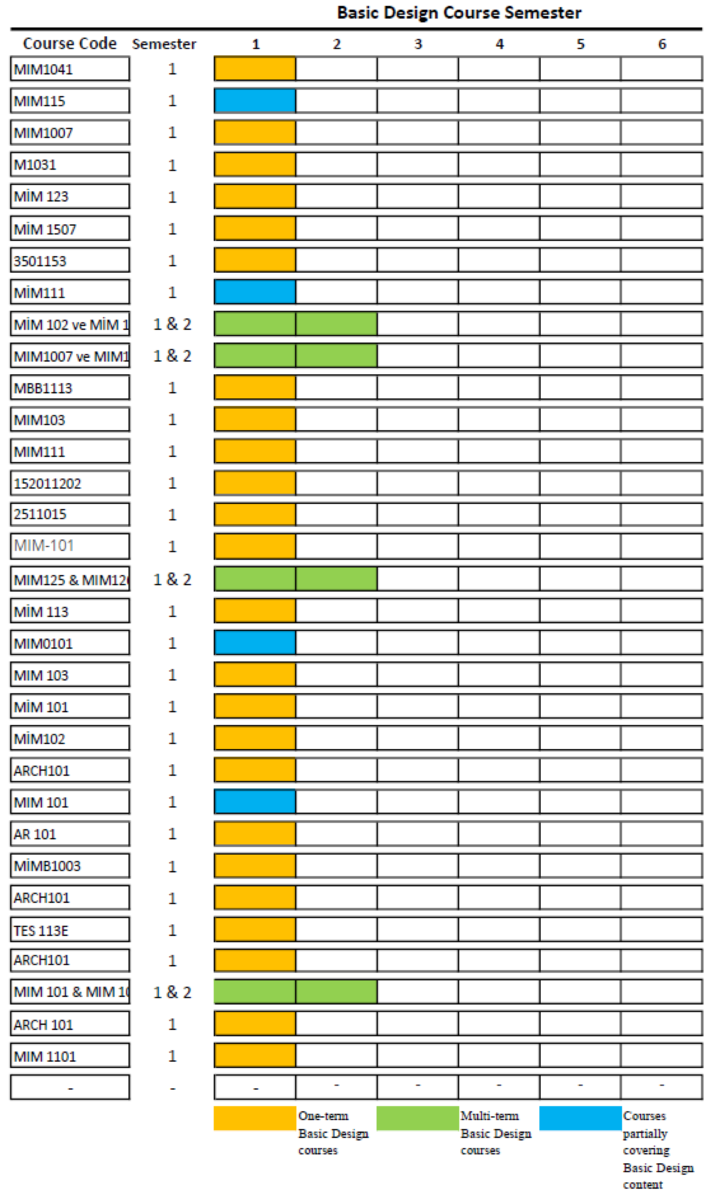

Figure 6. The semesters of basic design courses.

These courses, which are concentrated in the first semester, are offered under names such as 'Introduction to Architectural Design,' 'Basic Education and Architectural Design,' 'Introduction to Architectural Design and Professional Orientation,' and 'Architectural Design I' (Figure 6).

In which semester or semesters is the mandatory Basic Design course offered?

Schools offering basic design courses in the first semester are highlighted in Figure 6 (orange). Those offering these courses in both the first and second semesters are marked in Figure 6 (green). Some other courses that include basic design content only partially in the first semester are shown in Figure 6 (blue). As a result, all schools offer a basic design course or course content in the first semester.

How many hours are the mandatory Basic Design courses? 5. Are there practical hours in the required basic design course?

The hourly distribution of Basic Design courses is provided in Figure 6. The total duration of basic design courses ranges from 3 to 16 hours. The average duration of theoretical classes is 3.21 hours, while the average duration of practical sessions is 4.85 hours. The average total duration of both theory and practice combined is 7.81 hours. This indicates that the basic design course is predominantly practice-oriented course.

Quantitative Comparison of Building Materials and Basic Design Courses

Comparing the hours of Building Materials and Basic Design courses, it is observed that the basic design courses has more hours for both theory and practice (Figure 7). While Building Materials courses are taught for an average of 2.66 theoretical hours, Basic Design courses are taught for 3.21 hours. The Basic Design course is approximately 20% longer. The significant difference comes from the practice hours. The average practice hours for Building Materials courses are 0.96, whereas for Basic Design courses it is 4.85 hours.

The practice hours for Basic Design are about 5 times more than those for Building Materials courses. When comparing the total hours of theory and practice combined, Basic Design courses have about two times more course hours. The current findings indicate that the necessity of abstract design is prioritized in architecture departments, as seen in both the number of course hours and the comparison of course semesters.

Basic Design courses, which provide education in abstract design, are offered in the first semester. In contrast, Building Materials courses, which are needed to teach the requirements of concrete design, are offered as early as the first semester in only one school, and is taught as late as the fifth semester. The fact that building materials courses are predominantly offered in the third semester supports the thesis that the course aims to provide technical knowledge rather than being a part of design process.

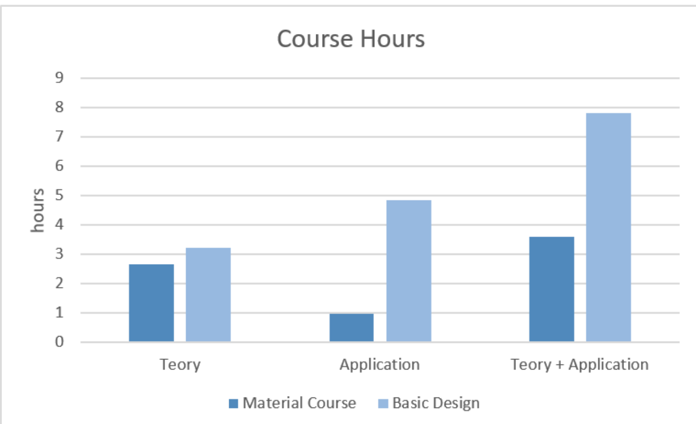

Figure 7: Comparison of Building Material and Basic Design Course Hours

Qualitative Analysis

In Turkey, on-site production in the construction sector was a common practice until recently. To enable architects and engineers to become site supervisors and to ensure they have the competence to prepare, produce and control concrete according to standards, concrete calculations were included as practical exercises in material courses. Therefore, it was common for engineering professors to teach material courses in architecture departments. However, due to the requirements that emerged after the 1999 earthquake, on-site concrete preparation was banned in Turkey. To achieve quality and standardization in concrete, the use of ready-mixed concrete was mandated by Circular No. 248 "Requirements to be Followed in Concrete Pouring and Maintenance," published in 2004 (URL-2). Even though professional requirements have changed, it is known that many traditions continue in architectural education. Therefore, it is important to examine qualifications (the area of expertise of) the of building materials course instructors and the practical content of these courses.

The undergraduate educational background of instructors teaching mandatory building materials courses in 28 departments was investigated. The names of the faculty members, which is listed in the course curricula obtained from university websites, were cross-referenced with the official academic database, YÖK Academic, to determine their undergraduate education backgrounds (URL-3). Six universities were excluded from this evaluation because the course instructor names was not specified in their course curriculum. In 12 universities, building materials courses are taught by faculty members with an architecture background, while in 5 departments, the courses are taught by faculty members with a civil engineering background. In 4 universities, the material courses are co-taught by faculty members from different disciplines, and in 1 university, the course is taught by an instructor with a background outside of architecture or engineering.

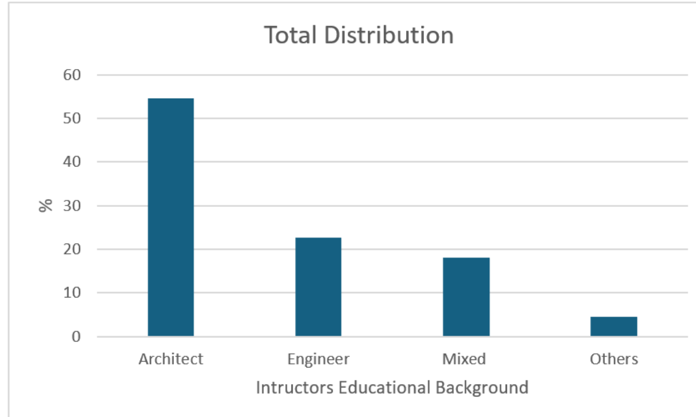

Figure 8. Undergraduate Backgrounds of Instructors Teaching Building Materials Courses.

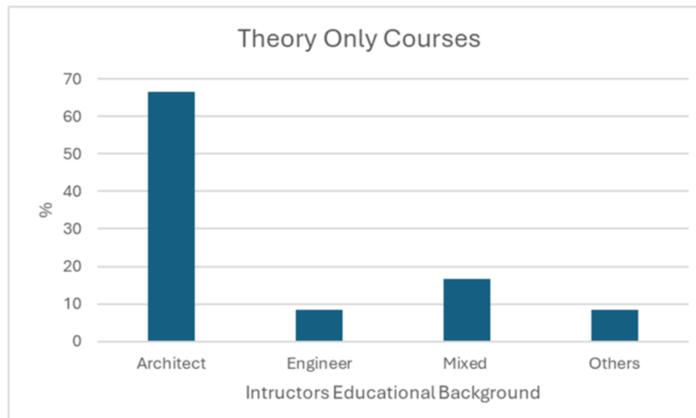

Figure 9. Instructor's background in Building Materials courses (theory only).

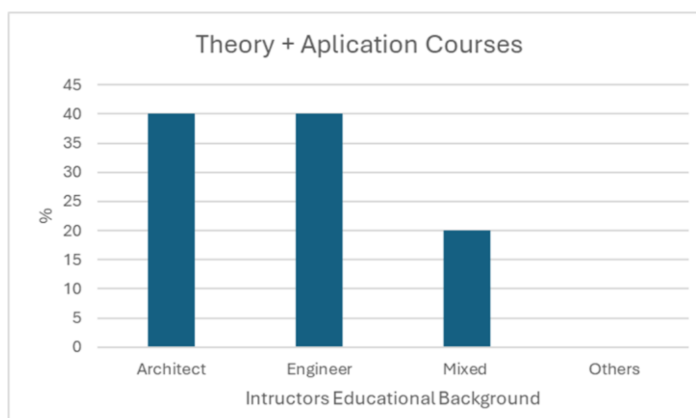

Figure 10. Instructor's background Building Materials courses (Theory and Practice).

In the examined schools, only 55% of the building materials courses are taught by faculty members with an architecture background (Figure 8). In building materials courses that are only theoretical, the percentage of faculty members with an architecture background is 67% (Figure 9). However, in materials courses with practical application, this percentage drops to 40% (Figure 10). These results indicate that the proportion of faculty members with an architecture background teaching building materials course is not at a sufficient level.

To sum up, these statistics shows that building materials courses with insufficient course hours are also lacking in application content that supports architectural design. It is because instructors without architectural background will not be able to teach design aspects of material in an applied way.

Reviewing the application content of the Building Materials courses

Interviews were conducted with the instructors of building materials courses offered with practical applications to understand the application content. Buildign materials course in architecture departments is offered in a theoretical format only at 13 universities. Aside from, 14 universities offer it in both theory and application format. Faculty members from 14 universities that offer the materials course in both theoretical and application formats were contacted. An email was sent, including the ethics report and a summary of the research's aim and subject. Some course administrators were additionally contacted by phone based on the email responses. The course instructors were asked for information about their application content, application methods and outcomes. No response was received from 3 universities. The course syllabi of the universities that did not respond were re-evaluated in detail. The common issues identified during the interviews are:

- The very high number of students,
- Insufficient class hours,
- Insufficient practical hours,
- Inadequate classrooms for the content of buildign materials course,
- Lack of building materials laboratories to support the course,
- In universities with laboratories, the high number of students and the inadequacy of the laboratory size for this number,
- In universities with laboratories, the instruments are not calibrated and unusable

In addition, some faculty members expressed their dissatisfaction with the current application part of their courses. They mentioned planning changes to the application content and are considering different content for future. The current application contents are listed below (Table 1). These points provide information about the application content at one or more universities.

Considering all application contents listed Table 1, there is no significant difference between universities that offer the course only theoretically and those that offer it both theoretically and practically. With this type of education, it is not possible for the materials course to become a part of design projects, because these do not include hands-on experience. Besides, the average of 0.96 hours of practical sessions for the materials course does not allow for such a design-based application. Two important factors have been found to influence the formation of the content applications: a) the common issues mentioned above, and b) the course instructor's undergraduate background. While basic design courses in architecture departments are taught by architects, it is found that this is not always the case for the materials courses. Although the instructor's background has a limited impact on the theoretical part of the material courses, it significantly determines the nature of the application part.

Table 1. Current application content of building materials courses in architectural programs.

1	Students are given various predetermined questions or problems from the class to develop solutions and understand key points in material selection. The goal is to create a discussion environment in the classroom to help students grasp both the problems and the role of the materials in solution.
2	In the practical part of materials courses, which are entirely focused on concrete theory, students take technical visits to a ready-mix concrete plant and are expected to prepare a technical report. In our country, which is at risk of earthquakes, great importance is given to concrete due to the potential of architects to become construction site managers.
3	Building materials that previously produced for various purposes in the laboratory of the Construction Department are brought into the classroom for discussion. Along with materials, supplamentary document are shared with students. These include videos, photos, and experiment videos using mechanical tools.
4	Throughout the term, three separate practical assignments are planned: heat calculation in the building envelope, concrete calculation, and presenting a research report on a chosen material. The heat and concrete calculations focus on the technical properties of materials. The material selection assignment allows students to independently choose a material and conduct research.
5	In the building materials course, that is offered across two separate terms, students are given two distinct research assignments. Based on the theme for that term, such as innovative materials, students must research an innovative material, find ten projects designed with it, and study the system details. If time permits, students present their research. At the end of the term, all research reports are compiled into a folder, which is open to students. A small portion of the final exam includes questions on these assignments, making all students responsible for them.
6	Certain themes are defined and students are asked to prepare an assignment. If the term's theme is traditional materials, students are expected to prepare an assignment on traditional materials. If the theme is contemporary materials, the assignment should focus on contemporary materials. Students must select a traditional material and an example of a historical building where this material was used. Students need to submit a text explaining their reasons for selecting their materials and their buildings, discussing the material's formal use, and its technical and sensory impact on the building, supported by both verbal and visual elements. This process helps students develop an understanding of the effectiveness of materials in building production from their own perspective.

Discussion

This study aims to evaluate the current state of building materials courses in architecture departments, both qualitatively and quantitatively, and to examine their contributions to the design process. Through this research the following common issues are identified:

- Insufficient class hours

- Very high number of students

- The course being predominantly theoretical and focused on the technical properties of materials

- Lack of application sessions in some schools, and insufficient time and content for application sessions in others

- Schools showing application hours on the schedule but conducting only theoretical sessions

- Lack of classrooms or laboratories suitable for the course content

- Course content varying due to instructors not having an architecture background, leading to a more technical focus with no emphasis on sensory aspects

- Application content not being feasible for hands-on experiments

- Application content not encouraging students to think independently and develop solutions

- The delivery method of the building materials course lacks contemporary learning approach or method. Traditional teaching behavior is commonly adopted. It means the teacher is active, and the students remain passive.

These findings show that building materials courses are not provided at a sufficient level for architecture students. Adequacy can be considered from many different perspectives and opposing views may arise. It is essential not to think of adequacy only within the education period. Education should be in a format that fundamental knowledge and habits are acquired, and it should instill the ability to think with materials and choose the right material under necessary conditions. The lack of this behavior can be easily understood from the statements of students who have graduated over the years and from the general architectural environment around us.

In the research, the results obtained from building materials courses depend on each university's conditions, including the number of courses, whether they are theoretical or practical, and the qualifications of the teaching staff. There is no system to evaluate or question this setup. The most significant problem is that architecture departments can determine the quality and quantity of the courses based on the university's resources, and there is no oversight to regulate this.

The issue is not limited to the building materials courses. The main concern is that universities can create their course programs with any desired quality and quantity. There is no system to check whether a building materials course exists in any architecture department or to assess its quality. Different architecture program approaches can enrich the academic environment. However, in Turkey, every graduate from an architecture department—whether from a private or state university—obtains the same professional rights within an unregulated system. In other words, there is no proficiency exam organized by the chamber of architects or the ministry. Therefore, what needs to be done is to establish a legally controlled system that can assess the level of graduates after their graduation, defining various threshold levels to determine and particularly enhance the candidates' development.

Accrediting institutions could be considered a solution for overseeing the departments. However, applying to these institutions is entirely voluntary for the department. During accreditation processes, most evaluations are not conducted with the necessary rigor but rather with an approach of giving the department another opportunity.

The Bologna Process, which includes Turkey and allows each country to participate voluntarily, is also against a uniform higher education system. However, instead of improving the courses, the Bologna Process aims to facilitate free movement, especially through a common structure based on credits. It focuses on quantitative data rather than the quality of courses, creating a common language in terms of numerical values.

In architecture education in Turkey, there is a lack of synergy between practical application and theoretical education. With theoretical education outweighing practice, this prolongs the process of translating theoretical knowledge into practice (Yurtsever, 2011).

The profession of architecture is both a science and an art, requiring creativity and innovation. It demands the ability to quickly solve problems, adapt to science and technology, and understand and utilize new materials and systems. These requirements highlight the need for education that can uncover and enhance these skills in students.

However, research shows that the content and teaching methods of building materials courses fail to foster student potential due to their passive role in the learning process. This underscores the necessity of revisiting and reforming teaching methodologies. In fact, it has been widely accepted that education system should prepare students to the needs of 21 century (Binkley et al., 2012; URL-4)

Despite this, academics in architectural education are typically architects who have not received training on how to design or update educational programs. In today's rapidly changing world, the speed of transformation necessitates a shift in learning methods. In applied disciplines like architecture, collaboration with educational sciences on teaching and learning approaches is particularly essential.

Modern educational approaches highlight that knowledge is constructed internally rather than transmitted externally. Dialogue-driven processes and active student involvement are essential, especially in constructivist settings like design education and studio culture, where learning occurs through discovery. In the constructivist education approach, Okta states that "knowledge" is developed through interactions and dialogues that individuals engage in with the city, spaces, materials, and other people (URL-5). Therefore, "In the information society, architecture schools should no longer be places where knowledge is simply transmitted but rather environments that enable the construction and re-creation of knowledge."(Aydınlı, 2015)

In constructivist education in architecture, "learning by doing" stems from the passion for building. This process takes shape through the integration of theory, design, and construction. Students develop design ideas while simultaneously considering constraints like materials, time, budget, details, and location. This cyclical, interdisciplinary research involves constant interaction between the main idea and details. Socially, students engage in teamwork, gaining experience in consensus-building, task distribution, and sharing responsibilities (URL-5).

Aside constructivist education, with developing and changing technology, today's learning theory focuses on "Connectivism" (Downes, 2008; Siemens, 2005).

Connectivism has become a prominent learning theory today due to factors such as the needs of the new generation of students not being adequately met by traditional education methods, the rapid increase in knowledge and the necessity of new methods to access information, and the developments in technology enabling students to communicate more with each other. Connectivism is a topic of debate as a new learning approach. Many researchers argue that it is not a theory but rather a learning approach, emphasizing the need for more data on the subject.

Generations Y and Z, as individuals born into and adept at using digital tools, clearly reflect the shift in learning towards connectivism. In all fields of education, databases are utilized as sources of information. For today's students, digital networks have become more significant than printed resources. Activities such as learning, researching, preparing assignments, and sharing data all take place on networks. As active participants in the process, students know what, how, and where to search, evaluate and analyze the results, and establish connections.

In fact, this study observes that some universities partially apply the connectivist learning approach within the framework of specific assignment topics. However, since students are expected to research predefined topics, they do not develop the ability to independently select an assignment subject. To determine a topic, they would need to conduct more detailed research on the subject and clearly articulate the rationale behind their choice.

In constructivism, learning involves making sense of information, whereas in connectivism, it happens through networks (Çoban & Ay, 2023).

Connectivist learning focuses on creating knowledge rather than simply consuming it, as is common in traditional learning environments (Hendricks, 2019).

In light of evolving generations and learning methodologies, the teaching of building materials courses should adopt a hybrid approach that integrates both constructivist and connectivist learning strategies. These courses, structured around both theoretical and practical components, should employ constructivist methods to provide diverse experiences with building materials, while connectivist methods should encourage critical inquiry, research, and analysis of material knowledge.

Conclusion

In architectural education, learning methods applied in project studios actively engage students. However, the main problem is that the design process is not carried out in conjunction with building materials within these studios. Designing, which involves making the unprecedented feasible and buildable, relies on the informed use of building materials. However, studio outputs often remain detached from the presence of building materials, confined to the level of paper architecture.

It has been observed that the current building materials courses do not meet the requirement of addressing the technical, aesthetic, and perceptual aspects of materials as defined in the research. Additionally, they do not provide a platform for students to learn about materials through hands-on experience or to internalize materials through design-build projects. In this context, the following recommendations have been developed for the material courses in architecture departments.

Firstly, the courses should provide environments where students can interact with building materials. Students should be able to touch, break, stretch, and feel the materials, engaging with them directly. They should be able to incorporate materials into their design thinking.

Instead of directly teaching the technical properties of materials, the courses should focus on teaching how to find solutions using materials based on specific requirements.

New building materials are constantly being introduced in the market. As an architect, one will continually encounter and need to evaluate these new materials in their professional life. Therefore, students should be taught to engage with materials through inquiry and critical thinking.

Instead of focusing on a single topic throughout the semester, students should be given opportunities to work on various topics for shorter periods. This approach keeps students' interest active, creates a dynamic and engaging learning environment, and enhances their desire to learn.

The focus should be on developing students' abilities to understand and select building materials.

Instead of giving students ready-made, standardized information, assignments should encourage them to think critically. Students should be given opportunities to develop and express their own perspectives and opinions.

Design-material integration should be addressed through small design projects, allowing students to experience how materials can provide various options and possibilities for their designs.

A discussion environment should be created to ensure students are actively engaged in the class. This environment will foster individual thinking and provide opportunities for students to learn from one another.

During their education, students need to learn the technical, functional, and sensory properties of building materials. This knowledge will enable them to not only understand the material and its properties technically but also define design requirements and identify potential risks during the usage process. Consequently, they will be able to select building materials based on the problems they foresee.

Material knowledge is not static. It is highly dynamic, especially with the development of various technologies, including aviation technology. Therefore, material knowledge should be considered in terms of requirements and solutions rather than focusing solely on the materials themselves. In today's conditions, it is not possible to teach thousands of materials to students. Instead, students should be taught (or helped them develop) the approach of how to generally think about and use materials.

The architecture profession involves creating problems and then working to solve them. Materials are at the center of this problem-solving. Therefore, building materials education should be restructured to align with this purpose. It is important to receive support from educational sciences in order to adjust new learning methods in a healthy way.

Learning approaches that encompass not only building materials education but also the entirety of architectural education should be structured based on methods such as constructivist and connectivist learning. However, these approaches must fundamentally be designed with the goal of equipping students with 21st-century skills to become competent professionals.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - H.B., Ç.T.; Design- H.B., Ç.T.; Supervision- H.B., Ç.T.; Resources- H.B., Ç.T.; Data Collection and/or Processing- H.B., Ç.T.; Analysis and/or Interpretation- H.B., Ç.T.; Literature Search- Ç.T.; Writing Manuscript- H.B., Ç.T.; Critical Review- H.B., Ç.T.; Other- H.B., Ç.T.

Ethics Committee Approval Certificate: Ethics committee approval was received for this study from the ethics committee of Mimar Sinan Fine Arts University on March 07, 2024 with the number of E-15207191-050.99-156017.

Informed Consent: Informed consent was obtained from all participants in the study.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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