DESIGN AND APPLICATION OF ACOUSTICS WORKSHOPS AS PART OF INTERIOR ARCHITECTURE DESIGN STUDIO

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ABSTRACT

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M.Sc. in Interior Architecture

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Architectural acoustics serves as a vital factor in creating functional and comfortable spaces. Nevertheless, it greatly influences the space experience. Therefore, it is an inseparable component of spatial design. Spatial designers, such as interior architects and architects, should possess the ability to identify potential acoustical problems during the design phase, propose suitable solutions, and collaborate with acousticians, when necessary, effectively communicating with them. Hence, it becomes essential to establish a strong foundation for these skills throughout the process of undergraduate studies.

Spatial design education aims to develop future designers with the essential qualities of experience, intuition, skills, and knowledge required for the design process. Design studio courses are the core of spatial design education, where students are expected to integrate diverse knowledge; however, visual concerns often overshadow other disciplines, hindering the application of theoretical knowledge. Architectural acoustics discipline is one of these theoretical subjects that students tend to overlook in the design process.

Architectural acoustics should not be separated from the design process but should be integrated and emphasized to enhance the overall design outcomes.

Therefore, the aim of this study is to investigate the effectiveness of acoustics workshops conducted parallel to the design studio course in encouraging the application of acoustic knowledge within students' design projects. The study involved two groups of students, control group, experimental group, and data was collected through surveys. Additionally, the same surveys were administered to the same participants at the end of the next semester to assess the long-term effects.

The study's findings demonstrate that conducting acoustics workshops parallel to the design studio course may have positive effects on the students' acoustical awareness levels, acoustical knowledge, and application levels of acoustics in their design studio projects. Moreover, this approach has the potential to be adapted to other subjects in spatial design-related disciplines. With the integration of workshops, design studios may become a beneficial educational setting for teaching students how to make use of their theoretical knowledge in real-life situations. However, the method and the evaluation of the workshops needs further improvements and more testing. Future research can be conducted with larger sample sizes, in various educational settings, with other disciplines related with design education and practice, and in a well-controlled experimental setting.

Keywords: Architectural acoustics, acoustics education, spatial design education

ÖZET

İÇ MİMARLIK TASARIM STÜDYOSU KAPSAMINDA AKUSTİK ÇALIŞTAYLARININ TASARIMI VE UYGULANMASI

COUTINHO KITAPCI, Asya Larisa
İç Mimarlık Yüksek Lisans

Danışman: Doç. Dr. Papatya Nur DÖKMECİ YÖRÜKOĞLU
Ortak Danışman: Öğr. Gör. Dr. Gökçe ATAKAN
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Mimari akustik, işlevsel ve konforlu mekanlar yaratmada kritik bir faktör olarak hizmet etmekle birlikte, mekân deneyimini büyük ölçüde etkiler. Bu nedenle mekân tasarımının ayrılmaz bir parçasıdır. İç mimarlar ve mimarlar gibi mekân tasarımcıları, tasarım aşamasında potansiyel akustik sorunları belirleme, uygun çözümler önerme ve gerektiğinde akustik uzmanlarıyla etkin bir şekilde iletişim kurarak iş birliği yapma becerisine sahip olmalıdır. Bu nedenle, lisans eğitimi sürecinde bu beceriler için güçlü bir temel oluşturmak çok önemlidir.

Mekân tasarımı eğitimi, tasarım süreci için gerekli olan deneyim, sezgi, beceri ve bilgi gibi temel niteliklere sahip tasarımcılar geliştirmeyi amaçlar. Öğrencilerden farklı bilgileri bütünleştirmelerinin beklendiği tasarım stüdyosu dersleri, mekân tasarımı eğitiminin çekirdeğini oluşturur; ancak görsel kaygılar genellikle diğer disiplinleri gölgede bırakarak teorik bilginin uygulanmasını engeller. Mimari akustik disiplini, öğrencilerin tasarım sürecinde gözden kaçırma eğiliminde oldukları bu teorik konulardan biridir.

Mimari akustik tasarım sürecinden ayırmamalı; aksine, entegre edilmeli ve vurgulanmalıdır. Bu nedenle, bu çalışmanın amacı, tasarım stüdyosu dersine paralel olarak yürütülen akustik çalıştaylarının, öğrencilerin tasarım projelerinde akustik bilginin uygulanmasını teşvik etmedeki etkinliğini araştırmaktır. Kontrol grubu ve deney grubu olmak üzere iki öğrenci grubundan oluşan çalışmada, veriler anket yolu ile toplanmıştır. Ek olarak, uzun vadeli etkileri değerlendirmek için bir sonraki eğitim dönemi sonunda aynı katılımcılara aynı anketler tekrar uygulanmıştır.

Çalışmanın bulguları, tasarım stüdyosu dersine paralel olarak akustik çalıştaylarının yürütülmesinin, öğrencilerin akustik farkındalık düzeyleri, akustik bilgileri ve tasarım stüdyosu projelerinde akustiği uygulama düzeyleri üzerinde olumlu etkileri olabileceğini göstermektedir. Ayrıca, bu yaklaşım, mekân tasarımı ile ilgili disiplinlerdeki diğer konulara uyarlanma potansiyeline sahiptir. Çalıştayların entegrasyonu ile tasarım stüdyoları, öğrencilere teorik bilgilerini gerçek yaşam durumlarında nasıl kullanacaklarını öğretmek için faydalı bir eğitim ortamı haline gelebilir. Ancak, çalıştayların yöntem ve değerlendirilmesi konularında iyileştirilmesi ve daha fazla sınanması gerekmektedir. Gelecekteki araştırmalar, daha büyük örneklem ile, çeşitli eğitim ortamlarında, mekân tasarımı eğitimi ve uygulamasıyla ilgili diğer disiplinlerle ve kontrollü bir deneysel ortamda yürütülebilir.

Anahtar Kelimeler: Mimari akustik, Akustik eğitimi, mekân tasarımı eğitimi

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LIST OF SYMBOLS AND ABBREVIATIONS

ISO	: International Organization for Standardization
BS	: British Standards
TS	: Turkish Standards
NR	: Noise Reduction
TL	: Transmission Loss
STC	: Sound Transmission Class
IIC	: Impact Insulation Class
RT	: Reverberation Time
dB	: Decibel
SPL	: Sound Pressure Level
IFI	: International Federation of Interior Architects/Designers
L_{eq}	: Equivalent Continuous Sound Level
α	: Absorption Coefficient
E_i	: Incident Sound Energy
E_r	: Reflected Sound Energy
E_a	: Absorbed Sound Energy
E_t	: Transmitted Sound Energy
λ	: Wavelength

CHAPTER I
INTRODUCTION

From the very first days of human existence, visuals have always been crucial in combination with other senses, such as hearing, smelling, touching, and tasting (Pallasmaa 2005). Although the visual sense kept humanity safe and secure during the day, they needed more sensual data in the nighttime to survive, which was provided by the sense of hearing. Hearing enables us to be aware of our environment and provides a comprehensive understanding of the environment without the need for visual observation (Brownell 1997). Given the significant role that hearing plays in individuals' perception of the environment, understanding acoustics becomes essential in spatial design related disciplines, such as interior architecture and architecture.

Acoustics is a crucial provider of functional and comfortable spaces. Hence, it is an inseparable component of spatial design. Professionals from spatial design disciplines should be able to identify possible acoustical problems in the design phase of their projects, propose solutions on some level, refer to acousticians when necessary, and communicate with them (Bard et al. 2013; Caliskan and Arslan 2005; Sygulska 2021). Therefore, it is essential to establish a strong foundation for the mentioned abilities throughout the process of undergraduate studies (Çakır et al. 2014; Fullerton 2013; Meric and Caliskan 2013).

Within the scope of this study, spatial design is considered as interior architecture and architecture and architectural acoustics is discussed through three main subdisciplines - buildings acoustics, rooms acoustics, and soundscape - based on the resources relevant to spatial design (Aletta et al. 2014; Brown et al. 2011; Demirkale 2007; Dokmeci and Kang, 2010b; Egan 1988; Ermann 2015; Kang and Schulte-Fortkamp 2016; Kinsler et al. 2000; Kuttruff 2017; Long 2006; Moore 1978; Schaffer 1994). Building acoustics deals with noise, its propagation, and control. Room acoustics, on the other hand, is engaged with providing sound quality within a space. Finally, soundscape studies are concerned with the perception of the acoustic environment.

Design is a decision-making process that requires a combination of experience, intuition, and the application of skills and knowledge (Paker Kahveci 2007; Salama 2015; Uluoğlu 2000). Combining the mentioned aspects requires behavioral development, which can be achieved through experience and education (Onat 1985). Therefore, it is the aim of spatial design education to gain future designers such qualities (Demirbas and Demirkan 2007).

Spatial design education consists of theoretical, applied, and design studio courses, with the latter being the core of the curriculum (Civaroğlu 2003; Heylighen et al. 1999; Lackney 1999; Ozorhon et al. 2012). During design studio courses, students acquire practical skills in creating functional and creative spaces while integrating knowledge from other disciplines (Crowther 2013). However, visual concerns are often prioritized throughout this process, consequently placing the other disciplines at a lower priority. Consequently, students often encounter challenges applying their theoretical knowledge to their designs (Abbasoğlu Ermiyagil 2019). Researchers argue that this difficulty may arise from a lack of emphasis on the relevance of theoretical subjects with the design process (Afacan 2015; Demirbilek and Demirbilek 2007). Architectural acoustics discipline is one of these theoretical subjects that students tend to overlook in the design process (Demir and Bayazıt 2018; Kitapci 2019). Therefore, it should not be separated from the design process; rather, it should be integrated and emphasized.

2.1 AIM AND SCOPE

The primary objective of this study is to examine the effectiveness of acoustics workshops conducted parallel to the design studio course in encouraging the application of acoustic knowledge within students' design projects. The study aims to determine whether students who participate in the workshops display a higher inclination to integrate acoustic concepts in their design studio projects compared to those who do not partake in the workshops.

To achieve this aim, the study was conducted with two groups of students: a control group and an experimental group, both enrolled in the 4^{th}-grade course Interior Design Studio V in Interior Architecture Department, Çankaya University. All the students have previously completed the mandatory course *Architectural Acoustics*.

The experimental group participated in two workshops –*Soundscape Workshop* and *Building Acoustics Workshop*- consisting of short lecture sessions, hands-on application exercises, and interactive discussions. On the other hand, the control group proceeded through the design studio course without participating in the workshops.

After completing the final jury process of the course, both groups were administered surveys to assess aspects related to acoustical understanding and its application in design projects. The survey consisted of sections to assess noise sensitivity levels, rate the importance of acoustics concepts in various building types, evaluate acoustical terminology knowledge, and evaluate the extent of acoustic concept integration within their design studio projects.

Acknowledging the potential benefits of a longitudinal evaluation, the same survey was administered again to the same participants after the completion of the next semester's design studio, Interior Design Studio VI, final jury exam. This approach allowed for a more comprehensive assessment of the long-term effects of the workshops on students' application of acoustic knowledge.

Through an analysis of survey results between the experimental and control groups, this study intends to provide insights into the potential impact of acoustics workshops on enhancing students' ability to apply theoretical acoustic knowledge practically. The findings from this research can contribute to further understanding the importance of incorporating acoustics education into the design process. The collaborative and hands-on nature of the workshops can promote practical application and reinforcement of knowledge, potentially leading to a more comprehensive approach to spatial design that considers the critical role of acoustics in creating functional and aesthetically pleasing spaces.

2.2 STRUCTURE OF THE THESIS

In this section, the structure of the thesis will be outlined, and the content of the chapters will be presented. The thesis consists of five main chapters. The first chapter, 'Introduction,' gives general information on the thesis. The aim and scope of the thesis are presented in this chapter, along with the current section.

The 'Literature Review' chapter delivers the theoretical background of the study. Initially, the three main subjects of architectural acoustics - buildings acoustics, room acoustics, and soundscapes - are comprehensively explained. These subjects constitute the scope and content of the workshop modules that were utilized in the empirical study. The following section discusses the history, aim, and methods engaged in design education. This section focuses on the design studio course, which is the core of spatial design education. It explains the objectives, processes, and activities taking place in the design studio and covers the theoretical basis for choosing the design studio course as the setting for the experiment. The final section, which formed the theoretical foundation of the workshop method, presents the current state of acoustics in spatial design education, challenges of teaching acoustics to students, and the current methods engaged in architectural acoustics courses.

The 'Study Design' chapter explains the method of the study in detail. The chapter includes the study's objectives, research questions, and hypothesis along detailed insights into the evaluation and statistical methods employed. Additionally, the preliminary course 'Architectural Acoustics,' that the workshops were based on, and the design studio courses, where the experiments were conducted, are discussed. Finally, the content and process of the workshop modules, participants, and the experimental process are presented.

The 'Results and Discussion' chapter consists of five sections. The first four sections are based on the survey's components: noise sensitivity levels, ratings of the importance of acoustics concepts in building types, acoustical terminology knowledge, and application of acoustics concepts in design studio projects. Each section presents the short-term and long-term findings, followed by a discussion. Finally, the 'Chapter Summary' section provides an overall discussion of the results.

The final chapter, 'Conclusion,' begins by summarizing the results and the main findings of the study. Afterward, the impact of the research is presented. Finally, the Study's limitations are addressed, and recommendations are provided for future research.

CHAPTER II
LITERATURE REVIEW

In this chapter, the theoretical background of the study will be presented. Initially, concepts of architectural acoustics will be explained in three sub-sections: soundscapes, building acoustics, and room acoustics. These subjects form the content of the workshop modules employed in the study. The following section will discuss spatial design education and the design studio process. The reasons for conducting the workshops parallel to the design studio will be covered in this section. The final section will deliver the role of acoustics in spatial design education and the methods in acoustics education, forming the basis on which the workshops were structured.

2.3 ARCHITECTURAL ACOUSTICS

Architectural acoustics has an essential role in shaping the overall spatial experience. It is key in providing acoustically comfortable and functional spaces for various functions. In this section, Architectural acoustics will be explained in three sub-disciplines -soundscape, building acoustics, and room acoustics- each having equally important roles in spatial design. The section is the basis for the content of the acoustics workshops employed in this study.

2.3.1 Soundscape

Sound is an ever-present aspect that surrounds people, influencing their experiences, whether they are aware of it or not. The human ear always stays open to sounds, making individuals immersed in the acoustic environment (Kang and Schulte-Fortkamp 2016). The acoustic environment refers to a physical phenomenon (Aletta et al. 2016). It is the combination of direct sound and environmentally modified sound perceived by a receiver (BS ISO 12913-1 2014). Therefore, it depends on the receiver's location, present sound sources, and the conditions along the path sound propagate (Kang and Schulte-Fortkamp 2016).

The sounds composing the auditory environment may lead to positive or negative experiences, depending on their properties and the context they are heard within. Unpleasant, unexpected, undesired, or harmful sounds are defined as noise (PD ISO/TS 12913-2 2018). Considering all its negative attributes, reducing noise levels is the first approach that comes to mind, as in environmental noise management studies. However, reducing the sound levels may not always result in acoustical comfort (Aletta et al. 2016; Kang 2007).

Soundscape is the "acoustic environment as perceived or experienced and/or understood by a person or people, in context" (BS ISO 12913-1 2014). Other definitions of it include ‘the acoustic environment as perceived by humans’ and ‘the total collection of sounds’ (Brown et al. 2011). It refers to a perceptual construct that exists through the perception of a place's acoustic environment (Aletta et al. 2016; Brown et al. 2011). The soundscape approach is a middle ground between science, arts, and society (

Figure **1**). It includes many areas of sound studies, such as acoustics, psychoacoustics, sound recording engineering, international noise abatement practices and procedures, aural pattern perception, communications, language and music (Schaffer 1994).

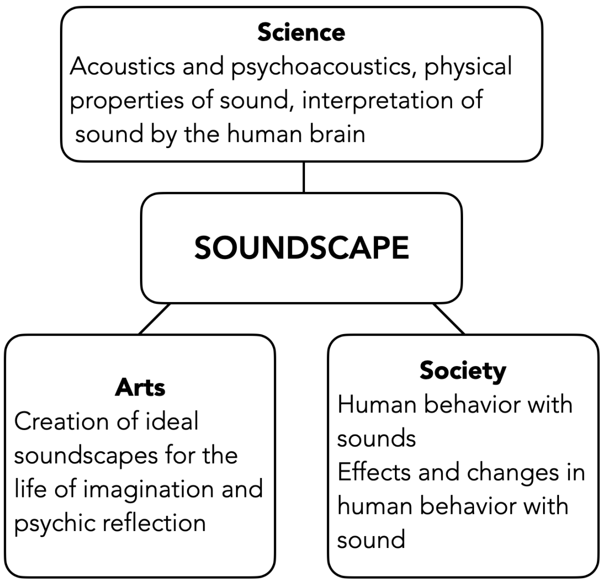

Figure 1: Components of the soundscape approach

The comparison of soundscape approach and environmental noise management approach is presented in Table 1. Unlike the environmental noise management, soundscape is a listener-centered model which qualifies sound as a resource that should be managed to contribute to human experience and quality of life (Kang and Schulte-Fortkamp 2016). It includes both negative and positive qualities, both wanted and unwanted sounds; therefore, provides a holistic approach to the acoustic environment by assessing all sounds perceived in a place upon human perception (PD ISO/TS 12913-2 2018).

Table 1: Comparison of soundscape approach and environmental noise management approach (Kang and Schulte-Fortkamp 2016; Truax 1998)

Soundscape Approach	Environmental Noise Management Approach
Listener-centered model	Energy-based model
Sound is a resource to manage	Sound is a waste to reduce
Focusses on sounds of preference	Focuses on sounds of discomfort

The term soundscape was first introduced by Granö in 1929 to characterize the acoustic environment as a concept of understanding the relationship between sound and human experience of urban environments (Porteous and Mastin 1985). In 1976 Granö and Ohlson divided anthropocentric sonic landscapes into the immediate soundscape and the distant soundscape (Porteous and Mastin 1985). The concept of soundscape gained significance during the 1970s, mainly due to the research conducted by Schaffer. The emergence of the World Soundscape Project played a crucial role in bringing focus to the auditory environment. Schaffer and his collaborators defined the focus of soundscape studies as how a sonic environment is perceived by individuals or society (Aletta et al. 2016). In 1999 the first papers on soundscape from an acoustical perspective started to appear (Davies 2013). Being initialized with a concern for environmental noise, the soundscape approach was later adapted to urban sound studies and indoor sound studies (Dokmeci and Kang 2010a). Today, soundscape studies involve a range of disciplines, especially architecture, urbanology, sociology, psychology, music, and acoustics (Aletta et al. 2014; Kang 2007; Schaffer 1994).

According to BS ISO 12913-1 (2014), seven key topics define the general concepts of experiencing, perceiving, and/or understanding an auditory environment. These concepts are context, sound sources, acoustic environment, auditory sensation, interpretation of auditory sensation, responses, and outcomes (

Figure **2**).

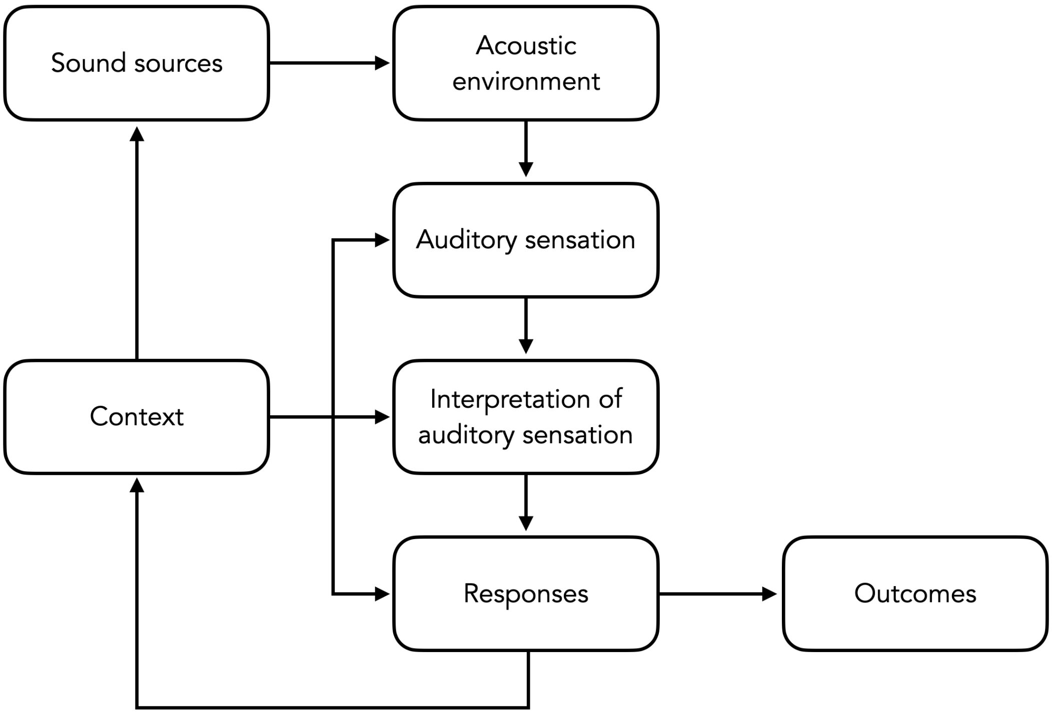

Figure 2: Elements in the perceptual construct of soundscape and their relations (BS ISO 12913-1 2014)

Context refers to the relationship between people, their activities, and their location (BS ISO 12913-1 2014). The context of space can influence individuals' preferences and expectations for the soundscape of that environment (Aletta et al. 2016; Brown et al. 2011; Bruce and Davies 2014). It influences auditory sensation, interpretation of auditory sensation, and responses to the acoustic environment (BS ISO 12913-1 2014). Sound sources comprise of the sounds caused by human activity or nature (BS ISO 12913-1 2014; Hong and Jeon 2015). Sound sources and their distribution in time and space form the acoustic environment. Auditory sensation is a physical phenomenon affected by various factors such as spectral contents , masking, the spatial distribution of sound sources, temporal patterns, meteorological conditions, hearing aids, and hearing impairments (BS ISO 12913-1 2014). The auditory sensation affects the interpretation of auditory sensation. Interpretation of auditory sensation involves the conscious and unconscious processing of the auditory signal to generate useful information, which can lead to an understanding of the acoustic environment. It is influenced by the attitude towards the sound sources and context, and it influences responses. Responses are short-term reactions, behaviors, and emotions that may change the context. Examples of possible responses to a soundscape include acoustic comfort, excitement, pleasure, fear, place attachment, restoration of well-being, a sense of harmony, or appreciation of nature (Kang 2007; Kang and Schulte-Fortkamp 2016). All these concepts collectively affect the outcomes, which are the overall, long-term consequences facilitated or enabled by the acoustic environment (BS ISO 12913-1 2014). Outcomes include beliefs, judgments, attitudes, habits, well-being, visitor/user experiences, quality of life, health, and reduced social costs for society (Kang 2007; Kang and Schulte-Fortkamp 2016).

Data collection methods mentioned by PD ISO/TS 12913-2 (2018) are binaural measurements, questionnaires, guided interviews, sound taxonomy, and soundwalks. The soundwalk method implies a walk with a dedicated emphasis on actively listening to the acoustic environment in an area. They are participatory listening and group sound walks through an environment to receive human sensations/responses/outcomes. People's views should be obtained via questionnaires and/or interviews in soundscape studies. Questionnaires may encompass sections addressing components such as the perceived affective quality, evaluations of the surrounding auditory environment, identification of sounds, and suitability of the sound environment. The other approach, interviews, may cover a range of subjects, including residential experience, satisfaction with the living space, daily routines, experiences in relation to sounds in life, and the effects of various kinds of sounds. The final method, binaural measurements, is preferred in soundscape studies since the aim is to consider how human beings perceive the acoustic environment (PD ISO/TS 12913-2 2018).

Sound sources are key elements composing a soundscape, and classifications are important in identifying and presenting them (Kang and Schulte-Fortkamp 2016).

Sound source taxonomy assists researchers in source reporting (PD ISO/TS 12913-2 2018). The main themes of soundscape were defined by Schaffer (1994) as keynote sounds, signals, and soundmarks. Keynote sounds form a background in the perception of other sounds. They are usually created by the geography and climate in which they exist and do not require conscious listening. Signals are foreground sounds that are consciously listened to (Schaffer 1994). They intend to attract attention (Kang 2007). The term soundmark comes from the word landmark. It refers to sounds that are unique to a place (Schaffer 1994). The first noticed sounds in an urban space are not the loudest but the soundmarks (Yang and Kang 2005). Therefore, urban soundscapes can be characterized by soundmarks (Jeon et al. 2011).

Schaffer (1994) classified sounds according to their physical characteristics, referential aspects, and aesthetic qualities. In the classification based on physical characteristics, factors such as the sound source's distance from the observer, strength, perceptibility, duration, frequency, and dynamics are considered. In the classification, according to referential aspects, he studied the functions and meanings of sounds. He believed that sounds could carry cultural, social, and historical meanings that are embedded in them. In the classification based on aesthetic qualities, factors such as beauty, expressiveness, and emotional impact were taken into consideration. In another classification Gage et al. (2004) introduced, sound sources were categorized as biophonic, geophonic, or anthrophonic. Biophonic sources are sounds generated by living beings such as birds and insects. Geophonic sources are created by physical processes such as. ocean waves and wind. Finally, anthrophonic sounds are generated by human activity. Brown et al. (2011) introduced a classification system aimed at a standardized framework for reporting sources. This classification system serves as the foundation for the taxonomy suggested by PD ISO/TS 12913-2 (2018). The framework they created is applicable to both urban and indoor acoustic environments (

Figure **3**). Kang and Schulte-Fortkamp (2016) merged the models created by Brown et al. (2011) and Gage et al. (2004) to come up with a more comprehensive taxonomy. The model first categorized places as outdoors and indoors. The spaces were subdivided into the urban, rural, wilderness, and underwater domains. Under each topic, sound source categories and sound sources themselves that may be existent in that spaces are indicated.

Soundscape studies should consider and provide comprehensive reports on key components, acoustic environment, participants, data collection, and context. Participants should be classified and reported in terms of how they are selected, if they are visitors or residents in the study's environment, and if they are lay people or experts in a relevant field. Information on their gender, age, distribution, and hearing ability should be obtained (PD ISO/TS 12913-2 2018). Additionally, cultural differences affect the perceptions of individuals exposed to similar acoustics environments. Consequently, the inclusion of cultural and social factors as integral components of soundscape evaluation studies is likely to result in more precise assessments (Mohamed and Dokmeci Yorukoglu 2020). The acoustic environment should be described using necessary acoustic and psychoacoustic indicators, such as equivalent continuous sound pressure level (L_{eq}), percentage exceedance levels, and loudness. In addition, sound sources that are present in the study area should be described following a sound source taxonomy. Type of the study area (virtual, real, or recorded), time of the year and day, weather and wind conditions, measurements points and measurement types, results of the measurements, type of site (indoors or outdoors), and description of the study site should be specified and reported. The methods, language used, and questions asked for data collection regarding human perception of the acoustic environment should be reported, and the context should be described (PD ISO/TS 12913-2 2018).

The findings of the soundscape studies lead the designers to create better acoustic environments (Schaffer 1994). The primary goal of soundscape design is to achieve acceptability and a sense of connection with the place while promoting feelings of satisfaction, comfort, well-being, and appreciation (Coelho 2015). Torresin et al. (2020) investigated the relationship between acoustic design and practices in terms of well-being and health in the built environment. Through structured interviews with a panel of experts, they ascertained that implementing soundscape methods has the potential to enhance the well-being of individuals in the built environment, particularly in terms of cognitive performance, emotional responses, and overall health outcomes.

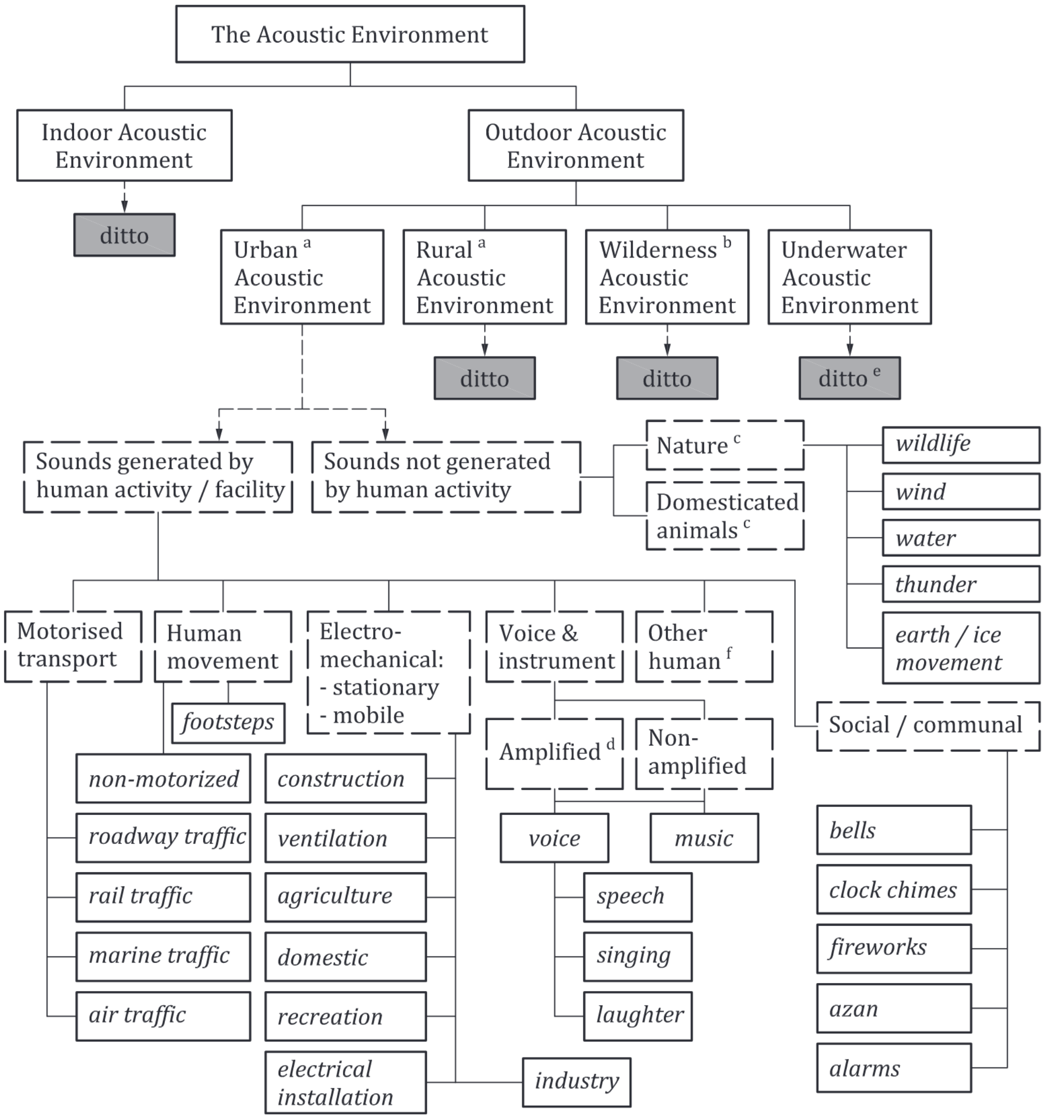

Figure 3: Taxonomy of the acoustic environment for soundscape studies, recommended by PD ISO/TS 12913-2 (2018)

An appealing soundscape may attract more users to spaces (Yang and Kang 2005). Identifying diverse soundscape areas within cities can significantly aid in research, re-organization, development, or modernization of urban structures. Such knowledge allows for a comprehensive understanding of the acoustic environment and facilitates informed choices for optimizing urban environments to improve the overall quality of life (Raimbault and Dubois 2005). Soundscape design is a set of principles to be employed. These principles include a respect for the ear, an awareness of sound symbolism, an understanding of balance, and a knowledge of the rhythms of the soundscape. It focuses on how sound may be rearranged and reintroduced to create balanced and non-monotonous auditory environments (Schaffer 1994).

Table 2: Steps of soundscape design (Coelho 2015)

Steps	Criteria/Paths	Techniques
1. Define the acoustic character	1.1 Define activities and purpose 1.2 Define acoustic objectives	• Consider project objectives and listener expectations • Include stakeholders
2. Plan	2.1 Identify listening itineraries 2.2 Identify sound sources 2.3 Identify sound propagation paths 2.4 Identify unwanted and wanted sounds	• Perform soundwalks • Identify geographical variations, measure and characterize sound components • Define preferred sounds
3. Design and optimize	3.1 Manage sound components 3.1.1 Diminish unwanted sounds 3.1.2. Enhance preferred sounds 3.2 Identify wanted sounds in context	• Reduce and/or mask unwanted sounds • Enhance or introduce preferred sounds • Involve groups of interest

Coelho (2015) summarized the steps of soundscape design (Table 2). He identified the three main steps as identifying/defining the acoustic character, planning, and designing and optimizing. Identifying/defining the acoustic character of the place requires establishing its acoustic character, considering its purpose and the activities it may contain. Moreover, user profile and their expectations and preferences for that space should also be considered. Sounds that exist and may exist in the future in that place should be identified. Acoustic objectives should be set up. In the planning step, areas of listening, sound sources, users' itineraries, sonic interests, sound components, and context should be determined. It is necessary to classify and characterize the sounds that were identified in the first step. Acoustic measurements should be done, and a catalog of the sounds should be organized. At this stage, the involvement of the stakeholders and users is recommended. In the designing and optimizing step, the aim is to reduce unwanted sounds and to enhance or introduce wanted sounds in context. During this step, soundscape management options should be considered and discussed with the groups of interest. To eliminate or reduce unwanted sounds, noise control strategies or masking techniques may be used. The management of sound sources' distribution and audibility, the listening places' structure, and the introduction of details plays a crucial role in shaping the soundscape. The objective is to intentionally guide users' attention towards particular sounds while diverting attention away from undesired sounds. (Coelho 2015).

Kitapci & Ozdemir (2021a, 2021b) proposed a context-dependent sound design framework *CLIC* (Create, Limit, Isolate, Control) for urban and indoor sound design. It combines the environmental sound categorization methods, film sound categorization methods, and product sound categorization methods. The framework consists of two axes: Diegetic/ non-diegetic sound sources, Intentional/ consequential sound sources. The axis divides the categorization chart into four zones creation zone, limitation zone, isolation zone, and control zone (Figure 4).

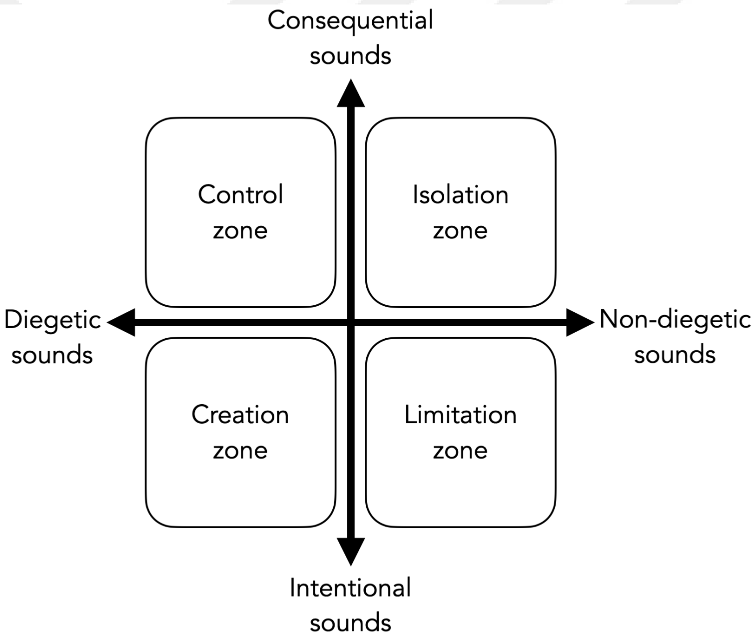

Figure 4: The context-dependent CLIC framework (Kitapci & Ozdemir, 2021a)

Requiring a multi-sensory approach, the audial aspects of spatial design can greatly benefit from the soundscape approach, which embraces sound in a holistic manner. The soundscape approach includes the physical properties and the social, cultural, perceptual, and contextual aspects of sound. It provides an understanding of how sound and acoustics can shape the built environment. Therefore, it may captivate students' attention and interest in sound without intimidating them. It can encourage them to consider sound as part of their designs by enabling the creative use of sound.

Integrating the soundscape approach into design studio courses and/or acoustics courses may improve students' abilities in acoustic design, leading to the design of spaces that are more responsive to user needs and preferences.

2.3.2 Building Acoustics

Building acoustics mainly deals with the reduction of sound transmission. Exposure to noise can have adverse effects on individuals' physiological and psychological well-being. Some of these effects may be listed as frustration caused by loss of sleep, decreased working efficiency, accidents caused by the increase in error, annoyance, decreased learning, reduced entertainment, and noise-induced hearing loss (Moore 1978). The two ways of noise-induced hearing loss are trauma and chronic. Trauma is sudden hearing loss, and it can be caused by exposure to sounds with high intensity. On the other hand, chronic hearing loss may be caused by being repeatedly exposed to lower noise levels (Kinsler et al. 2000). To prevent such consequences, the background noise level should be kept at safe levels. Table 3 summarizes the effects of background noise (Ermann 2015).

Table 3: The effects of background noise (Ermann 2015)

Background Noise	**Effect**
Very loud noise	Can cause loss of hearing
Loud Noise	Can interfere with speech intelligibility
Relatively quiet noise	Can interfere with very quiet activities
Noise by its content	Can cause decreased working and learning efficiency

Noise is best controlled at its source, with complete enclosure and isolation from any supporting structure (Moore 1978). The measured or predicted sound pressure level (*SPL*) difference between the source and receiver rooms is 'Noise Reduction' (*NR*) (Ermann 2015). It is dependent on three factors (Egan 1988):

1. the area of the sound transmitting surface,
2. absorption in the receiving room,
3. the transmission loss of the common surface.

The amount each building element contributes to isolation depends on its mass, position, rigidity, and interconnection between elements (Moore 1978). Ideal sound isolator is heavy, limp, and airtight (Egan 1988). In sound isolation problems, it is necessary to locate the possible sound transmission paths (Moore 1978).

Two kinds of sound transmission are presented in Figure 5 (Moore 1978). Direct transmission occurs when sound passes directly through the barrier between the noise source and the listening position. On the other hand, indirect transmission takes place when sound travels through adjoining elements of the enclosing structure, propagating from the source to the listening position directly (Moore 1978). The most common transmission paths are flanking paths that might be caused by the false application of the building elements, poor seals, gaps, and openings, the transmission of airborne sound, which causes the common building elements to vibrate and radiate the sound, and the transmission of the impact sound which causes a solid structure to vibrate and propagate along the structure (Kinsler et al. 2000).

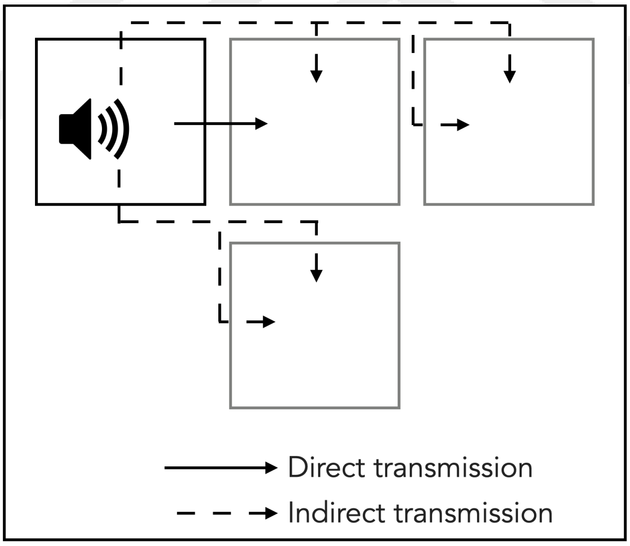

Figure 5: Sound transmission types (Moore 1978)

Noise can be carried through building elements from one room to another (Ermann 2015). Flanking is the sound energy bypassing the separating surfaces through indirect paths (Egan 1988). Some of the most common flanking paths where measures should be taken can be listed as partitions that do not extend all the way to the above structure, unsealed gaps in walls and floors, doors and windows, ducts connecting rooms with straight and short runs, back-to-back outlets, and built-in cabinets (Ermann 2015).

Airborne sound is transmitted through the air to the wall and floor-ceiling assembly, radiating through the separation to the other side (Ermann 2015). The amount of sound energy that is reduced in this process is ‘transmission loss’ (*TL*), and it is separately measured for octave band frequencies (Egan 1988). It quantifies the airborne-sound-insulating properties of a building element (Ermann 2015). *TL* is affected by the massiveness and stiffness of the material, the amount of damping, the airspace between the layers of the separating element, and sound-absorbing materials added to the airspace (Egan 1988). ‘Sound transmission class’ (*STC*) on the other hand, is a single number rating to address all the octave band frequencies, which provides ease for comparison of building elements (Ermann 2015). Table 4 presents the expected field results for given *STC* (Long 2006). *STC* rating increase when surface weight is increased; hence, heavier materials provide better isolation (Egan 1988).

Table 4: The expected field results for given *STC* (Long 2006)

STC	**Expected Field Result**
80	Very loud music audible
75	Very loud music clearly audible
70	Very loud music comprehensible, unamplified voice not audible
65	Shouting audible, loud voice not audible
60	Shouting clearly audible, loud voice audible
55	Shouting voice comprehensible, loud voice clearly audible
50	Loud voice comprehensible, raised voice not audible
45	Raised voice clearly audible, normal voice not audible

Impact sound is a type of structure-borne sound that is caused by the transmission of impacts and vibrations directly to the building. It is transmitted through the back-and-forth motion of the building elements caused by sound waves (Egan 1988). The impact sound transmission of building elements is presented as a single-number rating with ‘impact insulation class’ (*IIC*) (Ermann 2015). The impact noise level depends on the softness of the floor covering and the materials' elasticity, viscosity, weight, and resilience (Long 2006; Moore 1978). The most effective way of preventing such noise is at the point of impact by preventing the vibrations from reaching the structure (Moore 1978). Higher impact noise performance can be achieved through damping at the point of impact, between surface finish and structural surface, structural floor, and ceiling below, careful programming, insulation in cavities, soft floor finishes, rubber stops, suspended ceilings, and floating floors (Ermann 2015; Moore 1978).

For better noise control, it is important to consider acoustics from the early design phases. Rooms requiring quietness should be placed apart from the noise sources and noisy areas. Noisy areas can be grouped together to prevent their effect from spreading wider to other areas. Additionally, rooms that are not sensitive to noise can be used as buffer zones (Egan 1988; Ermann 2015; Kinsler et al. 2000). Massive, airtight, and structurally discontinuous building elements further improve noise control. The use of materials with higher mass, airtightness, resilience, cavity depth, and applying sound-absorbing materials in cavities are some of the other suggestions to consider (Ermann 2015).

In building acoustics, it is essential to refer to noise regulations established by governments, which include laws or guidelines regarding sound transmission. The "Regulation on the Protection of Buildings Against Noise" was established in 2017 in Turkey. It includes regulations on the following subjects (Çevre ve Şehicilik Bakanlığı 2017).

- The noise sensitivity levels and noisiness levels of various building types,
- Subjective values on which acoustic performance classification of spaces is based,
- The minimum airborne sound insulation values based on the properties of the source and receiver room and between the neighboring spaces in various building types,
- The maximum impact sound values based on the properties of the source and receiver room and between the neighboring spaces in various building types,

- The maximum noise levels allowed within spaces based on acoustical performance class,
- The maximum noise levels allowed caused by service equipment and fixtures.

2.3.3 Room Acoustics

The energy of the incident sound wave is reflected, transmitted through, and absorbed within the material, when sound waves interact with materials (Long 2006). This interaction is illustrated in Figure 6. Absorption is the decrease in the energy of a sound wave, as a portion of its energy is transformed to heat upon coming into contact with a material. The sound absorbing effectiveness of a material can be expressed by its 'absorption coefficient' (α), which is a number between zero and one (Egan 1988). The higher the value, the more sound is absorbed and the less is reflected (Ermann 2015). Materials with α greater than 0.50 are referred to as sound-absorbing materials, while materials with α lower than 0.20 are sound-reflecting (Egan 1988).

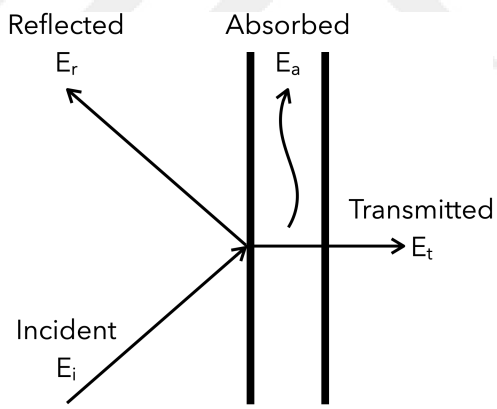

Figure 6: Interaction of sound waves with a surface (Long 2006)
(*E_i: incident sound energy, E_r: reflected sound energy, E_a: absorbed sound energy, E_t: transmitted sound energy*)

Sound absorbers can be listed as porous, panel, and resonant. Porous absorbers are the most broadband of the absorber types, and their absorption coefficients generally rise with frequency. Porous absorbers include mineral fiber, fiberboard, glass fiber, cotton, acoustical ceiling tile, velour, felt, and open-celled foams. Absorption effectiveness depends on density, thickness, porosity, and fiber orientation (Ermann

2015). Panel absorbers convert some of the incident acoustic energy into heat through vibration caused by an incident sound. Some examples of such absorbers are plywood, gypsum sheetrock, and thin wooden paneling. Panel absorbers are very effective at low frequencies. Moreover, the addition of porous absorbers in between the wall and the panel can increase efficiency even more at low frequencies (Kinsler et al. 2000). Resonant absorbers absorb energy by vibrating at a frequency which is determined by the damping and geometric characteristics of the panel (Egan 1988). Such absorbers include wood latices and perforated panels positioned at a distance from a solid backing. They are most effective in a narrow band of frequencies near their resonance (Kinsler et al. 2000). Panel absorbers and resonant absorbers are more narrow band in absorption compared to porous absorbers. Therefore, they are used in specialized applications. They are tunable to improve their effectiveness at the frequency of unwanted sound. The absorption spectrum of panel and resonant absorbers complement those of porous absorbers, which are less effective at low frequencies. Therefore, using two types together is more broadband than either alone (Ermann 2015).

Sound-absorbing materials can be applied for reverberation control, noise reduction in rooms, echo control, and preventing possible acoustical defects (Egan 1988). Through adding absorption to a room, reverberance can be lowered, and sound energy can be removed from the space (Ermann 2015). However, excessive use of sound-absorbing materials can reduce useful sound reflections (Egan 1988). Proper usage and distribution of the absorber classes can provide almost any desired acoustics environment by adjusting the reverberation time with frequency (Kinsler et al. 2000).

Reflection refers to a phenomenon where a sound wave returns after striking a surface (Figure 7). The angle of incidence is equal to the angle of reflection, if the dimension of the surface, through which the sound wave is reflected, is greater than four times of the wavelength of the impinging sound wave (Egan 1988). Reflection of the sound waves off the surfaces may cause reverberation and echo.

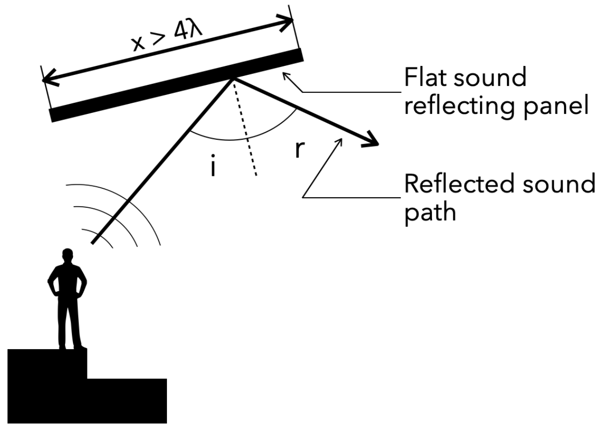

Figure 7: Illustration of sound reflection (Egan 1988)

Hard surfaces such as, sealed wood, acrylic plastic, thick plaster, and double-layered gypsum board are effective sound reflectors. The sound reflector types are concave, flat, and convex. Concave reflectors can focus sound, which may cause hot spots and echoes. Flat reflectors are hard-surfaced elements, which can effectively distribute reflected sound, when they are large enough and oriented properly. Convex reflectors are also hard-surfaced elements, which can provide the most effective distribution when they are large enough. Sound that is reflected from convex surfaces tends to be more uniformly dispersed across a broad spectrum of frequencies (Egan 1988). Sound reflecting surfaces are used to increase reverberation, or to provide beneficial sound reflections that might bolster loudness (Ermann 2015).

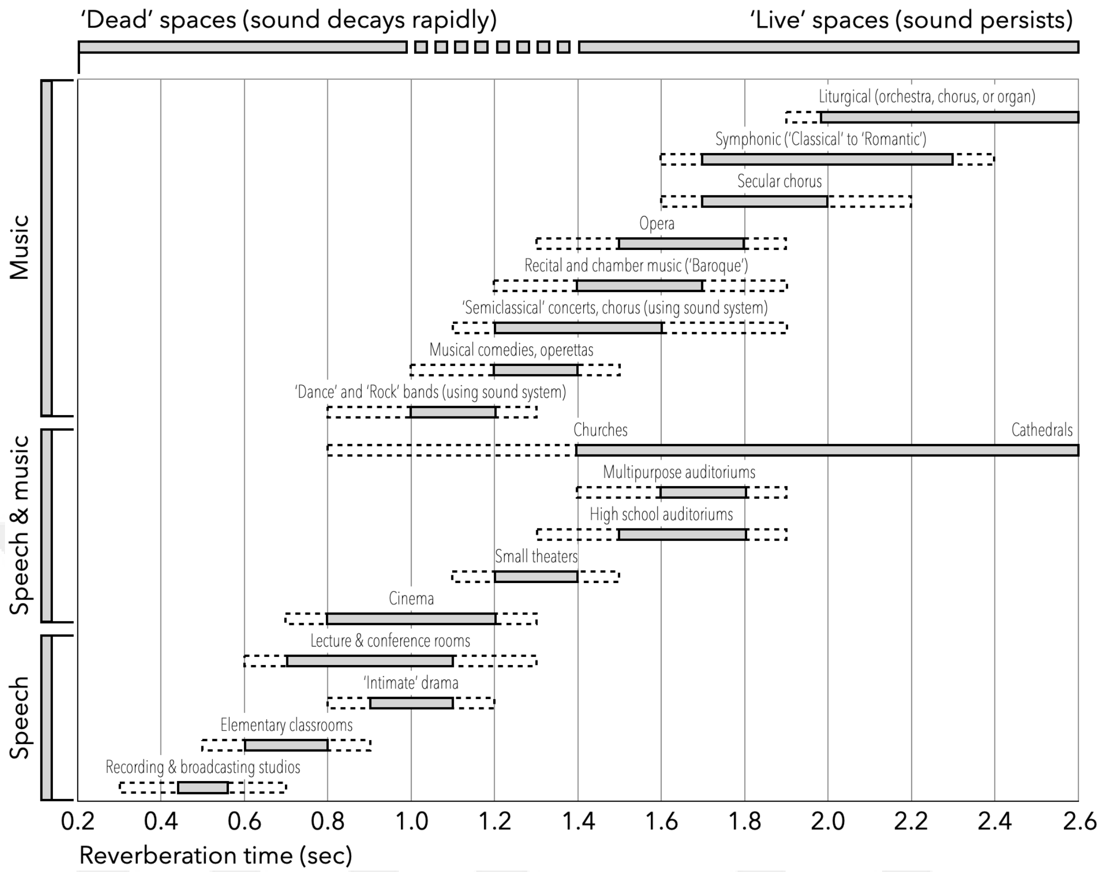

Figure 8: Optimum *RT* levels based on function (Egan 1988)

Reverberation can be defined as the persistence of audible sound in a space after the sound source has ceased. It is perceived as an extension or continuation of the original sound, gradually diminishing in intensity over time (Moore 1978). Reverberation time (*RT*) is the duration it takes for sound to decrease by 60 *dB* after it stops (Egan 1988). The *RT* of a room is affected by its volume and its total sound absorption (Kinsler et al. 2000). The optimum *RT* depends on the purpose of the room (Figure 8). While rooms for music require higher *RT* levels for musical quality, rooms for speech require lower, for better speech intelligibility (Ermann 2015). Echo refers to the clear and distinguishable repetition of an original sound, which is sufficiently loud to be heard above the surrounding background noise. To address the issue of echo, surfaces that produce echoes can be treated with sound-absorbing materials or by repositioning those surfaces to reduce sound reflections (Egan 1988).

Diffusion is the dispersion or spreading of a sound wave when it interacts with a surface. This scattering happens when the sound's wavelength is similar to the surface depth of hard-surfaced materials (Figure 9). The direction of an incident sound wave changes when it comes in contact with a sound-diffusing material (Egan 1988). The effective scattering of reflected sounds depends on the texturing degree of the diffusor; the more texture, the more effective scattering. Textures with large curves, large pyramids, and large coffers, thus, deeper textured surfaces, diffuse lower the frequencies. On contrary, shallower textured surfaces diffuse high frequencies (Ermann 2015). Diffusing surfaces have the ability to disperse and scatter sound reflections, which helps to reduce or eliminate acoustics defects that might arise from walls or ceilings. This becomes particularly important when addressing acoustic problems, since using absorption treatment could lead to a loss of desirable reverberation in the space. Additionally, the usage of diffusing surfaces can provide the listeners with the sensation of sound emanating from various directions (Ermann, 2015).

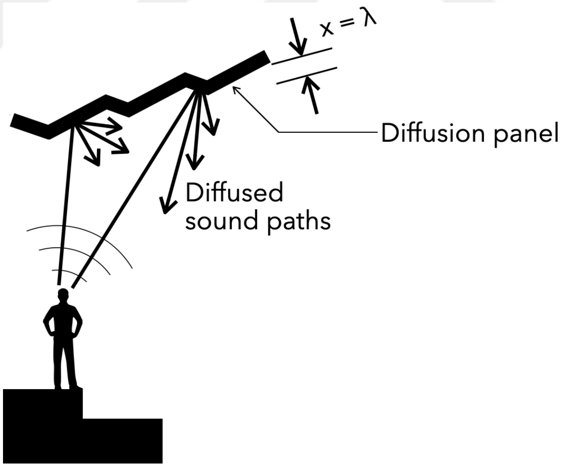

Figure 9: Illustration of sound diffusion (Egan 1988)

In general, some key points to consider in room acoustics design are as below (Egan 1988).

- The background noise level must be adequately low
- Sound energy must be uniformly distributed throughout the space
- Echoes and focusing effects should be avoided

- The wanted sounds must be adequately loud
- Proper RT for the purpose of the room should be provided

2.4 SPATIAL DESIGN EDUCATION

Spatial design is a decision-making process in which specific activities and events are organized to achieve specific goals (Salama 2015). It is a complex and multidimensional activity, which is conscious, selective, and intelligent (Paker Kahveci 2007; Uluoğlu 2000). The design process requires a combination of intuition, experience, and the practical application of skills and knowledge (Salama 2015). Consequently, it encompasses various abilities, including interpretation, communication, problem-framing, research, and integrating knowledge (Paker Kahveci 2007). The process includes all activities performed by the designer, from defining a problem to finalizing its solution (Kurt 2009). It is both creative and rational to different degrees since it combines human physicality and technical matters with creativity (Öztürk and Türkkan 2006; Paker Kahveci 2007). Given the aspects of the design activity, spatial education aims to guide future designers to understand and apply skills, processes, knowledge, and theories of design (Demirbas and Demirkan 2007). It teaches how to approach problems considering philosophy, sustainability, technologies, and other design-related areas (Ibrahim and Utaberta 2012; Ledewitz 1985). It is aimed at balancing scientific, technological, and artistic knowledge (Casakin 2012). Students are provided with behavioral development, which can only be obtained through one's own experiences (Onat 1985).

Types of courses included in the curricula are categorized in many ways. For example, Heylighen et al. (1999) divided the curricula into theoretical lectures and design courses. They explained theoretical lectures as courses where knowledge related to spatial design is delivered and design courses as where passive knowledge is transformed into active knowing. In another study, courses in the curricula are divided into studio courses; presentation courses; theoretical courses; technical courses; and supportive courses (Ozorhon et al. 2012). Although it can be argued that there are other ways to categorize the courses in the curricula, in the current study, the courses are categorized as theoretical courses, applicational courses, and design studio courses. Theoretical courses deliver knowledge directly to the students through lectures and visual tools. They are assessed through exams, in which the delivered knowledge is either asked for directly or through interpretation. Applicational courses include lectures and the application of the knowledge obtained through these lectures. They are assessed through the product developed throughout the semester, consisting of drawings, models, or other products to be produced using the information delivered. Design studio courses are processes where students are anticipated to utilize all the information they have gathered so far through theoretical and applicational courses to come up with a new, creative, and functional solution to a problem. As design is an ill-defined problem with no single correct solution, the evaluation of design studio courses is conducted through critiques and juries.

The roots of studio-based education go back to the atelier apprentice and even further to the guilds of the Medieval Ages, which were primarily focused on arts and crafts (Kurt 2009; Lackney 1999). Initially created as a component of arts education and training, architecture education did not adopt it until the 1800s (Lackney 1999). As educational programs progressed from an apprenticeship system to a studio-based tutorial setting, the design studio transformed into a learning laboratory where skills and values could be put into practice (Glasser 2000). With the École des Beaux-Arts movement in the nineteenth century, formal education in architecture began (Lökçe 2002). Founded in France, it aimed at educating students in drawing, painting, engraving, sculpture, and architecture (Salama 2015). The École regarded an architect as the master designer who generates abstract specifications for buildings on paper (Salama 1995). The admission and education process consisted of a competitive environment (Carlhian 1979). The education was based on the principles of classical art and architecture. École des Beaux-Arts was where jury evaluation and design studio culture were developed. With the modernism movement, Bauhaus was developed in Germany (Onur and Zorlu 2017). It rejected traditional artistic forms and embraced technology, industry, and mass production. It aimed to provide students with technical skills in various disciplines and train them to apply them with aesthetic concerns (Lackney 1999). The Bauhaus movement led to a shift away from traditional design methods towards a more functional and technical approach to architecture. Contrary to École des Beaux-Arts, Bauhaus supported creativity and self-expression and argued that future architects could only learn through a trial-error process, including application and experience (Dikmen 2011). Despite their differences, they preserved the studio-based educational model (Lackney 1999; Levent Kasap 2019). Both schools provided a base and inspiration for many schools (Yorgancıoğlu 2008). Today, it is thought that spatial design education continues to evolve and adapt to changing societal needs and new technological advancements. However, the core principles of spatial design education, which are to teach students the skills and knowledge they need to create innovative, functional, and aesthetic designs, remain the same.

Revolving around providing students with information and the application of the information in real life while gaining design experience, design studio courses form the fundamental basis of spatial design education (Afacan 2015; Attoe and Mugerauer 1991; Civaroğlu 2003; Demirbas and Demirkan 2003, 2007; Demirbilek and Demirbilek 2007; Gökmen and Süer 2003; Heylighen et al. 1999; Kurt 2009, 2011; Lackney 1999; Lökçe 2002; Onat 1985; Ozmehmet and Alakavuk 2016; Paker Kahveci 2007; Uluoğlu 2000; Uysal and Aydın 2012). Learning to design can only happen through experiencing, thinking, evaluating, and applying in the process of generating solutions (Demirbas and Demirkan 2003, 2007). Therefore, it can only be taught through a project-based approach, not instruction (Lackney 1999; Uluoğlu 2000). Design studio courses are physical environments where learning activities take place through experience and where design students spend most of their time throughout their education (Crowther 2013). It is where the relevant information is organized and internalized by application. Design studios are collaborative, learner-centered, and problem-based teaching environments that focus on learning by doing (Kurt 2009). In regard to its problem-solving-based nature, students not only learn how to solve problems, but they also learn how to define problems (Watanabe 1994). Moreover, they learn how to decide on the necessary knowledge and acquire it to come up with a solution (Attoe and Mugerauer 1991; Özgencil Yıldırım 2003). Ledewitz (1985) mentions the learning objectives of design studio education as learning visualization and representation skills, a new graphic and verbal language, and a new way of thinking, "design thinking". Therefore, design studios are educational environments where students develop creative and critical thinking abilities while integrating technical, theoretical, and practical knowledge to define design problems and come up with applicable, novel solutions for them through experience (Civaroğlu 2003; Çıkış and Çil 2009; Onur and Zorlu 2017; Sancar 1996).

The different sets of activities conducted through the design studio process require students to shift between analytic, synthetic, and evaluative modes of thinking (Dutton 1987). The design studio is a cyclical process, commonly beginning with the introduction of a design problem. These problems are usually realistic design projects in manageable scales (Çıkış and Çil 2009; Heylighen et al. 1999). Afterward, students are expected to conduct preliminary research on the problem to analyze the project and develop design concepts, either in groups or individually (Kurt 2009; Ungar 2008). Students propose creative solutions for the design problem based on their research and concepts. During this process of research and proposal, studio instructors frequently give critiques in the form of one-to-one, small group, or panel critiques (Attoe and Mugerauer 1991; Paker Kahveci 2007). The critiques require students to conduct more research and develop their solutions according to the feedback of the instructors. At the end of the semester, students are expected to present their projects to a jury. The presentations may include various forms such as visual, verbal, tactile, and written (Çıkış and Çil 2009).

Researchers argue that by combining various skills, types of knowledge, and techniques, design studio education addresses a wide range of learning styles (Demirbas and Demirkan 2003; Uluoğlu 2000). Demirbilek and Demirbilek (2007) mention that design students learn best through actively and independently solving design problems since it motivates them to seek out new knowledge and abilities relevant to the task. With a project-based approach, learning occurs through experience, communication, and trial-error practice, in the design studio. Within the interactional and social environment of the studio, students not only learn from their instructors, but they also learn from one another (Civaroğlu 2003; Çıkış and Çil 2009; Schön 1984).

In spatial design, it is essential to integrate technical and theoretical knowledge to find an applicable solution to a design problem (Demirbas and Demirkan 2007; Ozmehmet and Alakavuk 2016). Hence, future architects should absorb the information given and understand how to apply that knowledge. This can only be achieved through comprehensive thinking, questioning, and applying the information.

In spatial design education, the design studio is the place where experience is gained through synthesizing theoretical and applicational knowledge in a creative way (Civaroğlu 2003; Demirbilek and Demirbilek 2007). Therefore, the practical and theoretical courses in the spatial design curricula are structured to support the design courses (Ozmehmet and Alakavuk 2016). Their aim is to equip students with a solid knowledge base and encourage them to use this knowledge in their design projects (Demirbilek and Demirbilek 2007; Öztürk and Türkkan 2006). However, unless students are specifically asked for, they tend to avoid integrating technical knowledge into their design projects (Demirbilek and Demirbilek 2007). Abbasoğlu Ermiyagil (2019) conducted a questionnaire on students enrolled in the fourth-grade design studio, aiming to evaluate the relationship between design courses and theoretical courses from students' points of view. The study revealed that the most input to the design studio came from the Ergonomics lesson. The students explained the reason as the lesson being not completely theoretical but also practical and user-oriented. Courses such as "Introduction to building information" and "Mechanical systems in buildings" were found to be least related by the students. It was concluded that it is necessary to emphasize the connection between the theoretical courses in the curriculum and the design courses to students (Abbasoğlu Ermiyagil 2019). Another possible reason for not integrating knowledge from other courses into design projects is mentioned as students not being able to see the relevance of their knowledge with the design process, thus, finding it difficult to motivate and direct themselves in non-studio courses (Afacan 2015). In architectural education, instructors are responsible for creating a balance between aesthetic concerns and knowledge to answer the needs of individuals and the built environment (Combrinck 2018).

Formal architectural education systems follow a curriculum (Karslı and Özker 2014). Courses are divided into theoretical and design courses, leading to problems providing a holistic approach (Levy 1980). Researchers have been seeking educational methods to solve this problem. For example, Ozmehmet and Alakavuk (2016) has discussed a studio-based learning system: the integrated design studio. The integrated design studio is a system where every studio has its own integral course, which supports design studios theoretically or practically. In the integrated design studio approach, every studio has an integrated course to provide knowledge to be used in the design course. The outline of the integrated course was prepared to be parallel to the studio's outline (Ozmehmet and Alakavuk 2016).

Another approach to the problem is integrating informal methods into formal education to provide a more creative, free, and productive educational environment (Paker Kahveci 2007). Informal education aims at interrupting the usual order of the formal educational process by involving students in an out-of-ordinary and fun environment, causing a rise in their self-confidence and motivation levels (Karslı and Özker 2014). It encourages students to express themselves and work in groups to put their ideas together. Despite its benefits, it was noted that this sort of approach involves flexibility. Thus, it requires facilitators to work hard, be competent, and be knowledgeable (Yürekli and Yürekli 2004). Some informal approaches mentioned by Karslı and Özker (2014) are workshops, seminars, conferences, exhibitions, excavations, and competitions.

One of these informal approaches, workshops, are intense educational studies conducted in a short period of time, which trigger individuals' creativity and imagination (Civaroğlu 2003; Yürekli and Yürekli 2004). They run on a voluntary basis, enable relevant disciplines to work together, and may be on a specific or general topic (Karslı and Özker 2014). The discussion and brain-storming environments created by workshops help different points of view come together. Thus, alternative solutions are created for given tasks (Civaroğlu 2003; Yürekli and Yürekli 2004). Design education greatly benefits from workshops due to their similar nature involving creativity and communication. Conducting interdisciplinary workshops feeds the students' ability to apply knowledge to their design work in a creative manner. They provide an efficient, compelling, and fun opportunity to get away from the routine of education while still learning through activity-based research. Design workshops may include hands-on techniques such as collage, mapping, diagramming exercises, sketches, storyboards, and role-play interactions (Martin and Hanington 2012). The usual flow of design workshops is as follows: first, participants are introduced to the topic, and relevant information is briefly delivered. Then participants are asked to think on the topic and come up with design ideas in groups or individually. Finally, participants present their designs to other participants and the instructor to get comments and feedback, which creates a discussion environment (Martin and Hanington 2012; Ruohui 2016).

Researchers achieved positive results by integrating workshops into design education. Karslı and Özker (2014) conducted a survey, asking students about the workshop's contributions to formal education to evaluate its efficiency. The majority of the students stated that the workshop was helpful in improving their problem-solving skills, creative thinking skills, design thinking skills, pre-design investigation skills, team-working skills, interdisciplinary experiences, and verbal, written, and visual communication skills. Another positive result was obtained by Demirbilek and Demirbilek (2007). Authors engaged students with hands-on experiments that they carried out in technology and science lectures and asked them to integrate these exercises into their design projects. This approach enhanced students' learning process, helped them to apply the information gained to their designs, and gave them a better chance to remember what they have learned later on. Student feedback stated that combining theoretical lectures with practical work greatly helped them in internalizing the information.

Therefore, formal architectural education alone may not be sufficient since students learn best when motivated and having fun (Demirbilek and Demirbilek 2007). Hence, it may be supported by informal educational methods such as workshops (Civaroğlu 2003). Integrating workshops into design studio courses may create a free interaction environment, which may transform the studios into more creative, dynamic, and multi-dimensional communication environments that enhance students' applicational and communicational abilities and help them fuse their knowledge with creativity (Karslı and Özker 2014; Ruohui 2016). Making students realize how different disciplines can contribute to a common objective may be effective in reinforcing the connection between theoretical knowledge and the design process (O'Kane 2012). With this objective, the current study adopted a model in which hands-on workshop modules are run parallel to the design studio process.

2.5 ACOUSTICS IN DESIGN EDUCATION

In design education, the knowledge of acoustics is essential. It is declared by International Federation of Interior Architects/Designers (*IFI*) that interior architects "shape the spaces that shape the human experience" (IFI 2011). Sound and, therefore, acoustics discipline, which deals with sound, is one of the equally important aspects of human experience. However, visual concerns are prioritized in design disciplines, and acoustics is seen as a technical subject that requires deep mathematical and physical knowledge; hence, it is hard to understand for architects (Bard et al. 2013; Sygulska 2021). Similar to architectural practice, design studio courses are also based on the sense of vision and aesthetics (Kitapci 2019). However, design students should be aware of acoustics concepts and gain the base acoustical knowledge throughout their undergraduate education.

To discuss the subject, it is necessary first to identify the current situation of acoustics in design education. Çakır et al. (2014) and Meric and Caliskan (2013) conducted studies about acoustics in architectural education in Turkey. In their research, Meric and Caliskan (2013) investigated the curricula of forty-two universities with architecture faculty and found that thirty-two included acoustics subjects within other compulsory courses and attempted to deliver the subject in a time limited to two or three weeks. Only twenty-one of the universities contained elective courses dedicated to acoustics for undergraduate students. Their content included acoustical problems in buildings, acoustical design of concert halls and theaters, and sound insulation in buildings. A striking finding of the study was that in ten of these universities, students were introduced to acoustics only if they chose to enroll in elective courses. Çakır et al. (2014) prepared an inventory of all courses that include topics on acoustics, conducted interviews with instructors, and applied a web-based questionnaire with a similar objective. They have found that in 60% of architecture faculties, acoustics subject was given in the scope of other mandatory courses, and 92% of these universities were established before 1990. However, in universities established between 2010-2014, this percentage decreased to 33%. It was revealed that there was a significant decrease in the introduction of acoustics subjects in newer established universities. In a more recent study, Kitapci (2019) investigated the mandatory courses on acoustics, in interior architecture departments, in Turkey. The author listed sixteen undergraduate courses and found that 50% percent were not specialized in acoustics, containing other subjects such as lighting, fire safety, and equipment topics within their scope. In graduate curricula, fourteen courses were listed, and 35.7% of them included lighting and hygienic systems topics in addition to architectural acoustics. The author emphasized the fewness of specialized courses and the absence of acoustics courses with a creative design perspective parallel to design studio courses. Considering the findings of the mentioned studies, it can be concluded that there is a lack of creative perspective, time dedicated, and specialized courses and, therefore, a lack of importance given to the acoustics subject.

Despite being an essential component of architecture, integrating acoustics into design education has challenges. For instance, acoustics is introduced to students in the later years of design education, either as part of other courses or as elective courses that are limited in number and variety (Bickerstaff 1971; Busch-Vishniac and West 2007). Furthermore, technical aspects of the subject typically require laboratory settings for experiments, which are not always accessible (Xiao et al. 2022). Without experiments, the subject may fall beyond students' comprehension and be perceived as overly technical and challenging, relying on mathematics, physics, and thus far from architecture (Bard et al. 2013; Berardi 2017; Sygulska 2021; Xiao et al. 2022). Design students commonly prefer to learn through practice. Therefore, relying solely on theory may not be advantageous to learners and may discourage them (Sygulska 2021). Students may lose interest in the subject if the relationship between social applications and observations in the real world is not emphasized (Meric and Caliskan 2013). Another issue is that the predominance of vision in design studies makes disciplines related to other senses seem less significant (Demir and Bayazıt 2018; Regnault 2020). Design students, often preoccupied with visual aspects, may be insensitive to non-visual phenomena such as sound (Tachibana 2000). Another difficulty is that students consider non-studio courses less important since studio courses are the foundation of design education (Berardi 2017). Students generally focus solely on passing their exams, so they may encounter difficulties applying knowledge gained from various courses to the design studio. They may not learn how to apply their knowledge to their creative works through traditional teaching techniques, eventually having difficulty putting theory into practice (Bard et al. 2013). With all the challenges mentioned above, numerous studies on the method of acoustics courses were conducted.

Architects may fall behind in providing user comfort if they do not have a basic understanding of acoustics. As a result, the appropriate education on the subject should be provided throughout undergraduate courses. Acoustics should be considered a necessity, not a luxury, for a better environment (Sygulska 2021). For long-term sustainability, a professional architect should comprehend acoustical design (Caliskan and Arslan 2005). It should not be separated from form, design, or color to provide a holistic experience. Architects must understand how their architectural decisions affect acoustics. They should be able to detect acoustical issues early in the design process, develop solutions, and refer to a specialist if necessary. Therefore, students must understand the significance of acoustics and learn how to collaborate with an acoustician (Sygulska 2021). Architects should effectively communicate with acousticians and noise control specialists (Ramakrishnan 2017). They should be familiar with the terminology to explain their initiatives and engage with acousticians in a common language (Bard et al. 2013).

It is critical to understand the motives of those interested in acoustics to attract more students. Acoustics-related courses are preferred by students who want to learn more about how acoustics and architecture interact. They want to understand more about the impact of acoustics on user experience and to get more familiar with acoustical terminology (Fullerton 2013). Furthermore, many believe the course material will benefit them in their professional lives, and some are already interested in sound-related fields such as music.

The teaching approaches of existing courses should be thoroughly investigated to encourage more students to enroll in acoustics courses (Meric and Caliskan 2013). For example, Fiebig et al. (2010) conducted a workshop featuring three modules: concepts and terms, measurements, and analysis and evaluation. It comprised listening tests, acoustical measurements, soundscape experiments, and soundwalks. Similarly, Regnault (2020) employed experiential learning techniques to help acquire a balance between technique, intuition, and originality. The author utilized acoustic measurements, sound recordings, editing, and blind soundwalks. Students were asked to investigate and assess a performance space's architectural and acoustic qualities in a different study. They then performed sound level measurements and ran a room acoustics simulation.

Another approach was asking students to improve the acoustical conditions of an existing space. For example, Sheridan and Van Lengen (2003) asked students to develop a sound-based design strategy to alter an existing space. The authors first introduced a series of exercises to introduce students with sound's mechanical and cultural aspects. Then students were assigned to design a response to the acoustical condition of the given space. Similarly, Bauer (2012) conducted a workshop that included listening exercises and design tasks to draw attention to the sonic environment and raise awareness. The listening exercises included presenting the students with audio recordings of movies and describing the scene, listening to recordings of speech and music with various reverberation times, and describing the sound and the space. Design tasks included discussing and sketching design ideas for improving sound in their classrooms. Students found the workshop to be an exciting approach to design education.

Utilizing soundscape as a design problem was another method. Llorca-Bofí and Engel et al. (2019) aimed to raise awareness on the impact of design decisions on the auditory environment. Students were asked to listen to a soundscape without visual information and draw the architectural environment based on the recording. After, students were asked to make a design proposal. Furthermore, Bard et al. (2013) asked students to create educational movies to explain acoustics principles to their peers. Afterward, students were expected to implement the knowledge they acquired by the first assignment in their creative design projects. In a different approach, students were assigned to design a concert hall, aiming for them to apply their theoretical knowledge in their designs and to make them understand that acoustics is not a parameter independent of the initial design stage. Afterward, students evaluated the acoustic environment of their designs using computer software (Karabulut and Çali 2011).

Kitapci (2019) proposed an interdisciplinary and holistic acoustics course consisting of four phases: the technical lecture phase, the preliminary research and soundwalk phase, the initial design phase, and the holistic soundscape design phase. The course emphasized the creation of places and soundscapes within the socio-cultural context instead of overwhelming the students with intense theoretical acoustics content. It was structured in line with the design studio, emphasized the relationship between auditory environments and conceptual ideas, and aimed to deliver adequate levels of theoretical knowledge comprehensible by design students. Similarly, Dokmeci Yorukoglu (2022) proposed a research-based, elective course, ‘Listening to Spaces’, emphasizing the importance of a holistic approach. In the course, active involvement of the students was prioritized, and case-based, problem-based, experiential, and project-based teaching methods were utilized. Self-evaluations and peer-assessment were conducted through open discussions. Students were expected to prepare visual and audial presentations. Including six progressive tasks following the cognitive process dimensions (i.e., remember, apply, analyze, understand, evaluate, and create), the course aimed at raising students' awareness on conscious listening.

The approach of Demir and Bayazıt (2018) aimed at helping students comprehend the significance of the auditory aspect alongside visuality as an integrated part of the design process. They conducted a workshop that consisted of five stages: questionnaire, listening test, architectural project design, integrating the sound recordings into designs, and interview with students. The questionnaire answers revealed that although 66.6% of the students claim that they considered the auditory approach in their designs, 100% of them stated that they did not use it as a parameter. Students stated that after the workshop, they would be more sensitive in providing acoustic comfort in their future designs and would design buildings with better acoustics. The authors emphasize the need for more workshop experiments and state that even this two-day workshop was beneficial in raising awareness. Llorca-Bofí and Redondo et al. (2019) conducted a workshop consisting of a design-based phase and a theoretical masterclass. Interviews after the workshop revealed that participants found the design-based stage to be a good example of learning by doing, an excellent introduction to acoustics, and easy to understand method. However, it did not contain enough theoretical knowledge. On the other hand, the theoretical masterclass contained more details, concepts were clarified but lacked practicality, were challenging to follow, and needed more explanation. 62,5% of the participants preferred a design-based workshop.

Students' interest in acoustics design could be triggered by activities that involve listening to and recording sonic environments within the context of soundscape (Milo 2020). These tasks include sound diaries and sound maps to document aural experiences and sound and listening walks (Xiao et al. 2022). Moreover, recordings that allow the listener's experience to be communicated to others could be utilized to encourage further discussions (Milo 2020). Measurements and hands-on experimentation are two other ways that can be employed (Busch-Vishniac and West 2007; Sygulska 2021). Laboratory visits are mentioned to attract students' attention and improve their learning experience (Sygulska 2021). Students appreciate instructors bringing equipment, such as sound level meters, to class and teaching them how to operate it (Busch-Vishniac and West 2007; Sü Gül and Çalışkan 2022; Xiao et al. 2022).

Lectures can be more enjoyable by presenting material samples so that students can examine them closely (Sü Gül and Çalışkan 2022; Sygulska 2021). Research tasks and case studies can be involved in lectures (Busch-Vishniac and West 2007; Sygulska 2021). Seminars and exhibitions, along with courses, were also mentioned as other methods of acoustics education (Sygulska 2021). Questionnaires can be employed as a means to prompt students to contemplate the connection between objective measures and subjective parameters (Llorca-Bofí et al. 2020). Acoustical simulations are another effective way of capturing students' attention. Simulations can be utilized to explore specific acoustic design aspects, allowing students to identify acoustic issues and evaluate proposed design solutions effectively (Xiao et al. 2022).

Acoustics should be taught holistically, not just by employing acoustic solutions. Promoting complex thinking regarding spatial design can significantly increase students' understanding of acoustics (Sygulska 2021). Including soundscapes and various sensory components in the generative design process is another method of drawing architectural students' attention to sound as an essential element and inspirational concept (Llorca et al. 2018; Sheridan and Van Lengen 2003). The acoustic environment can be visualized, and a design approach can be developed to respond to the auditory elements. Short projects based on soundscape principles can be assigned to encourage considering the environment from an acoustical viewpoint. Architectural acoustics can be introduced through the soundscape approach. This approach allows it to be presented as a theoretical subject, encouraging students to contemplate their sonic experiences and gain insights into how sound operates within diverse environments (Xiao et al. 2022). Ideas can be utilized along with technical information, utilizing students' interest in form and aesthetics (Bickerstaff 1971). With a focus on practical purposes, the theory should be limited to introducing students to fundamental acoustic concepts (Sygulska 2021). Simple, comprehensible language should be used to describe complex subjects (Bickerstaff 1971). Instead of questions with a single correct answer, instructors should introduce open-ended problems (Busch-Vishniac and West 2007). Sharing ongoing acoustical projects and experiences effectively captures students' interest (Sü Gül and Çalşkan 2022; Xiao et al. 2022). Innovative activities that can serve as homework problems and potential exam questions can be used (Potel et al. 2022).

Regulations about specific spaces that align with design studio projects can be introduced (Xiao et al. 2022). Images, graphs, animations, aural samples, and active demonstrations can make theoretical subjects more interesting (Bickerstaff 1971; Busch-Vishniac and West 2007; Sygulska 2021; Xiao et al. 2022). It was observed that creating online tools and web pages was also beneficial in lectures (Busch-Vishniac and West 2007).

Acoustics should be taught in an interactive manner that addresses each student's diverse learning style (Bard et al. 2013). Students should be aware that their design decisions impact acoustic quality (Sygulska 2021). Educators should use examples to transfer theoretical content into practical applications. Additional training in acoustic simulations and materials is frequently required to create a relevant and realistic design concept (Xiao et al. 2022). According to Xiao et al. (2022), the soundscape approach offers instructors the chance to merge the science of acoustics with the design concepts and design language familiar to architectural students. By incorporating ideas from soundscape research, acoustics can be linked to spatial thinking and design. If the student's attention is captivated and their interest in the subject is aroused, they will eagerly use the recently learned information in their design studios. (Sü Gül and Çalışkan 2022).

CHAPTER III
STUDY DESIGN

The aim of the study is to make students consider acoustics concepts in their design projects by integrating workshop modules on acoustics into the fourth-grade design studio course in the Interior Architecture department at Çankaya University. In this chapter, the study design will be explained in detail.

First, the study's objectives, research questions, and hypothesis will be introduced. The evaluation and statistical methods employed will be presented, and the preliminary course that the workshops were based on, and the design studio courses where the experiments were conducted will be discussed. Finally, the content and process of the workshop modules, participants, and the experimental process will be delivered.

3.1. OBJECTIVES & RESEARCH QUESTIONS

The current study investigates the effects of integrating acoustics workshop modules into the design studio course. It is aimed to remind the students of their existing knowledge of acoustics and make them consider acoustics concepts during their design studio project process.

The objective of the research was to investigate the short-term and long-term effects of workshops:

- on student's noise sensitivity levels,
- on student's ratings on the importance of acoustics in different building types,
- on student's self-evaluations on acoustical terminology knowledge,
- in making students include acquired acoustics knowledge in their design process.

The research question of the study are as follows:

- How do acoustics workshops affect students' noise sensitivity levels in the long-term and the short-term?

- How do acoustics workshops affect students' ratings on the importance of acoustics in different building types in the long-term and the short-term?
- How do acoustics workshops affect students' self-evaluations on acoustical terminology knowledge in the long-term and the short-term?
- How do acoustics workshops affect students' inclusion of acquired acoustics knowledge in their design process in the long-term and the short-term?

In the following section, the hypothesis of the study will be explained.

3.2. HYPOTHESIS

With the mentioned objectives and research questions, the hypothesis of the study is as below:

- Including acoustics workshops in the design studio process affect students' noise sensitivity levels.
- Including acoustics workshops in the design studio process affect students' ratings of the importance of acoustics in different building types.
- Including acoustics workshops in the design studio process increase students' self-evaluations on acoustical terminology knowledge.
- Including acoustics workshops in the design studio process increase the application of soundscape and building acoustics concepts in design studio projects.

The method of the study was developed to test the hypothesis above. The participants, study design, workshop modules, and evaluation methods will be explained in detail in the following sections.

3.3.PARTICIPANTS

The participants of the study were chosen to be the students enrolled in INAR 401 Interior Design Studio V (See Section 3.6.1) for the following reasons. In Çankaya University, Architectural Acoustics is a must course, which covers all aspects of acoustics and is given in the 3rd year of interior architecture education (See Section 3.5). Therefore, all students have acquired the necessary acoustical knowledge until the beginning of the INAR 401 design studio, during which the experiment takes place. INAR 401 design studio course is held in two sections, which allows separating the students as the control group and the experiment group. This was crucial in being able to compare the results in the evaluation stage.

A total of 46 students participated in the experiment. The students confirmed that none of them has attended an acoustics-related course other than INAR 365 course. Therefore, the participants had similar backgrounds regarding acoustical and architectural knowledge. The mentioned selection criteria were decided to minimize the variance between participants. The ages of the participants were (std. dev. & average). In both groups, 30 of the participants were female, and 14 were male. Twelve students in the experimental group participated in all stages of both workshop modules. Therefore, the data from the rest of the experiment group were excluded.

3.4.EXPERIMENTAL PROCESS

In this section, the study design is presented. Figure 10 summarizes the experimental process. The process began with the participants enrolling in the 3rd-grade course Architectural Acoustics (INAR 326) in the 2020/2021 Spring semester. In the 2021/2022 Fall semester, the students enrolled in Interior Design Studio V (INAR 401) and were separated into two sections. Both of the sections were randomly selected; one section as the experimental group and the other as the control group. Two workshop modules, Soundscape Workshop and Building Acoustics Workshop were designed based on the scope of the INAR 326 course and reference books. The control group continued the regular design studio process without attending the workshops. On the other hand, the experiment group took part in the two workshop modules in addition to the regular design studio process after introducing the design problem. With the workshops, it was aimed to trigger students to make associations with their existing knowledge of acoustics in the synthesis stage of their design process. The first module focused on the soundscape topic, and the second was on building acoustics. The third workshop was planned to be on Room Acoustics. The modules' order and timing were decided based on the studio schedule. The soundscape workshop was conducted in the project's “Preliminary Design Ideas Including Conceptual Approach” stage, and the building acoustics workshop was conducted at the “Design Development” stage. The third workshop, Room Acoustics, was planned to be conducted in the 'Development of Selected Areas and Detailing According to Concepts' stage. However, it was not conducted due to delays in the studio schedule.

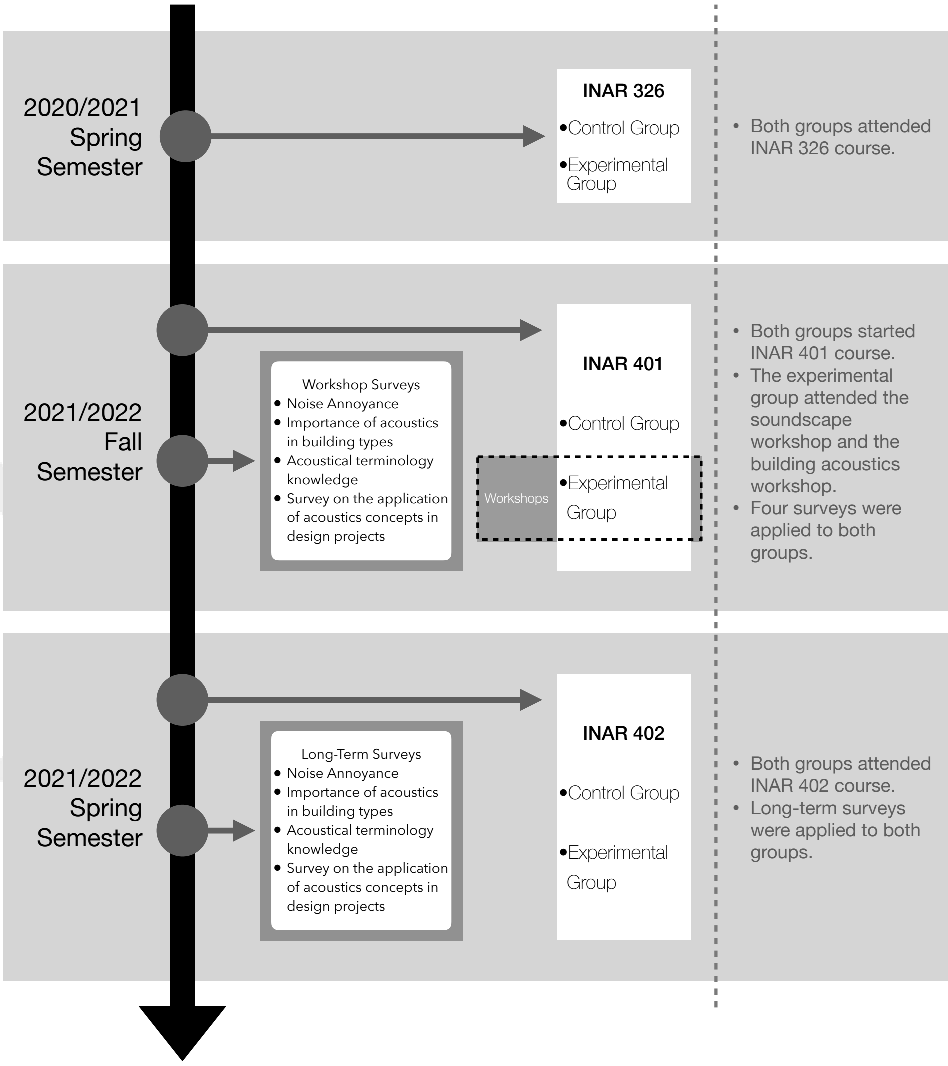

Figure 10: Illustration of the experimental process

At the end of the semester, a survey with five sections was applied to both groups aiming to gather demographic information and the effects of the workshop modules on student's noise sensitivity levels, ratings of the importance of acoustics concepts in building types, acoustical terminology knowledge, and the survey on the application of acoustics concepts in design studio projects. The surveys were prepared under two concepts of acoustics, building acoustics and soundscape, as given in the workshops. It was mentioned that in studies where the aim is creating awareness, gathering survey data six months after the intervention (longitudinal evaluation) is more effective (Illingworth and Allen 2020). Therefore, the four surveys were applied to the same students for the second time at the end of the 2021/2022 Spring semester.

3.5. UNDERGRADUATE COURSES

This section explains the courses in interior architecture undergraduate program curriculum that are considered within the scope of this study. Initially, the mandatory course Architectural Acoustics is explained based on which the workshops were structured. Afterward, the process and contents of the design studio courses, in which the experimental process took place are presented.

3.5.1. Architectural Acoustics Course

Architectural Acoustics (INAR 326) is a 3rd year mandatory course at Çankaya University, Interior Architecture Department (Çankaya University 2020). Table 5 presents the weekly schedule of the course. The course focuses on sound behavior in enclosed places, physical principles of sound, human hearing, basic principles of noise control techniques, and theories on architectural acoustics. It aims to introduce basic concepts and principles of acoustics, describe principles of auditory perception and acoustic comfort, environmental noise, characteristics of effectively designed spaces for various functions, theories used in building acoustics.

Table 5: Weekly schedule of INAR 326 (Çankaya University 2020)

Week	Subject
Week 1	Introduction and general information on acoustics
Week 2	What is sound? Basic principles
Week 3	How does sound travel?
Week 4	Sound phenomenon; room acoustics (absorption, reflection, diffusion)
Week 5	Sound phenomenon; building acoustics (sound transmission)
Week 6	Building acoustics and noise control applications
Week 7	Midterm-1 Exam
Week 8	Human hearing and perception
Week 9	Soundscape definition and terms
Week 10	Acoustics of spaces not having the primary function of acoustics
Week 11	Acoustics of performance spaces and auditoriums
Week 12	Acoustic measurement and analysis techniques
Week 13	Acoustic regulations and guidelines
Week 14	Midterm-2 Exam

3.5.2. Interior Design Studio V

Interior Design Studio series expect students to integrate the knowledge they have acquired from previous theoretical courses to their design projects. Each studio of the series covers various aspects of design, emphasizing the concept, topic, scale, and context of the design problem. The 4th grade courses INAR 401 and INAR 402 Design Studios are designed to assess the student's knowledge, abilities, and attitudes (design, technical, presentational, etc.) at the conclusion of their interior architecture education after they have completed all required courses and summer practices (Çankaya University 2021, 2022). Therefore, the courses try to combine all the knowledge and actions required to plan and implement a project in a professional setting. The students must contribute creatively to a given design challenge by taking several approaches to challenging interior architectural concerns. Students are urged to take individual perspectives and display more independence in their creative work. A high degree of creativity and critical thinking skills are required to situate and negotiate complex interior architectural programs at all scales in international and/or national contexts. In both courses, the term is divided into three project phases (Table 6). The workshops were conducted in the INAR 401 course, Soundscape Workshop in the first stage and Building Acoustics Workshop in the second stage.

Table 6: INAR 401 & INAR 402 project phases (Çankaya University 2021, 2022)

Stage 1: Preliminary design ideas, conceptual approach	**Stage 2:** Design development	**Stage 3:** Detailing according to concepts
Building analysis & research	Floor plans (1/100,1/50)	Partial plans (1/20)
Scenario & architectural requirement program	Reflected ceiling plans (1/100, 1/50)	Sections (1/20)
Site analysis	Sections (1/100, 1/50)	Elevations (1/20)
Conceptual development	Site plan (1/100, 1/50)	Reflected ceiling plans (1/20)
Conceptual sketches	Perspectives	Materials & details (1/5, 1/1)
Sketches on allocation	Materials	3D modeling/perspectives
Activity analysis	3D modeling	Overall video analysis
Circulation analysis	Video presentation	Cost analysis

INAR 401 (Interior Design Studio V) is the fifth studio in the Interior Design Studio series (Çankaya University 2021). The course particularly emphasizes recognizing various activities regarding their cultural, aesthetic, and social values in complex buildings. Students are expected to fulfill the following requirements:

existing building analysis; architectural programming considering similar buildings; conceptual study and design scenario; corporate identity design; function and climate analysis; circulation and allocation pattern studies; continuity of design concept in the overall design through indoor environmental parameters, solid/void relationship, building and finishing materials, furniture, details, etc.; considering room acoustics throughout the design. Other than the interior design of the building, students are also expected to deal with design of indoor–outdoor relationships, public spaces between buildings, landscape elements and street furniture.

The course aims to equip students with skills such as: analyzing problems in interior architecture, and re-structure user needs in a given building; establishing architectural requirement programs for the new needs; transferring the knowledge and skills that are previously obtained in the scenario development and architectural planning phase; formulating allocation and circulation plans and compare alternative design solutions; integrating indoor environmental quality parameters in the design process; using rooms acoustics principles throughout the design process.

In 2021/2022 Fall semester, 46 students participated in the course. The course was held in two separate sections. The project for the semester was re-functioning an existing hotel building with a total area of ~5000 m^2. Students were expected to design the interior of the building according to one of the assigned topics: dormitory for university students, residence, aparthotel, and senior living facility for elderly people. Table 7 presents the minimum requirement list for each project type.

The students were required to study the architectural requirement program for the subject and create a scenario for the project. Throughout the design process, students were required to expand and enhance these programs in accordance with the requirements of their projects and make their designs accordingly. Table 8 presents the weekly schedule of the course. In Stage 1 (Week 1 and Week 2), students were required to determine the conceptual approach of their projects regarding their research on: scenario and user profile analysis; existing building and site analysis; similar building examples for new function of the building; functional analysis and basic architectural programming; ecological & sustainable design principles; responsible and efficient material use; general concept and its continuity in design, as accessories, details, etc.; initial sketches and hand drawings/perspectives. Afterward, in Stage 2 (Week 3 –

Week 10), students were expected to prepare 1/100 and 1/50 furnished plan, section, and ceiling plan drawings. In the final stage, Stage 3 (Week 11 – Week 13), students were required to prepare; 1/20 partial plans, ceiling plans, sections, and elevations of selected areas, including architectural elements, material information, and information layers; 1/20 detail drawings presenting information on designed wall system drawings, movable wall system drawings, and built-in furniture system drawings; and 1/5 and 1/1 scale detail drawings from necessary areas.

Table 7: Minimum requirement list for the INAR 401 design project (Çankaya University 2021)

Topic	Dormitory	Residence	Senior Living	Apart Hotel
Rooms	-1bed+WC -2bedrooms+WC -4bedroom+WC -Director lodgment	-1+1 residence -2+1 residence -4+1 residence -Housekeeper's apartment	-1 bed suite -2-bed suite -3-bed Suite -Director's lodgment -Housekeeper's apartment	-Suites for 2-4 persons with kitchenette, WC, living area -Housekeeper's apartment
Auxiliary Spaces	-Group study area -Computer room -Library	-Children's playground (indoor and outdoor)	-Physiotherapy/ massage room -Nurse's room -Doctor's room -Library	-Tv/ game room
Social Spaces	-Lobby/ TV hall	-Lobby -Social gathering area, snack bar f	-Lobby with TV -Visitor's quarter -TV, game room	-Lobby with reception desk and visitor's bar
Common Eating Spaces	-Cafeteria -Snack bar -Shop -Kitchenettes	-Restaurant/ coffee shop	-Cafeteria/ restaurant -Snack bar -Shop	-Restaurant -Shop
Administrative Spaces	-Director -Secretary -Accountant office	-Apartment directorate office	-Director's room -Secretary's room -Accountant office	-Director's room -Secretary's room -Accountant office
Technical Spaces	-Technical center -Laundry -Main kitchen	-Technical center -Laundry -Main kitchen	-Technical center -Laundry -Main kitchen	-Technical center -Laundry -Main kitchen
Entertainment Spaces	-Pool, showers and changing rooms -Fitness center	-Pool, showers and changing rooms -Fitness center	-Pool, showers and changing rooms -Fitness center	-Pool, showers and changing rooms -Fitness center
Common Areas	-Lobby -Reception desk -WC's -Janitor rooms	-Security -Lobby -Reception desk -WC's -Janitor rooms	-Lobby -Reception desk -WC's -Janitor rooms	-Lobby -Reception desk -WC's -Janitor rooms

Table 8: INAR 401 weekly schedule (Çankaya University 2021)

Stage	Week	Subject
Stage 1	Week 1	**Introduction to project, preliminary research, student presentations**
	Week 2	**Critiques:** Preliminary design ideas including conceptual approach
Stage 2	Week 3	**Critiques:** 1/100 drawings
	Week 4	**Critiques:** 1/100 drawings
	Week 5	**Pre-Jury I**
	Week 6	**Critiques:** 1/100 drawings
	Week 7	**Critiques:** 1/50 drawings
	Week 8	**Critiques:** 1/50 drawings
	Week 9	**Critiques:** 1/50 drawings
	Week 10	**Pre-Jury II**
Stage 3	Week 11	**Critiques:** 1/20 drawings + 3D model/perspectives + video presentation
	Week 12	**Critiques:** 1/20 drawings + 3D model/perspectives + video presentation
	Week 13	**Critiques:** 1/20 drawings + 3D model/perspectives + video presentation
	Week 14	**Critiques:** 1/20, 1/5, 1/1 drawings + video presentations

3.5.3. Interior Design Studio VI

INAR 402 (Interior Design Studio VI) is the sixth studio in the Interior Design Studio series (Çankaya University 2022). The course expects students to analyze an existing building, to establish a design language, and to design the interior of the building. It requires them to develop an autonomy in design work, make an original contribution to the specified design assignment, and demonstrate high levels of creativity and critical skills in negotiating and situating significantly complex interior architectural programs at all scales in international and/or national contexts.

By the end of the course, students should be able to demonstrate knowledge of contemporary methodologies in interior architectural design, economic and social sustainability, and apply the analytical knowledge and skills acquired in the course. They should develop the ability to fulfill the complex tasks required by the project briefs and be actively involved in the critical development, understanding, and definition of an interior architectural program, ability to work on the specialized and complex architectural problems, display advanced skills in the use of representation techniques and communication, and an ethical responsibility towards issues related with the cultural heritage, environment, and society.

In 2021/2022 Fall semester, 45 students participated in the course. The course was held in two separate sections. The project for the semester was Arts and Crafts Studio, with a total area of ~1300 m^2. Students were expected to design the interior of the building according to one of the given Arts and Crafts Studio subjects (gastronomy/culinary arts, art (with a specific field/s of art), fashion design, jewelry design, dance, cinema and TV or Theatre, modeling, photography, and illustration, music) and age groups (kids with their families, young, adult, elderly, and combined age groups). Minimum functional requirements of the project were as follows: entrance/info desk, workshop/training/course areas, exhibition, management unit, instructors' room, meeting room, canteen/café, service areas/wet spaces, and additional activities/functions according to selected Art Studio. The weekly schedule for the 2021/2022 Spring semester is presented in Table 9. The students had to develop a scenario and research the architectural requirement program as part of the assignment. They were required to develop and improve these programs as part of the design process to meet their projects' needs. Additionally, it was necessary for students to establish the building's interior completely.

Table 9: INAR 402 weekly schedule (Çankaya University 2022)

Stage	Week	Subject
Stage 1	Week 1	**Introduction to the term project**
	Week 2	**Student presentations:** Preliminary design ideas, conceptual approach
Stage 2	Week 3	**Critiques:** 1/100 drawings
	Week 4	**Critiques:** 1/100 drawings
	Week 5	**Critiques:** 1/100 drawings
	Week 6	**Pre-Jury I**
	Week 7	**Critiques:** 1/50 drawings
	Week 8	**Critiques:** 1/50 drawings
	Week 9	**Critiques:** 1/50 drawings
Stage 3	Week 10	**Critiques:** 1/20 drawings + 3D model/perspectives + video presentation
	Week 11	**Critiques:** 1/20 drawings + 3D model/perspectives + video presentation
	Week 12	**Pre-Jury II**
	Week 13	**Critiques:** 1/20, 1/5, 1/1 drawings + video presentations
	Week 14	**Critiques:** 1/20, 1/5, 1/1 drawings + video presentations

3.6.WORKSHOP MODULES

The modules utilized the hands-on learning method, which adopts learning by doing since it was found to be a more appropriate method for the INAR 401 design studio process. The contents of the workshops were designed based on the preliminary must-course INAR 326 Architectural Acoustics and reference books on the subjects (see Section 3.7.1 and Section 3.7.2). Each workshop module included three stages: lecture, application, and discussion. In the lecture stage, it was aimed to remind the students of the information they have obtained from the Architectural Acoustics course.

The purpose of the application stage was to develop an understanding of the method of applying their knowledge in real-life situations, which is important in transforming information into knowledge. In the final stage, discussion, the goal was to understand how much the students internalized the information given and to help them better understand the subject by discussing and commenting on each other's opinions. After every workshop, a feedback form was given to the participants, which helped the researchers get feedback on the structure and efficiency of the workshops. The workshop modules were conducted online via Zoom software (Zoom Video Communications 2011) due to COVID-19 restrictions. All the process was in Turkish, as it was the native language of the participants. Participation was not mandatory; however, encouraged.

3.6.1. Soundscape Workshop

The Soundscape Workshop consisted of three stages: lecture, application, and discussion, and it was planned to take 130 minutes (Figure 11). All the stages were aimed at being interactive. It was tried to include students by asking them questions. Since the subject was on soundscapes, audible examples were included in the presentation. It was aimed to cover as many aspects of soundscapes as possible in a short time. The workshop was conducted during the project's conceptual development phase after the design problem was given for students to develop sound-related design ideas. A total of 16 students participated in all three stages of the workshop.

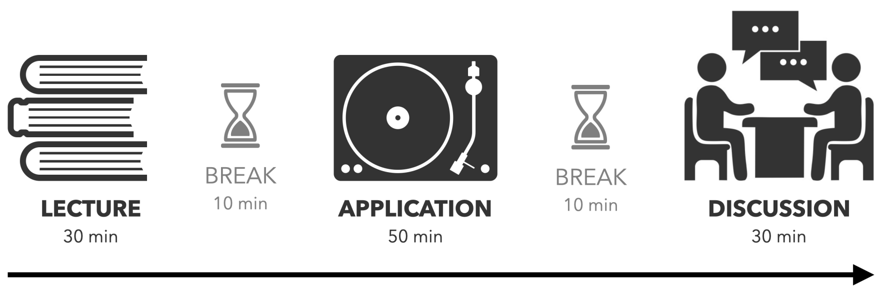

Figure 11: Soundscape workshop process

The outline of the lecture stage included eight subjects (Figure 12). The content was prepared based on the lecture notes of “Architectural Acoustics” course (Dokmeci Yorukoglu n.d.) and reference publications (Table 10). It began with the importance of acoustical design. Students were asked to list spaces that have acoustics as the primary function and spaces that do not have acoustics as the primary function. Students were shown two pictures and were presented with three different soundscape recordings for each. This approach aimed to show them the difference that occurs with the sound environment of space. The next subject was noise. Students were introduced to the basic definitions of noise and were explained that noise is a subjective notion and that in soundscape studies, sound is a source to be managed rather than a problem to be solved (Schaffer 1994).

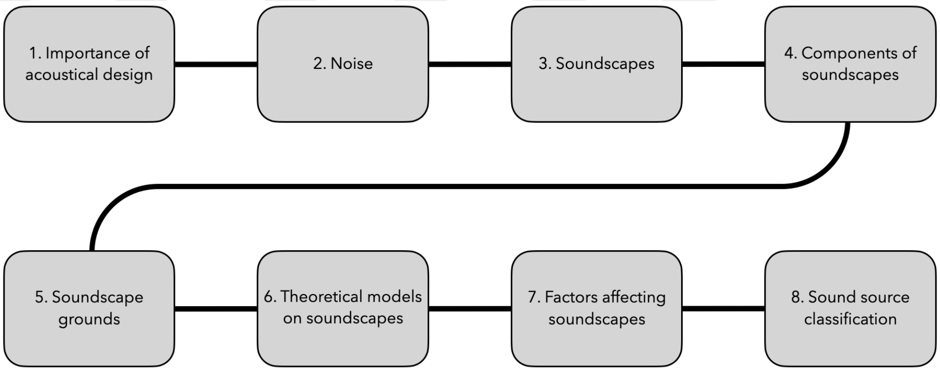

Figure 12: The outline of the Soundscape Workshop lecture stage

In the next topic, the definition and a short history of soundscapes were given briefly (Pijanowski et al. 2011). Afterward, the components of soundscapes, keynotes, signals, and soundmarks (Schaffer 1994), were given with visual and audible examples. The next subject was The Soundscape Grounds which included, from general to specific, explanations of the soundscape ecology, urban soundscapes, and indoor soundscapes. In the next subject, two theoretical models on soundscapes were introduced (Job et al. 1999; Zhang and Kang 2007). Afterward, the factors affecting soundscapes and the concepts of biophony, anthrophony, and geophony were explained (Dumyahn and Pijanowski 2011). The lecture section was finalized by giving the sound source classification by Schaffer (1994), with aural examples. After the lecture stage, a 10-minute break was given.

Table 10: References used in Soundscape Workshop lecture stage

Source	Subject
Dokmeci Yorukoglu n.d.	Spaces with/without the primary function of acoustics
Dummyahn & Pijanowski 2011	Factors affecting the soundscape
Job et al. 1999	Theoretical models on soundscapes
Pijanowski et al. 2011	Definition of soundscape
	Historical development of soundscape
Schaffer 1994	Sound and noise
	Components of soundscapes
	Classification of sound sources
Zhang and Kang 2007	Theoretical models on soundscapes
Kang and Schulte-Fortkamp 2016	Soundscape design

The application stage of the workshop was prepared based on the study of (Kitapci and Ozdemir 2021a, 2021b). Students were asked to design a sound environment for a Cafe setting with the atmosphere and architectural properties of their own decision. Traktor Pro Software (Native Instruments 2008) was used for the process. Figure 13 presents the schematized version of the software used in the application stage of the workshop. Figure 14 presents the list of sound sources. Sound sources were selected under 4 main categories: background sounds (4), human and technology sounds (4), kitchen and movement sounds (4), and out-of-context sounds (2). Three options were given for each sound source. The options were chosen to carry different spatial and atmospheric information.

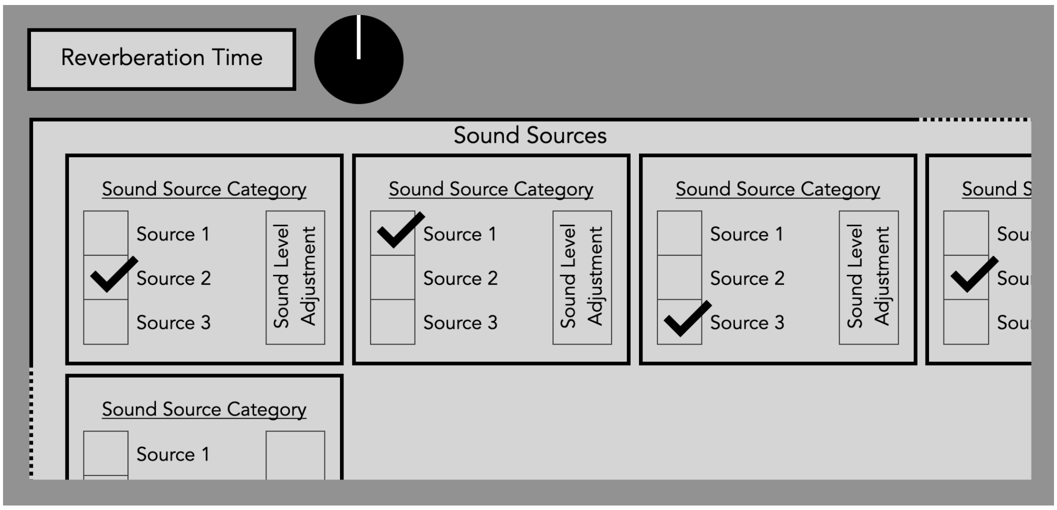

Figure 13: Schematized version of the software used in the Soundscape Workshop application stage

Background Sounds											
Traffic			Nature			Mechanical Ventilation			Music		
Traffic 1	Traffic 2	Traffic 3	Nature 1	Nature 2	Nature 3	Ventilation 1	Ventilation 2	Ventilation 3	Music 1	Music 2	Music 3

Human & Technology Sounds											
Phone			Footsteps			Human 1			Human 2		
Message	Phone Ringing 1	Phone Ringing 2	Footstep 1	Footstep 2	Footstep 3	Speech 1	Speech 2	Speech 3	Children	Laughing	Coughing

Kitchen & Movement												Out of Context Sounds					
Cooking			Kitchen			Cutlery			Chair			Out of Context 1			Out of Context 2		
Frying	Oven	Cutting	Drink Pouring	Coffee Machine	Sink	Cutlery 1	Cutlery 2	Cutlery 3	Chair 1	Chair 1	Chair 1	Worksite	Flush	Office	Announcement	Photocopier	Alarm

Figure 14: List of sound sources used in the Soundscape Workshop application stage

The process began with introducing the students to the stages of soundscape design (Kang and Schulte-Fortkamp 2016). Afterward, they were given their design task and were introduced to the software. The students were separated into three groups, and a participant to control the software via remote access was chosen from each group. Finally, they were asked to fill out the given form in groups and use it as a guide during their design process. The form included questions to define the functions and activities in the space, user profile, acoustical objectives, wanted and unwanted sounds in the space and a section to state their sound source selections and selection reasons. Each group was given 10 minutes to experiment with the sound sources and 5 minutes to make their final decision and create a 30-second sound recording. Students were asked to choose at most one sound source from each type and adjust the sound level for each sound source and the reverberation time of the whole environment. After the application stage, a ten-minute break was given.

The discussion stage of the workshop aimed at understanding how much the students internalized the information delivered and helping the participants better understand the subject by discussing and commenting on each other's opinions. The following process took place for each group: first, the recording of the group was played. Afterward, the guide form was shared, and the group participants were asked to explain their spatial and sound source decisions. They made comments on the information they obtained from sources and explained the reasons for their selections.

Afterward, other group participants were asked to comment on the subject groups' decisions. After this process was completed for every group, the students were asked to comment on the workshop process and state in what ways it was useful for them. Finally, students were sent a feedback form, and the Soundscape Workshop was finalized. The workshop was found to be very useful in making them think of how their designs affect the auditory environment and how the auditory environment can affect their design decisions. They also added that they would start considering sound as a design element.

3.6.2. Building Acoustics Workshop

The Building Acoustics Workshop consisted of three stages: lecture, application, and discussion, and it was planned to take 110 minutes (Figure 15). The Building Acoustics Workshop was structured to create awareness of sound transmission and noise control in the built environment. The workshop was conducted during the INAR 401 course's 1/100 plan drawing phase for students to refer to Noise Regulations, consider acoustics in their layout planning, and take measures about possible acoustical problems. The workshop structure was practice-based, including but not limited to defining acoustical problems and creating practical solutions to these problems. A total of 17 students participated in all three stages of the workshop.

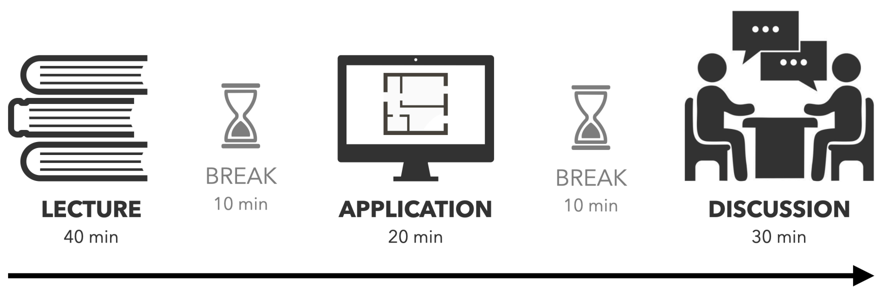

Figure 15: Building Acoustics Workshop process

The outline of the lecture stage included 11 topics (Figure 16). The content was prepared based on the lecture notes of 'Architectural Acoustics' course (Dokmeci Yorukoglu n.d.) and reference publications (Table 11). It began with noise exposure's psychological and physiological effects on people (Demirkale 2007). It was aimed to emphasize the importance of noise control. Consequently, sound transmission in buildings, direct transmission, and indirect transmission subjects were briefly explained with visuals (Moore 1978). Next, the basic principles of sound isolation and the properties of an ideal isolation construction were delivered (Egan 1988; Long 2006). The next topic was Sound Transmission Loss (Egan 1988; Long 2006). First, the subject was defined, and then it was explained with visuals. In the next topic, the Sound Transmission Class (*STC*) was described, and examples were given on the results of changes in the *STC* to clarify the concept. Afterward, ways of sound transmission were explained in three categories: airborne sound transmission, structure-borne sound transmission, and sound transmission through openings (Demirkale 2007). After defining these subjects, examples of problems that might occur and methods for improving them were given. In the methods to prevent airborne sound transmission subject, examples of improvement for sound leaks and transmission in the walls were introduced. Next, methods to prevent transmission in ceilings and slabs were exemplified.

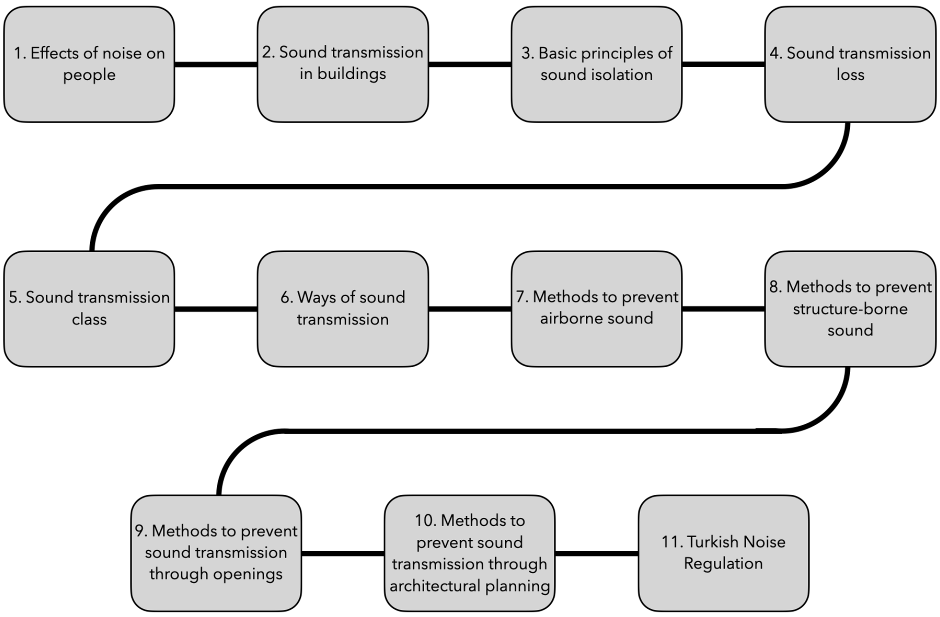

Figure 16: The outline of the Building Acoustics Workshop lecture stage

In the methods to prevent sound transmission through openings topic, doors and windows were addressed. Methods to prevent sound transmission through architectural planning were exemplified through visuals (Egan 1988; Ermann 2015;

Long 2006). Finally, the ‘Regulation on the Protection of Buildings Against Noise’ was introduced, and how to use the Regulation was explained. It was emphasized that the students could easily refer to the Regulation during their educational and professional life (Çevre ve Şehicilik Bakanlığı 2017). After the lecture, a 10-minute break was given.

Table 11: References used in the Building Acoustics Workshop lecture stage

Source	Subject
Çevre ve Şehircilik Bakanlığı 2017	Regulation on the Protection of Buildings Against Noise
Ermann 2015	Methods to prevent sound transmission
Moore 1987	Sound transmission in buildings
Demirkale 2007	Effects of noise on people
	Ways of sound transmission
Egan 1988	Principles of sound isolation
	Sound Transmission Loss
	Methods to prevent sound transmission
Long 2006	Principles of sound isolation
	Sound Transmission Loss
	Methods to prevent sound transmission
Dokmeci Yorukoglu n.d.	Principles of sound isolation
	Sound Transmission Loss
	Sound Transmission Class

In the application phase of the workshop, students were asked to plan the layout of a school, considering acoustics. Figure 17 presents the translated version of the drawing task assigned. The drawings were prepared using Autocad Software (Autodesk 2022). A representative grid was prepared, and circulation areas were placed by the researcher prior to the workshop. Common spaces in a school building, with their noise levels and noise sensitivity levels based on the ‘Regulation on the Protection of Buildings Against Noise’ (Çevre ve Şehicilik Bakanlığı 2017), were given as representative squares. Additionally, three types of wall options to be placed between spaces as necessary were given: high sound transmission class, medium sound transmission class, and low sound transmission class. With this task, it was aimed at making students think of acoustics while doing architectural planning. The task was prepared to be as simple as possible to be finished in a short time.

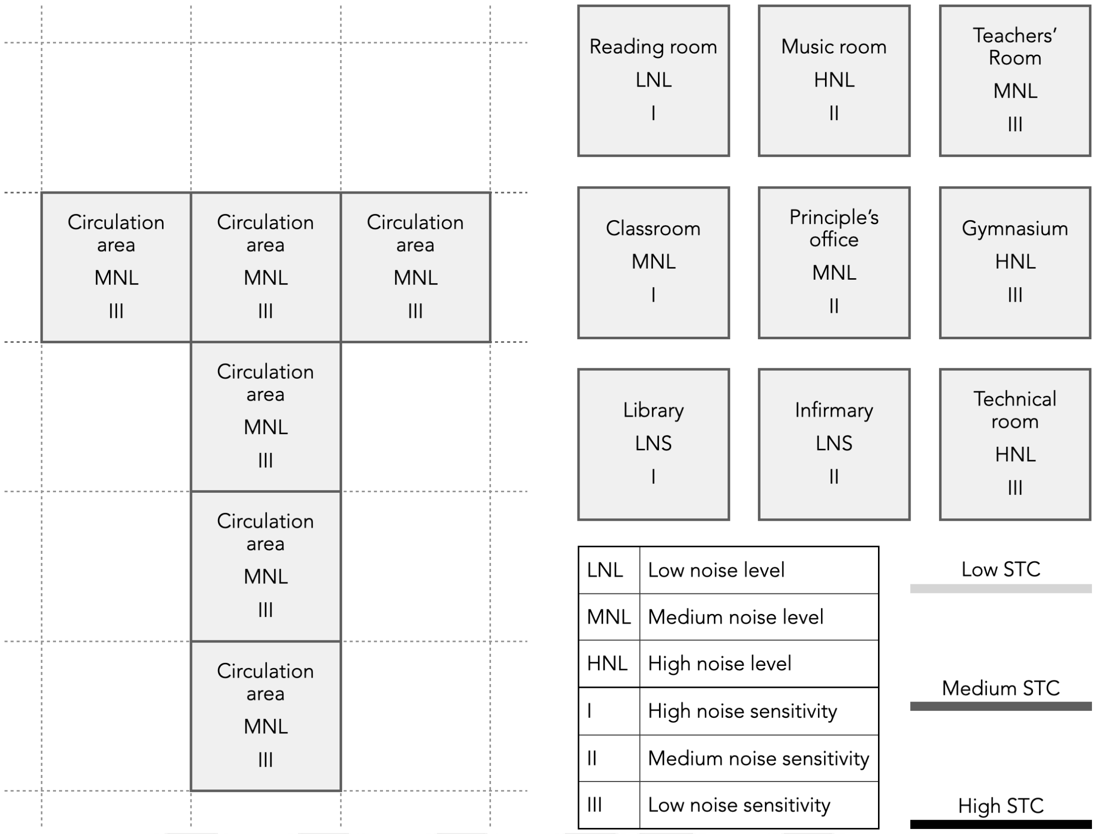

Figure 17: Building Acoustics Workshop application stage task (translated)

The process began with dividing the students into three groups. A coordinator that was assigned to place the spaces in the drawing based on their group discussion was selected from each group. The drawing file was sent to the coordinator. After the task was explained to the students, each group was sent to their breakout rooms with a moderator to observe the process. Each group was given 20 minutes to prepare their drawings. After the application process, a 10-minute break was given.

The discussion stage aimed at organizing the recently learned information on building acoustics by conducting both in-group and moderated discussions. The section consisted of two parts. In the first one, the following process took place for all groups. First, the group was asked to share their drawing and explain their decisions on space placement and divider selection. Afterward, they were asked questions about these decisions by the moderators and the students from other groups. The students from other groups made comments on the subject group's drawing.After this process was completed for each group, the second part of the discussion stage began. The students were presented with a plan drawing, adapted from Ermann (2015), with possible acoustical problems in this part. Each problematic part of the plan was highlighted one by one, and the students were asked what problem the highlighted part might cause and how they could solve it. After each part, an example solution was presented to them. Finally, the students were sent a feedback form, and the workshop was concluded.

2.1.1 Room Acoustics Workshop

The Room Acoustics Workshop was not conducted in the current study due to limitations caused by the process of the selected design studio, such as delays in the process and the workload of the course. However, in the current section, recommendations will be made for the workshop. The workshop was planned to consist of three sections, as the other workshops, lecture, application, and discussion, and take 130 minutes. The workshop aimed at creating awareness on the importance of sound quality within spaces. The workshop was planned to be conducted during the INAR 401 course's third phase, detail drawing, for students to consider acoustics in their material selections and details and take measures about possible acoustical problems.

The outline of the lecture stage was planned to include nine subjects (Figure 18). The content was prepared based on the lecture notes of "Architectural Acoustics" course (Dokmeci Yorukoglu n.d.) and reference publications (Egan 1988, Ermann 2015, Kinsler et al. 2000, Long 2006, Moore 1978). The workshop would include information on sound absorption, sound absorbers and examples, sound reflection, sound reflectors and examples, reverberation time, echo, sound diffusion, sound diffusers and examples, and key points to consider for efficient room acoustics design. After the lecture stage, a 10-minute break would be given.

In the application stage of the workshop, the students could be asked to use ray diagrams, design absorptive or diffusive panel systems, or propose an acoustical treatment of room surfaces with sound-absorptive materials of their own choice in required areas and locations in a given space (Sü Gül and Caliskan 2022). Additionally, the students could be presented with an existing space with the primary function of acoustics. Afterward, the students could be explained how to run acoustic simulations in a software and how to interpret the outcomes. Finally, the students could be asked to acoustically improve the given space and run the simulations again on their improved versions with the guidance of the instructors. In the discussion stage, students could be asked to present their outcomes from the application stage and comment on each other's outcomes.

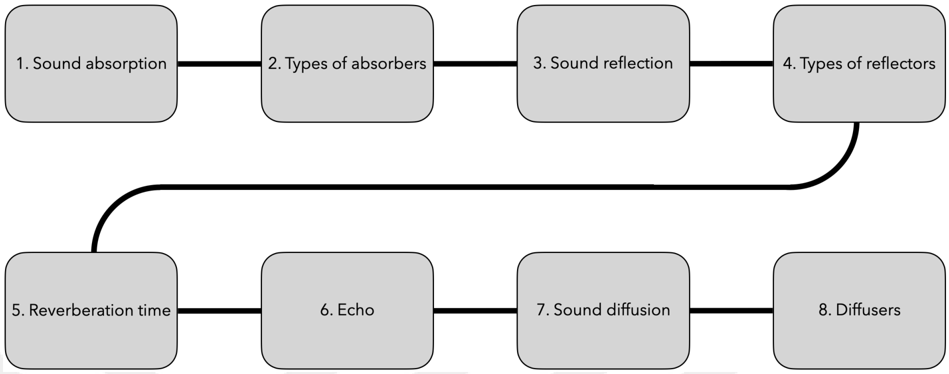

Figure 18: The outline of the Room Acoustics Workshop lecture stage

3.7.METHODS

This section presents the data-gathering methods and the statistical analysis methods of the study. The survey method was used to gather data on the effects of the workshop modules on the students. The gathered data was analyzed through the non-parametric Mann- Whitney *U* test since the study consisted of experiment and control groups.

3.7.1. Data Gathering Methods

A survey consisting of five sections, to be applied to both the experiment and the control groups, was prepared for the evaluation of the study (Appendix). The first section aimed at gathering information on students' age, gender, and participation in workshop modules. The second section of the questionnaire included five questions on the noise sensitivity levels on a 6-point Likert scale. It was adapted from 'Noise Sensitivity Scale-Short Form' (Benfield et al. 2014) and translated into Turkish. The third section asked the participants to rate the importance levels of acoustics subjects in the given 14 types of buildings on a 5-point Likert scale. The building types and their classifications were adapted from the study of (Dokmeci and Kang 2010a). The fourth section included 30 self-evaluation questions on acoustical terminology knowledge. The section was adapted from the questionnaire conducted by Meric and Caliskan (2013). The last section of the survey aimed for students to self-evaluate their application ratings of acoustics subject in their design projects with 25 questions in a 6-point Likert-Scale. The questions were prepared based on the contents of the workshop modules.

3.7.2. Statistical Analysis Methods

Statistical analysis was conducted using *IBM SPSS* Statistics software, version 29.0.0.0 (IBM Corp 2019). The data consisted of two independent sample groups. Median values were calculated for all variables. Reliability analysis was conducted for each section and group using Cronbach's α. Exploratory analyses were run to decide on the statistical analysis methods. Shapiro-Wilk test revealed that data were mostly non-normally distributed. Therefore, the non-parametric Mann-Whitney U test was used instead of the independent t-test (Field 2009). The differences between the control group and the experimental group were measured, and the effect sizes were calculated by the r value.

CHAPTER IV
RESULTS & DISCUSSION

This chapter will initially present the results and discussion of the study. Short-term and long-term results of the statistical and descriptive analysis of each survey section will be reported and discussed. Finally, the discussion for the whole study will be presented.

4.1. THE EFFECTS OF THE WORKSHOP MODULES ON NOISE SENSITIVITY LEVEL

The Noise Sensitivity Scale - Short Form (*NSS-SF*) consisted of 5 questions on a six-point Likert scale. The answers were coded as follows for the analysis: 1=Disagree very strongly; 2=Disagree strongly; 3=Disagree; 4=Agree; 5=Agree strongly; 6=Agree very strongly. The subsection originally had four 'positive' and one 'negative' question. However, the answers to the 'negative' question were inverted for ease of analysis. The short-term and long-term results of the survey subsection will be presented and discussed in the current section.

Short-term Effects on Noise Sensitivity Level

The subsection had high reliability for both the control group (Cronbach's α = .88) and the experimental group (Cronbach's α = .89). Shapiro-Wilk test revealed that the data were non-normally distributed except for the following items in the experimental group: Q1, p=.213; Q2, p=.109; Q5, p=.219. Table presents the Mann-Whitney *U* test results. The results indicate that there were no significant differences between the control group and the experimental group. The results of the noise sensitivity scale were evaluated as an indicator of awareness since it was previously used in an awareness-related study conducted by Aletta et al. (2017). The non-significant results indicate that the noise sensitivity levels of the participants were not affected. Hence, the awareness levels of the participants might not have improved.

Table 12: Short-term results for the 'Noise Sensitivity Scale'

	Control Group *Mdn*	Experimental Group *Mdn*	*U*	*z*	*p*	*r*
Q1. I am sensitive to noise.	5	4	121,50	-0,95	,352	-0,16
Q2. I find it hard to relax in a place that's noisy.	6	5	104,00	-1,63	,107	-0,27
Q3. I get mad at people who make noises that keeps me from falling asleep or getting work done.	5	5	134,50	-0,52	,612	-0,09
Q4. I get annoyed when my neighbors are noisy.	5	5	141,00	-0,29	,783	-0,05
Q5. I get used to most noises without much difficulty (answers reversed)	5	3	95,00	-1,84	,068	-0,31

Results were also descriptively analyzed through the mean scores. Descriptive analyses were conducted comparatively for the median scores of the control group and the experimental group (Figure 19). It was found that the control group had higher median scores for questions Q1, Q2, and Q5, and the median scores were the same for questions Q3 and Q4. The higher scores obtained from the control group may indicate that they had a higher noise-sensitivity level.

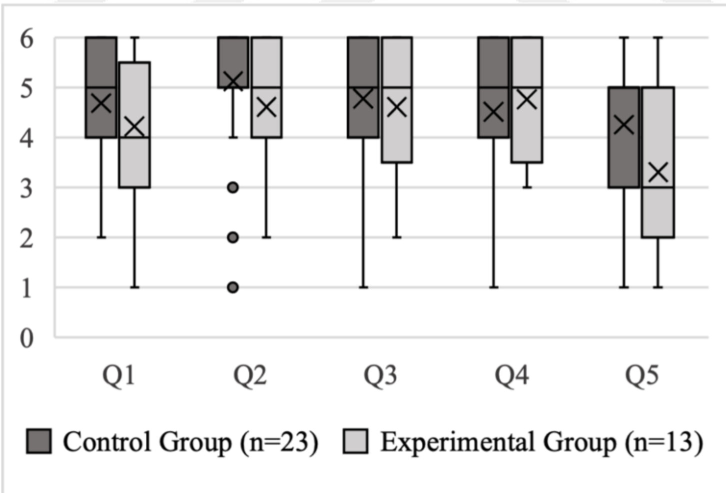

Figure 19: Short-term median score graph for the 'Noise Sensitivity Scale' section

In the study of Aletta et al. (2018) the *NSS-SF* was evaluated through a k-means cluster analysis, creating three clusters, and interpreted them as three levels of noise sensitivity. Similarly, in the current study, a *k*-means cluster analysis was conducted on the data. The first attempt was to force the data into three clusters; however, the results were not meaningful. Therefore, two clusters were formed instead and were interpreted as 'high noise sensitivity' and 'low noise sensitivity'. Figure 20 presents the *k*-means cluster graphs. The analysis revealed that, in control group 73,9% of the participants and in the experimental group 69,2% of the participants had 'high noise sensitivity'.

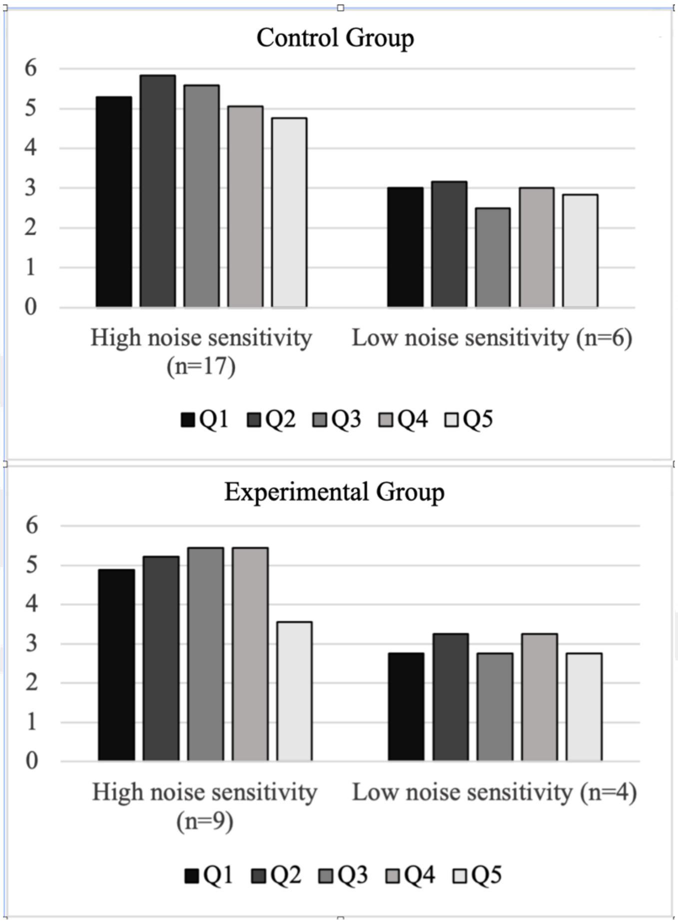

Figure 20: Short-term *k*-means cluster analysis graphs for the control group and the experimental group

Long-term Effects on Noise Sensitivity Level

The subsection had high reliability for both the control group (Cronbach's α = .80) and the experimental group (Cronbach's α = .75). Shapiro-Wilk test revealed that the data were non-normally distributed except for the following items in the experimental group: Q3, p=.102; Q4, p=.181; Q5, p=.097. Table presents the Mann-Whitney *U* test results, median values, and the effect size. A statistically significant result was obtained from Q2 (Control group Mdn=5,5; Experimental group Mdn=5), U=66.00, z=-2.19, p=.031, r=-.38. The control group gave a half-point higher score to the question ‘I find it hard to relax in a place that’s noisy’. The fewness of significant results may indicate that the noise sensitivity levels of the participants were not affected by the workshops.

Table 13: Long-term results for the ‘Noise Sensitivity Scale’ section

	Control Group *Mdn*	**Experimental Group *Mdn***	***U***	***z***	***p***	***r***
Q1. I am sensitive to noise.	5	4	84,50	-1,45	,162	-0,25
Q2. I find it hard to relax in a place that’s noisy.	5,5	5	66,00	-2,19	**,031**	-0,38
Q3. I get mad at people who make noises that keeps me from falling asleep or getting work done.	5,5	4	96,00	-1,01	,317	-0,18
Q4. I get annoyed when my neighbors are noisy.	5	4	79,50	-1,47	,145	-0,26
Q5. I get used to most noises without much difficulty (answers reversed)	4,5	4	90,00	-1,22	,230	-0,21

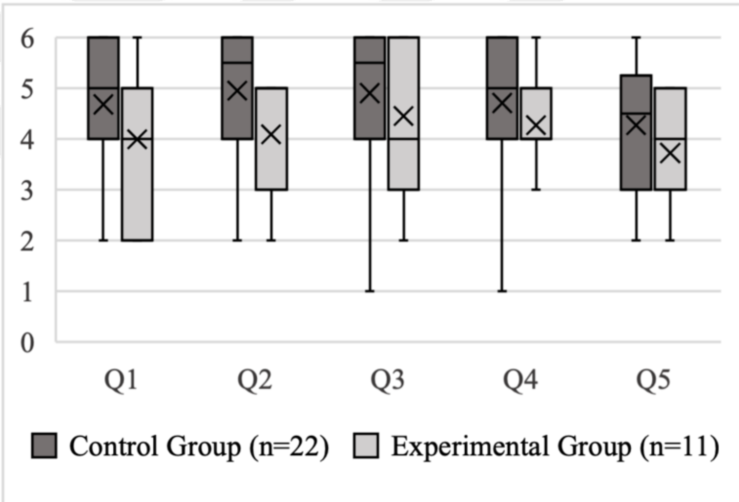

Figure 21: Long-term median score graph for the ‘Noise Sensitivity Scale’ section

Results were also descriptively analyzed through the mean scores. Descriptive analyses were conducted comparatively for the median scores of the control group and the experimental group (Figure 21). It was found that the control group rated all questions higher than the experiment group. Thus, similar to the short-term results, it can be mentioned that the control group had higher noise sensitivity levels.Similar to the short-term results, the attempt to form three clusters through the *k*-means cluster analysis resulted in unmeaningful groups. Therefore, two clusters were formed and were interpreted as ‘high noise sensitivity’ and ‘low noise sensitivity’. Figure 22 presents the *k*-means cluster graphs. The analysis revealed that, in the control group 85,7% of the participants and in the experimental group 63,6% of the participants had 'high noise sensitivity'.

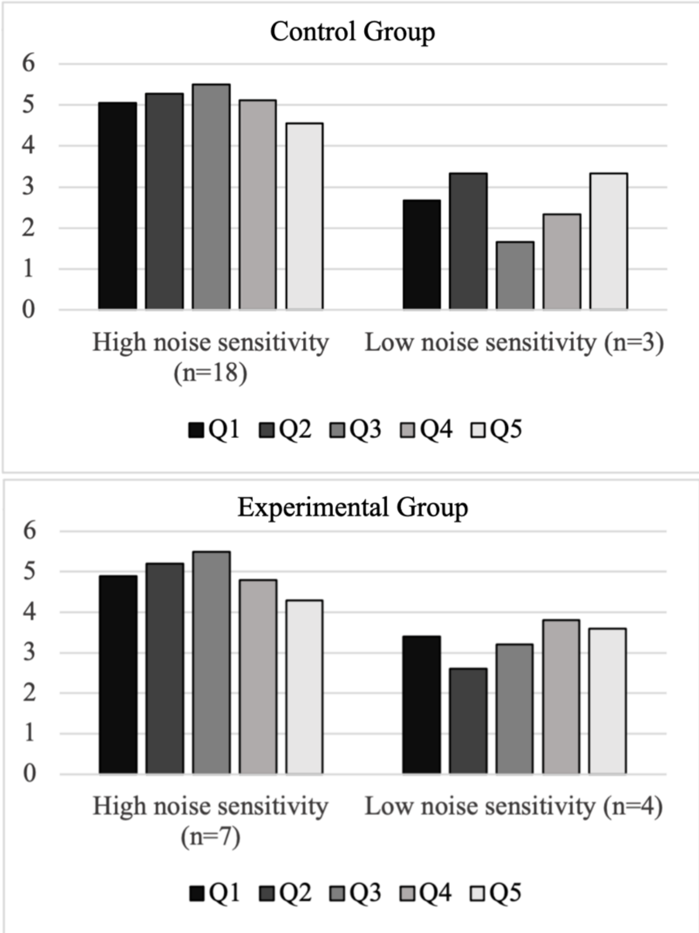

Figure 22: Long-term *k*-means cluster analysis graphs for the control group and the experimental group

Overall Outcomes on Noise Sensitivity Level

The k-means cluster analysis indicated that, both in the short-term and the long-term, a greater number of participants in the control group were in the 'high noise sensitivity level' cluster. Moreover, the non-significant results obtained from the section indicate that the noise sensitivity levels of the participants, thus their awareness levels, may not have improved. These results may be interpreted as workshops did not influence the awareness levels of the participants. Furthermore, as a limitation, may be due to the sample size and the population of the study. It should also be noted that noise sensitivity level is a personality trait (Worthington 2017). Hence, it may not be related to awareness.

4.2. THE EFFECTS OF THE WORKSHOP MODULES ON IMPORTANCE RATINGS OF ACOUSTICAL CONCEPTS IN VARYING BUILDING TYPES

The 'Importance rating of acoustical concepts in various building types' subsection consisted of 14 questions on a five-point Likert scale. The answers were coded as follows: 1=Not important; 2=Slightly important; 3=Moderately important; 4=Important; 5=Very important.

Short-term Effects on Importance Ratings

The subsection had high reliability for the control group (Cronbach's α = .89); however, it was not reliable for the experimental group (Cronbach's α = .57). Shapiro-Wilk test revealed that the data were non-normally distributed except for the following items in the experimental group: Q7, p=.174; Q11, p=.089. The building type, primary function of acoustic/primary function not acoustic classification, noise sensitivity level, and the noise level of the given building types, based on Çevre ve Şehicilik Bakanlığı (2017) and the study of Dokmeci and Kang (2010a), are presented in Table , based on which the results were evaluated.

The Mann-Whitney *U* test results are presented in Table . Significant differences were found in the items religious buildings, commercial buildings, recreational buildings, and industrial buildings, which all tend to have lower scores for the experimental group compared to the control group.

As explained in Section 3.7.2., 'Regulation on the Protection of Buildings Against Noise' was included in the scope of 'Building Acoustics Workshop'. All the statistically significant items, except for religious buildings, are defined as buildings that are not sensitive to noise. This may be the main reason why acoustical concepts were rated less important in these items by the experimental group compared to the control group.

Table 14: Classification of the building types in the 'Importance Ratings of Acoustical Concepts in Varying Building Types' section (Çevre ve Şehircilik Bakanlığı 2017; Dokmeci and Kang 2010a)

	Building Type	**Primary function**	**Noise Sensitivity**	**Noise Level**
Q1.Governmental buildings	Civil	Not acoustics	Not sensitive	Medium noise level
Q2.Service buildings	Public	Not acoustics	Not sensitive	Medium noise level
Q3.Educational buildings	Public	Not acoustics	Sensitive	Medium noise level
Q4.Health buildings	Public	Not acoustics	Very sensitive	Medium noise level
Q5.Cultural buildings	Public	Not acoustics	Very sensitive	Medium noise level
Q6.Religious buildings	Public	Not acoustics	Sensitive	High noise level
Q7.Commercial buildings	Commercial	Not acoustics	Not sensitive	Medium noise level
Q8.Recreational buildings	Commercial	Not acoustics	Not sensitive	High noise level
Q9.Performance buildings	Public	Acoustics	Not sensitive	High noise level
Q10.Eating spaces	Commercial	Not acoustics	Not sensitive	High noise level
Q11.Industrial buildings	Commercial	Not acoustics	Not sensitive	High noise level
Q12.Office buildings	Commercial	Not acoustics	Not sensitive	Medium noise level
Q13.Dwellings	Private	Not acoustics	Very sensitive	Medium noise level
Q14.Short-term accommodation buildings	Private	Not acoustics	Sensitive	Medium noise level

Table 15: Short-term results for the 'Importance Ratings of Acoustical Concepts in Varying Building Types' section

	Control Group *Mdn*	**Experimental Group *Mdn***	***U***	***z***	***p***	***r***
Q1. Governmental Buildings	4	4	139,00	-,38	,689	-0,06
Q2. Service Buildings	4	4	104,00	-1,58	,121	-0,26
Q3. Educational Buildings	5	5	129,50	-,84	,440	-0,14
Q4. Health Buildings	5	5	130,50	-,78	,527	-0,13
Q5. Cultural Buildings	5	5	130,50	-,75	,477	-0,12
Q6. Religious Buildings	5	4	74,00	-2,85	**,005**	-0,48
Q7. Commercial Buildings	4	2	71,50	-2,65	**,006**	-0,44
Q8. Recreational Buildings	5	4	75,00	-2,68	**,010**	-0,45
Q9. Performance Buildings	5	5	137,00	-,68	,634	-0,11
Q10. Eating Spaces	4	4	127,50	-,80	,462	-0,13
Q11. Industrial Buildings	5	3	70,00	-2,72	**,006**	-0,45
Q12. Office Buildings	4	4	113,50	-1,31	,210	-0,22
Q13. Dwellings	4	4	142,00	-,27	,840	-0,04
Q14. Short-term accommodation	5	4	118,00	-1,16	,288	-0,19

The results were also descriptively analyzed based on the median scores of the groups (Figure 23). It was observed that the control group rated acoustics as either important (4) or very important (5) in all building types. However, the ratings of the experimental group were more in line with the noise sensitivity levels and noise levels of the building types. Therefore, it can be assumed that the workshops affected the awareness of the control group in that manner. The item 'Performance Buildings' were rated very important (5) by both groups, as it was the only space with the primary function of acoustics in the list. Commercial Buildings, classified as not sensitive to noise, had the lowest score from the experimental group (2=Slightly important), followed by Industrial buildings, which are also classified as not sensitive to noise (3=Moderately Important).

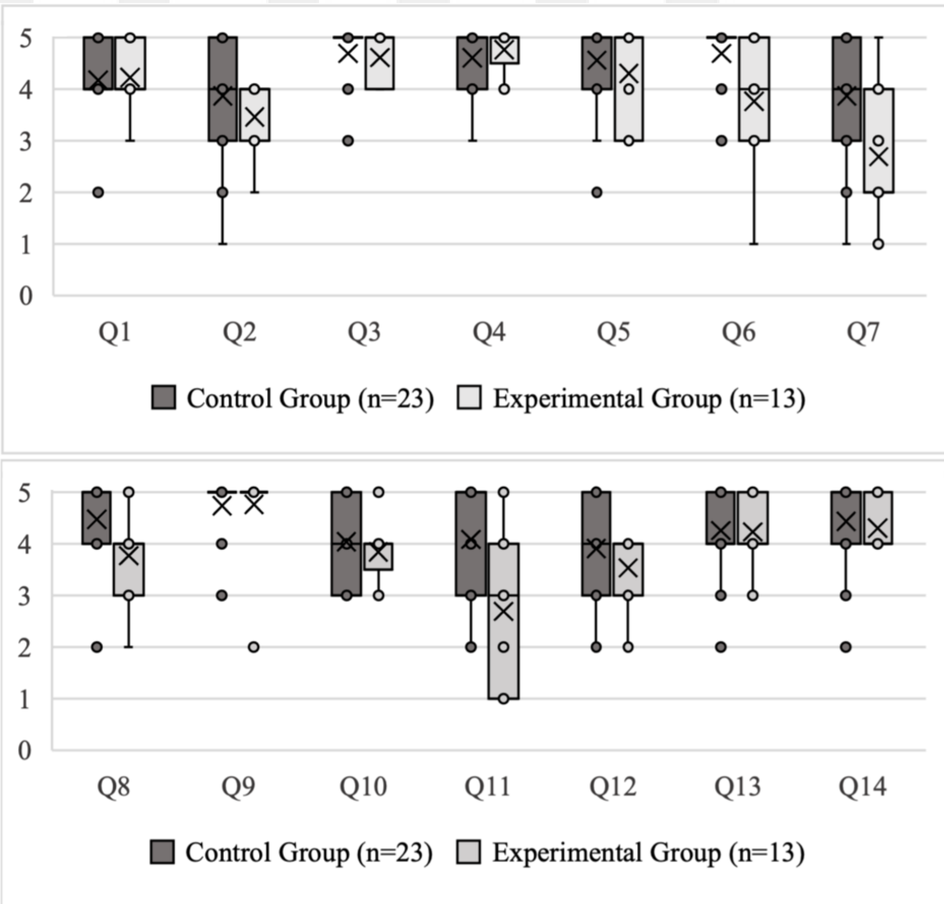

Figure 23: Short-term median score graph for the 'Importance Ratings of Acoustical Concepts in Varying Building Types' section

Long-term Effects on Importance Ratings

The subsection had high reliability for the control group (Cronbach's α = .88); however, it was not reliable for the experimental group (Cronbach's α = .64). Shapiro-Wilk test revealed that the data were non-normally distributed except for the following items in the experimental group: Q8, p=.149; Q11, p=.067. The Mann-Whitney *U* test results are presented in Table . Significant results were obtained from items 'religious buildings', 'commercial buildings', 'recreational buildings', and 'industrial buildings'. However, all significant items had identical scores from both the control group and the experimental group, except for 'commercial buildings', in which the control group had a higher median value. The reason why the experimental group rated the item lower may be due to commercial buildings not being sensitive to noise and having medium noise levels (Table).

Table 16: Long-term results for the 'Importance Ratings of Acoustical Concepts in Varying Building Types' section

	Control Group *Mdn*	Experimental Group *Mdn*	*U*	*z*	*p*	*r*
Q1. Governmental Buildings	4	4	112,00	-,37	,689	-,06
Q2. Service Buildings	4	4	67,50	-2,29	,121	-,40
Q3. Educational Buildings	5	4	82,00	-1,32	,440	-,23
Q4. Health Buildings	5	4	85,00	-1,64	,527	-,28
Q5. Cultural Buildings	5	5	108,00	-,70	,477	-,12
Q6. Religious Buildings	5	5	106,00	-,67	**,005**	-,12
Q7. Commercial Buildings	4	3	91,00	-1,20	**,006**	-,21
Q8. Recreational Buildings	4	4	103,50	-,70	**,010**	-,12
Q9. Performance Buildings	5	5	115,50	-,37	,634	-,06
Q10. Eating Spaces	4	3	63,00	-2,38	,462	-,41
Q11. Industrial Buildings	4	4	104,00	-,68	**,006**	-,12
Q12. Office Buildings	4	4	96,00	-1,04	,210	-,18
Q13. Dwellings	5	4	77,00	-1,84	,840	-,32
Q14. Short-term Accommodation Buildings	5	4	70,50	-2,07	,288	-,36

Results were also descriptively analyzed based on the median scores of the groups (Figure 24). The analysis indicates that, overall, the control group gave higher scores to six items: educational buildings, health buildings, commercial buildings, eating spaces, dwellings, and short-term accommodation buildings. Other than those, the result was the same for both groups. It was observed that the control group tended to rate acoustics as either important (4) or very important (5) in all building types, regardless of their noise sensitivity levels or noise levels. The item 'Performance Buildings' had high scores from both groups, as it is the only acoustic space in the list. Similar to the short-term results, it was observed that the experimental group tended to rate building types based on their noise sensitivity level, and noisiness level.

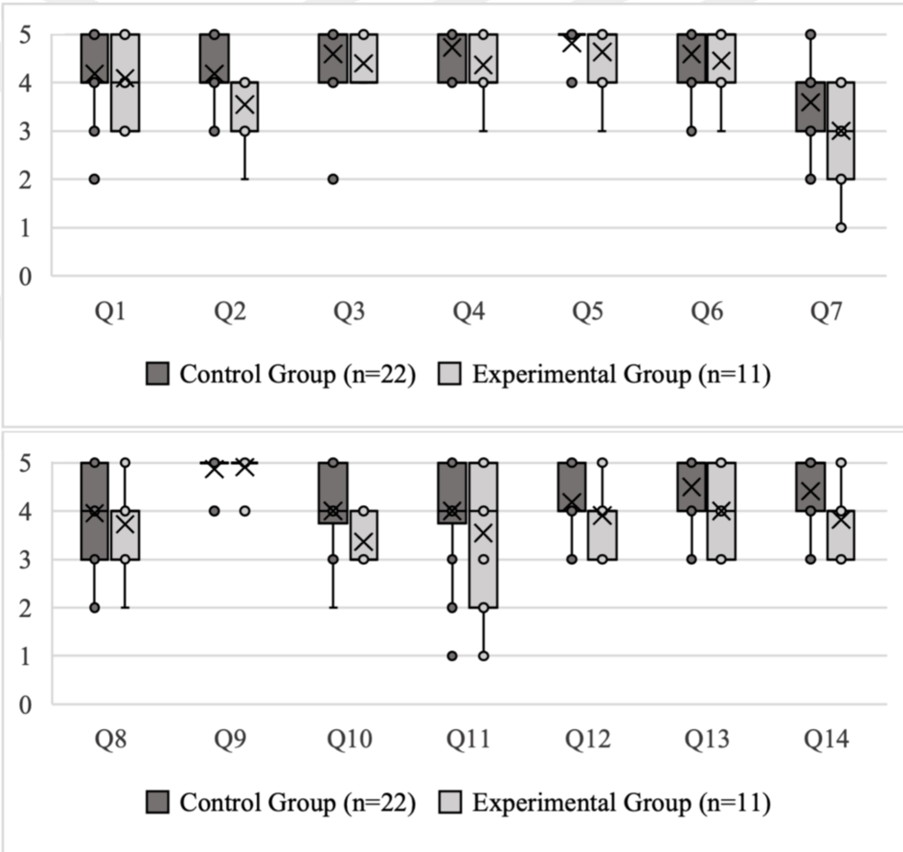

Figure 24: Long-term median score graph for the 'Importance Ratings of Acoustical Concepts in Varying Building Types' section

Overall Outcomes on Importance Ratings

The importance of acoustics in various building types section of the questionnaire was evaluated based on the building's properties indicated in the

‘Regulation on the Protection of Buildings Against Noise’, which was delivered in the scope of both the preliminary course and the workshop modules. For both the short-term and the long-term survey, the same items had significant results. However, in the short-term survey all the significant items had higher scores from the control group. On the other hand, in the long-term survey the significant items had identical scores from both groups expect for the item, ‘commercial buildings’, which was rated higher by the control group. The descriptive analysis indicated that both groups rated acoustics in performance buildings as very important since the building type has acoustics as the primary function. Additionally, both in the short-term and the long-term tests, the experimental group has not rated any item higher than the control group and it was observed that the control group tended to rate acoustics as important or very important for every item, regardless of their noise sensitivity and noisiness levels. When the regulations are considered, it can be observed that the ratings of the experimental group were more in line with the noise sensitivity and noisiness levels of the given building types, while the ratings of the control group did not indicate a pattern. Therefore, it can be assumed that the workshop modules may have had positive effects on the ratings of the importance of acoustics concepts in various building types, thus on the participants’ awareness levels on the subject.

4.3. THE EFFECTS OF THE WORKSHOP MODULES ON FAMILIARITY WITH ACOUSTICAL TERMINOLOGY

The familiarity with acoustical terminology section included 30 items, asking the participants to rate their familiarity with the given terms. It was on a four-point Likert scale, coded as follows: 1=I have never heard this term before; 2=I have heard the term; 3=I know what this term is; 4=I can explain what this term is.

Short-term Effects on Familiarity

The ‘Familiarity with Acoustical Terminology’ subsection had high reliability for both the control group (Cronbach’s α = .95) and the experimental group (Cronbach’s α = .96). Shapiro-Wilk test revealed that the data were non-normally distributed except for the following items in the experimental group: Q11, p=.064; Q23, p=.165; Q25, p=.079. Mann-Whitney *U* test results are given in Table . The results show no significant differences between the control group and the experimental group.

Table 17: Short-term results for the 'Familiarity with the Terminology' section

	Control Group *Mdn*	Experimental Group *Mdn*	*U*	*z*	*p*	*r*
Q1. Vibration	3	4	111,00	-1,36	,184	-0,23
Q2. Sound Wave	3	4	117,50	-1,19	,274	-0,20
Q3. Audio Frequency	3	4	115,00	-1,27	,219	-0,21
Q4. Octave	3	3	133,00	-0,62	,568	-0,10
Q5. Hertz	3	3	116,00	-1,36	,207	-0,23
Q6. Tone	3	3	146,50	-0,12	,943	-0,02
Q7. Intensity	3	3	122,50	-1,04	,339	-0,17
Q8. Sound Pressure Level	3	3	133,00	-0,36	,701	-0,06
Q9. Decibel	3	3	128,50	-0,77	,499	-0,13
Q10. Hearing Curve	3	3	140,00	-0,34	,792	-0,06
Q11. Absorption	3	3	123,50	-0,91	,376	-0,15
Q12. Transmission	3	2	140,00	-0,32	,781	-0,05
Q13. Reflection	3	3	114,00	-1,23	,236	-0,20
Q14. Refraction	4	3	125,50	-0,47	,647	-0,08
Q15. Diffraction	3	3	135,50	-0,57	,715	-0,09
Q16. Resonance	3	4	126,50	-0,87	,442	-0,14
Q17. Diffusion	3	3	115,50	-0,99	,335	-0,17
Q18. Anechoic Chamber	3	3	88,00	-1,87	,073	-0,32
Q19. Reverberation	3	4	110,50	-1,40	,201	-0,23
Q20. Echo	3	4	102,00	-1,63	,116	-0,27
Q21. Sound Propagation	3	4	116,00	-1,19	,270	-0,20
Q22. Airborne Sound	4	4	139,50	-0,14	,914	-0,02
Q23. Structure-borne Sound	3	3	132,50	-0,59	,588	-0,10
Q24. Impact sound	4	4	143,50	-0,24	1,000	-0,04
Q25. Noise	3	3	132,00	-0,62	,578	-0,10
Q26. Sound Masking	3	3	145,50	-0,14	,892	-0,02
Q27. Auditory Perception	4	4	143,00	0,00	1,000	0,00
Q28. Acoustic Comfort	4	4	127,00	-0,85	,435	-0,14
Q29. Noise Annoyance	4	4	123,00	-0,98	,372	-0,16
Q30. Noise Regulation	3	3	132,50	-0,60	,531	-0,10

The data were also descriptively analyzed. The median score graph is given in Figure 25. While the experimental group gave higher scores to the items vibration, sound wave, audio frequency, resonance, reverberation, echo, and sound propagation, they rated the transmission and refraction terms lower compared to the control group. The lowest score, 2 (I have heard this term), was given to the item 'transmission', by the experimental group. The mentioned terms, except for sound propagation and transmission, were not the main subjects of the workshop modules; however, they were mentioned as part of other subjects. Therefore, it can be assumed that the workshops had a positive effect on the terminology knowledge of the participants. However, the results indicate that the topics related to 'sound transmission' should be further discussed in the workshop modules.

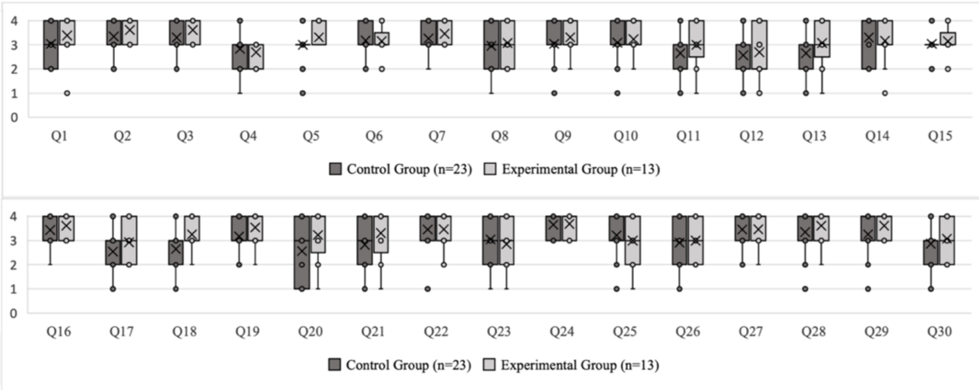

Figure 25: Short-term median score graph for the 'Familiarity with the Acoustical Terminology' section

The familiarity levels for the rest of the terminology were the same for the control group and the experimental group. Terms such as airborne sound, impact sound, auditory perception, acoustic comfort, and noise annoyance were rated as 4 (I can explain what this term is) by both groups. Since these terms were rated high by both groups, the participants' knowledge of the terms may not be the outcome of the workshop modules.

In a similar study, Meric and Caliskan (2013), found that undergraduate students rated the terms: Airborne sound and structure-borne sound as 1 (I have never heard this term before), and terms: Frequency, sound pressure level, absorption, reverberation, echo, and noise regulation as 2 (I have heard the term). Unlike their study, the control group in the current study rated those terms 3 (I know what this term is) except for the item airborne sound, which was rated 4 (I can explain what this term is). The experimental group on the other hand, rated four of the terms 3 and the rest as 4 (I can explain what this term is).

Long-term Effects on Familiarity

The 'Familiarity with Acoustical Terminology' subsection had high reliability for both the control group (Cronbach's α = .95) and the experimental group

(Cronbach's α = .97). Shapiro-Wilk test revealed that the data were non-normally distributed. Mann-Whitney U test results are given in Table . Only two items had significant results, 'anechoic chamber' and 'reverberation', indicating that the experimental group were more knowledgeable about the terms. Although the mentioned terms were not the main subjects of the workshops, they were mentioned within the other subjects. Therefore, it may be assumed that the workshop modules had a positive effect on the knowledge levels of the participants.

Table 18: Long-term results for the 'Familiarity with the Terminology' section

	Control Group *Mdn*	**Experimental Group *Mdn***	***U***	***z***	***p***	***r***
Q1. Vibration	3	3	109,00	-0,50	,618	-0,09
Q2. Sound Wave	3	3	112,00	-0,38	,756	-0,07
Q3. Audio Frequency	3	3	112,50	-0,13	,946	-0,02
Q4. Octave	3	3	108,50	-0,31	,779	-0,06
Q5. Hertz	3	3	109,50	-0,27	,863	-0,05
Q6. Tone	3	3	113,50	-0,33	,741	-0,06
Q7. Intensity	3	3	109,50	-0,49	,736	-0,09
Q8. Sound Pressure Level	3	4	79,00	-1,55	,115	-0,27
Q9. Decibel	3	4	89,50	-1,35	,230	-0,24
Q10. Hearing Curve	3	4	95,50	-1,08	,309	-0,19
Q11. Absorption	3	3	114,50	-0,27	,823	-0,05
Q12. Transmission	3	3	72,50	-1,84	,077	-0,33
Q13. Reflection	3	3	82,50	-1,59	,109	-0,28
Q14. Refraction	3	3	111,50	-0,38	,701	-0,07
Q15. Diffraction	3	3	115,50	-0,23	,889	-0,04
Q16. Resonance	3,5	4	113,00	-0,35	,913	-0,06
Q17. Diffusion	3	4	83,50	-1,53	,132	-0,27
Q18. Anechoic Chamber	3	4	67,00	-2,33	**,024**	-0,41
Q19. Reverberation	3	4	65,50	-2,33	**,027**	-0,41
Q20. Echo	3	3	74,00	-1,88	,061	-0,33
Q21. Sound Propagation	3	3	99,00	-0,89	,386	-0,15
Q22. Airborne Sound	3	4	83,50	-1,57	,131	-0,27
Q23. Structure-borne Sound	3	3	98,50	-0,92	,404	-0,16
Q24. Impact sound	3,5	4	96,50	-1,05	,338	-0,18
Q25. Noise	3	4	94,50	-1,11	,297	-0,19
Q26. Sound Masking	3	3	100,50	-0,83	,428	-0,15
Q27. Auditory Perception	3	3	94,50	-0,93	,405	-0,16
Q28. Acoustic Comfort	3	3	117,00	-0,17	,930	-0,03
Q29. Noise Annoyance	3	4	96,50	-1,03	,356	-0,18
Q30. Noise Regulation	3	3	80,00	-1,68	,096	-0,29

The data were also descriptively analyzed. The median score graph is given in Figure 26. The experimental group gave higher scores to the items: sound pressure level, decibel, hearing curve, resonance, diffusion, anechoic chamber, reverberation, airborne sound, impact sound, noise, and noise annoyance. The terms sound pressure level, decibel, hearing curve, airborne sound, and impact sound were some of the main topics in the ‘Building Acoustics’ workshop and the terms noise, and noise annoyance were the main subjects in both workshops. While the rest were not the main topics, they were discussed within the scope of other subjects in the workshop modules. Therefore, it can be assumed that the workshops increased the knowledge levels of the participants. The familiarity levels for the rest of the terminology were the same for the control group and the experimental group. Both groups rated the terms at least 3 (I know what this term is). The knowledge on these terms may not be a result of the workshop modules.

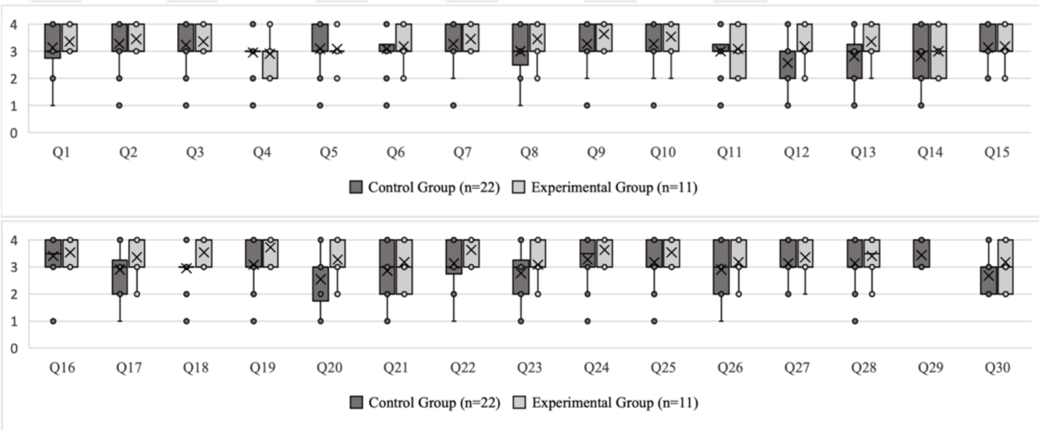

Figure 26: Long-term median score graph for the ‘Familiarity with the Acoustical Terminology’ section

As mentioned before, Meric and Caliskan (2013) found that undergraduate students rated the terms Airborne sound and structure-borne sound as 1 (I have never heard this term before), and terms Frequency, sound pressure level, absorption, reverberation, echo, and noise regulation as 2 (I have heard the term). Unlike the results they have obtained, the control group in the current study rated those terms 3 (I know what this term is). The experimental group, on the other hand, rated five of the terms 3, and the rest as 4 (I can explain what this term is).

Overall Outcomes on Familiarity

The familiarity with the acoustical terminology section was evaluated as an indicator of terminology knowledge. In a similar study by Meric and Caliskan (2013), it was found that undergraduate students rated the terms airborne sound, structure-borne sound, frequency, sound pressure level, absorption, reverberation, echo, and noise regulation the lowest, indicating that the participants at most have heard this term before but they are not sure what it is. On the contrary, in the current study, both the control group and the experimental group rated those terms higher, indicating that they at least know what that term is. Within the mentioned terms, airborne sound, structure-borne sound, sound pressure level and noise regulation items were the main topics of the 'Building Acoustics Workshop'. Nevertheless, the rest of the terms were mentioned within the workshops as part of other subjects and were previously explained in the 'Architectural Acoustics' course.

Additionally, while the short-term test results did not show any statistical significance, two items ('anechoic chamber' and 'reverberation') were statistically significant for the long-term test results, both receiving higher ratings from the experimental group. These terms were both discussed within the scope of the workshops. In the short-term test, the control group gave higher ratings to two of the items ('transmission' and 'refraction'), and the experimental group to the seven of the items (vibration, sound wave, audio frequency, resonance, reverberation, echo, and sound propagation). In the long-term test the control group did not give higher scores to any of the items, and the experiment group rated eleven items higher (sound pressure level, decibel, hearing curve, resonance, diffusion, anechoic chamber, reverberation, airborne sound, impact sound, noise, and noise annoyance). All the mentioned terms were discussed within the scope of the workshop modules and an improvement in the long-term knowledge ratings of the workshop participants were observed. Therefore, it can be mentioned that the participants have internalized the subjects within time. Furthermore, these results may be interpreted as, the workshop modules have contributed to the terminology knowledge of the participants. On the other hand, it was found that it is necessary to improve the content of the workshop on 'sound transmission' and 'refraction'.

4.4. THE EFFECTS OF THE WORKSHOP MODULES ON THE APPLICATION OF ACOUSTICAL CONCEPTS IN DESIGN STUDIO PROJECTS

The application of acoustical concepts in the design studio projects section included 25 items. It was on a six-point Likert scale, coded as follows: 1=Disagree very strongly; 2=Disagree strongly; 3=Disagree; 4=Agree; 5=Agree strongly; 6=Agree very strongly.

Short-term Effects on Application

The subsection had high reliability for both the control group (Cronbach's α = .96) and the experimental group (Cronbach's α = .95). Shapiro-Wilk test revealed that some of the data were normally distributed (Table). Mann-Whitney *U* test results are given in Table . The results show no significant differences between the control group and the experimental group.

Table 19: Short-term Shapiro-Wilk test results for the 'Application of Acoustical Concepts in Design Studio Projects' section

Non-normally distributed		
Item	Control *p*	Experimental *p*
Q1	,023	,001
Q2	,000	,000
Q3	,010	-
Q7	,029	-
Q12	,015	,015
Q13	,031	,071
Q15	-	,031
Q18	,041	-
Q20	,032	,001
Q21	-	,018
Q22	-	,003
Q23	-	,047
Q24	,027	-
Q25	-	,000

Normally distributed		
Item	Control *p*	Experimental *p*
Q3	-	,054
Q4	,110	,256
Q5	,129	,321
Q6	,137	,084
Q7	-	,050
Q8	,192	,175
Q9	,201	,057
Q10	,104	,256
Q11	,149	,093
Q14	,058	,182
Q15	,278	-
Q16	,175	,163
Q17	,146	,246
Q18	-	,735
Q19	,052	,162
Q21	,135	-
Q22	,129	-
Q23	,086	-
Q24	-	,054
Q25	,060	-

Table 20: Short-term results for the 'Application of Acoustical Concepts in Design Studio Projects' section

	Control Group *Mdn*	**Experimental Group *Mdn***	***U***	***z***	***p***	***r***
Q1. I have categorized spaces as primary function acoustics/not acoustics	4	4	124,50	-,65	,522	-0,11
Q2. I think the auditory environment of spaces is important	6	5	137,50	-,21	,832	-0,03
Q3. I have designed the auditory environment of the spaces	4	5	117,50	-,90	,382	-0,15
Q4. I have classified the sounds that may occur in the spaces as foreground/ background sounds.	4	4	141,50	-,05	,971	-0,01
Q5. I have classified the sounds that may occur in spaces as mechanical, natural, technological, etc.	3	4	122,00	-,74	,476	-0,12
Q6. I have set acoustical targets when designing the spaces	3,5	4	122,50	-,72	,483	-0,12
Q7. I have considered neighborhood relations from an acoustic point of view	5	4	127,00	-,56	,584	-0,09
Q8. I have classified the noise transmission between spaces as airborne/structure borne	4	4	134,00	-,31	,761	-0,05
Q9. I have applied sound insulation between spaces	4	4	123,50	-,31	,768	-0,05
Q10. I have considered the sound transmission coefficient of the materials in the separations between the spaces	3	4	118,00	-,87	,391	-0,15
Q11. I have considered the noise transmission in the structural elements of the separations between the spaces	4	4	119,00	-,65	,537	-0,11
Q12. I have considered the sound transmission needs of the spaces according to their functions	5	5	132,00	-,17	,903	-0,03
Q13. I have taken necessary measures, considering the sound transmission paths	4	4	131,00	-,42	,695	-0,07
Q14. I have identified the airborne sound transmission paths in my design	3	4	118,50	-,85	,403	-0,14
Q15. I have taken precautions against airborne sound transmission in my design	4	4	114,50	-,36	,729	-0,06
Q16. I have taken precautions against sound transmission on the walls	4	3	133,00	-,35	,736	-0,06
Q17. I have taken precautions against sound leaks	3	4	113,50	-1,05	,300	-0,18
Q18. I have identified the structure-borne sound transmission paths in my design	3	4	114,50	-1,00	,326	-0,17

Table 20 Continued

Q19. I have taken precautions against structure-borne sound transmission in my design	4	4,5	96,00	-1,33	,210	-0,23
Q20. I have taken precautions against sound transmission on the floors	5	6	113,00	-1,09	,298	-0,18
Q21. I have taken precautions against sound transmission on the ceilings	3	3	123,50	-,47	,652	-0,08
Q22. I have taken precautions against the noise that can be transmitted through openings such as windows and doors	3,5	3	119,50	-,82	,418	-0,14
Q23. I have taken precautions against sound transmission through planning	5	5	127,50	-,55	,582	-0,09
Q24. I have created buffer zones against sound transmission between spaces.	5	4	100,50	-1,32	,195	-0,23
Q25. I have referred to the acoustic regulation during the design process	4	4	126,00	-,59	,571	-0,10

The data were also descriptively analyzed. The median score graph is given in Figure 27. While the experimental group gave higher scores to the items: Q3, Q5, Q6, Q10, Q14, Q17, Q18, Q19, and Q20, they gave lower scores to the items: Q2, Q7, Q16, Q22, and Q24 compared to the control group. The ratings for the rest of the items were the same for the control group and the experimental group. The items Q2, Q3, Q5, and Q6 were discussed in detail in the 'Soundscape Workshop'. Since the experimental group rated three of these items higher, it can be mentioned that the 'Soundscape Workshop' had a positive effect on the participants. However, it should also be noted that the item Q2 was rated lower by the experiment group; therefore, it might be necessary to create an awareness on the importance of the auditory environment of spaces. The rest of the mentioned items were the main topics of the 'Building Acoustics Workshop'. The results indicate that the participants of the experiment group have considered the sound transmission coefficient of the materials, airborne and structure-borne transmission, sound leaks, and sound transmission through floors more in their design projects compared to the control group. However, it was also found that transmission through walls and openings, and usage of buffer zones during planning phase were rated lower. Therefore, the content of the workshops needs improvements on the subjects.

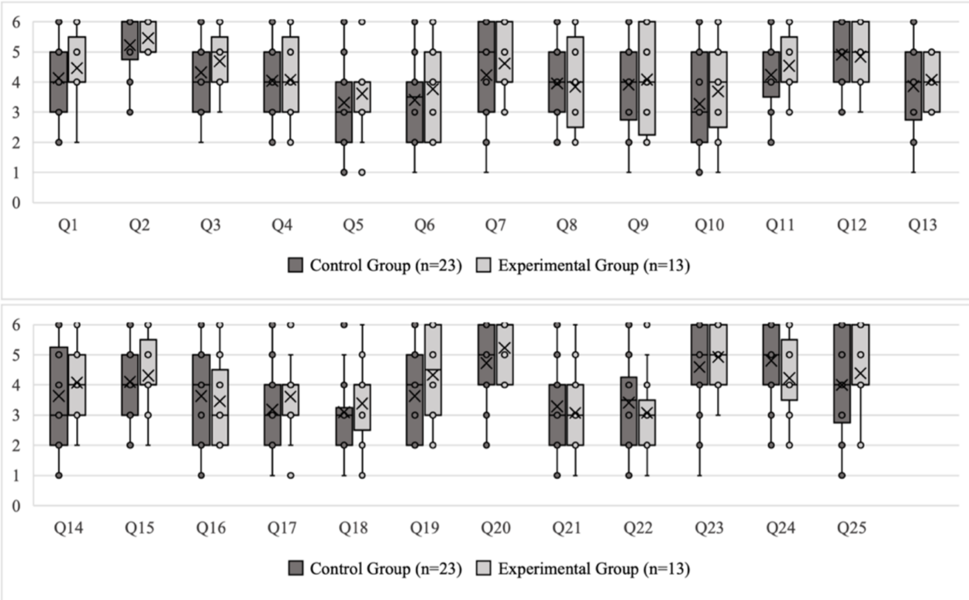

Figure 27: Short-term median score graph for the ‘Application of Acoustical Concepts in Design Studio Projects’ section

Long-term Effects on Application

The subsection had high reliability for both the control group (Cronbach’s α = .93) and the experimental group (Cronbach’s α = .98). Shapiro-Wilk test revealed that some of the data were normally distributed (Table). Mann-Whitney *U* test results are given in Table . The results show no significant differences between the control group and the experimental group.

Table 21: Long-term Shapiro-Wilk test results for the ‘Application of Acoustical Concepts in Design Studio Projects’ section

Non-normally distributed			Normally distributed		
Item	Control *p*	Experimental *p*	Item	Control *p*	Experimental *p*
Q1	,016	-	Q1	-	,575
Q2	,002	,000	Q3	-	,157
Q3	,006	-	Q4	,184	-
Q4	-	,004	Q5	,120	,089
Q7	,043	-	Q6	,231	,089
Q12	,021	-	Q7	-	,359
Q20	,012	,028	Q8	,138	,156
Q21	-	,047	Q9	,060	,073
Q22	,026	-	Q10	,453	,138
Q24	,024	-	Q11	,110	,067
Q25	-	,011	Q12	-	,108
			Q13	,265	,410
			Q14	,220	,067
			Q15	,062	,151

Table 21 Continued

Q16	,065	,341
Q17	,187	,158
Q18	,323	,145
Q19	,257	,157
Q21	,143	-
Q22	-	,268
Q23	,108	,074
Q24	-	,268
Q25	,139	-

Table 22: Long-term results for the 'Application of Acoustical Concepts in Design Studio Projects' section

	Control Group *Mdn*	Experimental Group *Mdn*	*U*	*z*	*p*	*r*
Q1. I have categorized spaces as primary function acoustics/not acoustics	5	4	81,50	-1,40	,176	5,66
Q2. I think the auditory environment of spaces is important	5	5	103,00	-0,54	,611	5,66
Q3. I have designed the auditory environment of the spaces	4	4	114,50	-0,04	,965	5,66
Q4. I have classified the sounds that may occur in the spaces as foreground/ background sounds.	4	5	84,50	-1,27	,211	5,66
Q5. I have classified the sounds that may occur in spaces as mechanical, natural, technological, etc.	4	4	112,00	-0,14	,895	5,66
Q6. I have set acoustical targets when designing the spaces	4	4	108,50	-0,29	,789	5,66
Q7. I have considered neighborhood relations from an acoustic point of view	4,5	4	96,50	-0,57	,585	5,57
Q8. I have classified the noise transmission between spaces as airborne/structure borne	4	4	100,00	-0,63	,534	5,66
Q9. I have applied sound insulation between spaces	4	4	115,00	-0,02	,999	5,66
Q10. I have considered the sound transmission coefficient of the materials in the separations between the spaces	3	3	100,50	-0,41	,694	5,57
Q11. I have considered the noise transmission in the structural elements of the separations between the spaces	4	5	100,00	-0,64	,558	5,66
Q12. I have considered the sound transmission needs of the spaces according to their functions	5	5	112,50	-0,12	,897	5,66

Table 22 Continued

Q13. I have taken necessary measures, considering the sound transmission paths	4	4	100,50	-0,61	,567	5,66
Q14. I have identified the airborne sound transmission paths in my design	3	3	104,00	-0,04	,983	5,57
Q15. I have taken precautions against airborne sound transmission in my design	4	5	98,00	-0,71	,474	5,66
Q16. I have taken precautions against sound transmission on the walls	4	4	102,00	-0,55	,601	5,66
Q17. I have taken precautions against sound leaks	3	4	97,50	-0,73	,481	5,66
Q18. I have identified the structure-borne sound transmission paths in my design	4	4	98,50	-0,69	,506	5,66
Q19. I have taken precautions against structure-borne sound transmission in my design	4	4	92,50	-0,94	,353	5,66
Q20. I have taken precautions against sound transmission on the floors	5	5	100,00	-0,64	,552	5,66
Q21. I have taken precautions against sound transmission on the ceilings	4	4	98,50	-0,69	,508	5,66
Q22. I have taken precautions against the noise that can be transmitted through openings such as windows and doors	3	4	101,00	-0,59	,590	5,66
Q23. I have taken precautions against sound transmission through planning	5	5	87,00	-1,17	,258	5,66
Q24. I have created buffer zones against sound transmission between spaces.	5	4	115,50	0,00	1,000	5,66
Q25. I have referred to the acoustic regulation during the design process	4	5	88,00	-1,12	,276	5,66

The data were also descriptively analyzed. The median score graph is given in Figure 28. While the experimental group gave higher scores to the items: Q4, Q11, Q15, Q17, Q22, and Q25, they gave lower scores to the items: Q1, Q7, and Q24, compared to the control group. The ratings for the rest of the items were identical for the control group and the experimental group. The items Q1 and Q4 were in scope of the ‘Soundscape Workshop’ while the rest were discussed in the ‘Building Acoustics Workshop’. It was observed that while the experiment group rated the subjects related to transmission through the structural elements, airborne sound transmission, sound leaks, transmission through openings, and noise regulations higher, they rated the planning-related subjects lower. Therefore, the workshops may need improvements on the lower-rated subjects.

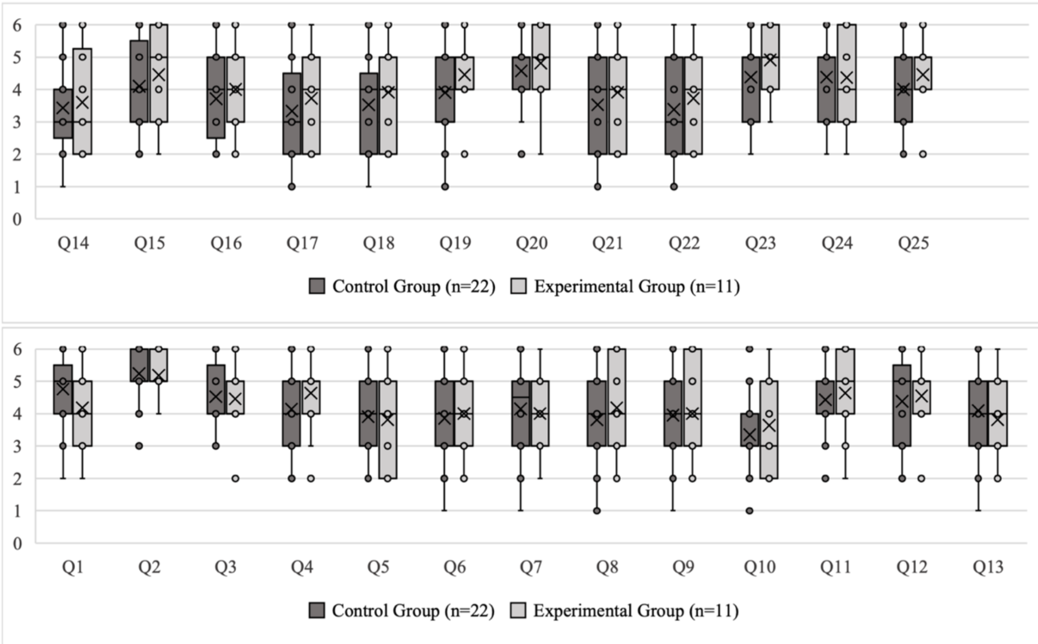

Figure 28: Long-term median score graph for the 'Application of Acoustical Concepts in Design Studio Projects' section

Overall Outcomes on Application

In the current survey section, no significant results were obtained from either the short-term test or the long-term test. This may be due to the structure of the survey questions, the sample size, or the population. On the other hand, the descriptive analysis has shown that the experimental group gave higher ratings to a greater number of items. Therefore, the results indicate that both the 'Soundscape Workshop' and the 'Building Acoustics Workshop' may have positively affected the experiment group's ratings for the application of the acoustics concepts in design studio projects. However, it should be noted that the workshop modules need improvements on the subjects that were rated lower by the experiment group such as, the importance of the auditory environment of spaces, transmission through planning, walls, and openings.

4.5. CHAPTER SUMMARY

In summary, the results indicate that the workshop modules did not affect the noise sensitivity levels; hence, the participants' awareness levels on the topic were not affected. However, the noise sensitivity level is a personality trait (Worthington 2017). Thus, it may not be related to awareness. On the other hand, it may be assumed that the workshop modules may have improved the participants' awareness levels of the importance of acoustics in various building types.

Another assumption is that the workshop modules may have positively affected the terminology knowledge of the participants. Nevertheless, it was found that the ratings of the experimental group have raised in the long-term results. Therefore, it can be mentioned that the participants further internalized the content of the workshops over time.

An interesting outcome of the study was that, while the experiment group rated the term 'sound transmission' lower in the terminology knowledge section, they rated a greater number of questions related with transmission higher in 'the application of acoustics concepts in design studio projects' section of the survey, compared to the control group. The higher ratings obtained by the experiment group in the same section indicate that the workshops may have positively affected the application of acoustics concepts in the design studio projects.

The overall results indicate that the workshop modules needed content improvements, and some subjects should be further discussed within, such as, refraction, the importance of the auditory environment of spaces, transmission through planning, walls, and openings. Additionally, a very low number of items in the study were significant. This may be due to the sample size, the population, or the structure of the survey questions.

To conclude, conducting acoustics workshops parallel to the design studio course may have positive effects on the students' acoustical awareness levels, acoustical knowledge, and application levels of acoustics in their design studio projects.

CHAPTER V
CONCLUSION

This chapter initially presents the summary of the results and the main findings of the study. Afterward, the impact of the research is illustrated. Finally, limitations are delivered, and suggestions are made for future studies.

The aim of the study was to investigate the effects of architectural acoustics workshops run parallel to the design studio course on students' noise sensitivity levels, ratings of the importance of acoustics concepts in building types, acoustical terminology knowledge, and application of acoustics concepts in design studio projects. The results of the study are summarized in Table .

Table 23: The summary of the findings

Section	Findings
Noise Sensitivity Scale (Short-term & Long Term)	• No statistically significant items were found • The control group showed higher noise sensitivity ratings • A greater number of participants in the control group showed high noise-sensitivity levels • The workshop modules may not have affected the awareness levels of the participants
Importance of Acoustics in Varying Building Types (Short-term & Long Term)	• Four statistically significant items were found • Higher ratings obtained from the control group • Ratings of the experimental group were more in line with the Turkish Noise Regulations • The workshop modules may have positively affected the ratings of the importance of acoustics concepts in various building types
Familiarity With Acoustical Knowledge (Short-term & Long Term)	• Two statistically significant items were found • The experimental group had a greater number of higher-rated items compared to the control group • The workshop modules may have contributed to the terminology knowledge of the participants
Application of Acoustics Concepts in Design Studio Projects (Short-term & Long Term)	• No statistically significant items were found • The experimental group had a greater number of higher-rated items compared to the control group • The workshop modules may have contributed to the application of acoustics concepts in design studio projects of the participants

Therefore, main findings of the effects of the acoustical workshop modules integrated to the design studio are as below:

- The noise sensitivity levels of the students were not affected; hence their awareness levels may not have improved.
- The ratings of the importance of acoustics concepts in building types might be affected, and the results were in line with the context of the workshop modules.
- The acoustical terminology knowledge of the students might be improved.
- The application of acoustics concepts in design studio projects may have increased.

The method tested in this study, which is integrating short, application-based acoustics workshop modules into the design studio process may have positive impacts on students' understanding of acoustics. Moreover, it may improve their ability to apply their acoustical knowledge in their design studio projects, hence, their future projects in their professional lives. Additionally, the method can be adapted to other subjects in spatial design-related disciplines. With the integration of workshops, design studios may become a beneficial educational setting for teaching students how to make use of their theoretical knowledge in real-life situations.

However, the study had some limitations. To begin with, the insignificant results might be caused by the relatively small sample size as a function of the population. Moreover, the study was conducted only in one University. More generalizable results could have been obtained if the study was conducted in wider educational setting. Furthermore, the method of the study or the structure of the questions may need improvements. The timing and duration of the workshops may be revised based on the operation and the workload of the studio course. Additionally, more effective results may be obtained if the workshop content is adapted to the theme of the studio project and related examples are given. It should also be noted that the students may not have given the best of their attention to the questionnaire or the workshop modules due to the stress caused by delays in the studio schedule. Moreover, the participants may have been more occupied with getting higher grades from the course, which may have led them to focus more on the requirements of the studio rather than acoustical aspects. Future research can be conducted with larger sample sizes, in various educational settings, and with other disciplines related to spatial design education and practice.

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APPENDICES

Appendix 1: İç Mimari Tasarımda Akustik Konusunun Ele Alınması Anketi

1

İç mimari tasarımda akustik konusunun ele alınması anketi

Bu anketin amacı, dönem içerisinde gerçekleştirilen çalıştayların öğrencilerin tasarım projelerinde akustik konusunu değerlendirmelerine olan etkisini gözlemlemektir. Anketteki bilgiler hiç bir şahıs , kurum ve kuruluşla paylaşılmayacaktır.

Ad Soyad: ____

TC kimlik numaranızın son 4 hanesi: ______________________________

Cinsiyetiniz: ☐ Kadın ☐ Erkek

Yaşınız: ____

Katıldığınız çalıştay/çalıştayları işaretleyiniz: ☐ İşitsel peyzaj çalıştayı

☐ Yapı akustiği çalıştayı

Lütfen aşağıda bulunan gürültü hassasiyeti ile ilgili ifadelere katılım oranınızı belirtiniz:

	Kesinlikle katılmıyorum	Katılmıyorum	Biraz katılmıyorum	Biraz katılıyorum	Katılıyorum	Tamamen katılıyorum
Gürültüye karşı çok hassasım						
Gürültülü bir yerde rahatlamak benim için zordur						
Uykuya dalmamı veya iş yapmamı engelleyecek şekilde gürültü yapan insanlara çok sinirlenirim						
Komşularımın gürültü yapması beni çok rahatsız eder						
Birçok gürültüye zorluk çekmeden alışırım						

Lütfen aşağıdaki yapı tiplerindeki akustik tasarımın önemini verilen kriterlere göre değerlendiriniz:

	Hiç önemli değil	Az önemli	Biraz önemli	Önemli	Çok önemli
İdari yapılar (meclis, bakanlıklar, belediyeler vb.)					
Hizmet yapıları (banka, posta ofisi vb.)					
Eğitim yapıları (kreş, okul, üniversite sınıfları vb.)					
Sağlık yapıları (hastane, klinik, rehabilitasyon merkezi vb.)					
Kültürel yapılar (müze, sanat galerisi vb.)					
Dini yapılar (cami, kilise vb.)					
Ticari yapılar (AVM, pazar, mağaza vb.)					
Dinlence yapıları (spor/masaj salonları, güzellik merkezleri vb.)					
Sahneli yapılar (konser/tiyatro salonları, opera binaları vb.)					
Yeme/içme mekanları (restoran, cafe, bar vb.)					
Sanayi yapıları (fabrika, atölye vb.)					
Ticari bürolar, ofisler					
Konutlar					
Kısa süreli konaklama yapıları (otel, konuk evi vb.)					

Lütfen aşağıdaki akustik terimleri verilen kriterlere göre değerlendiriniz:

	Bu terimi daha önce duymadım	Terim olarak duydum	Bu terimin ne olduğunu biliyorum	Bu terimin ne olduğunu anlatabilirim
Ses titreşimi				
Ses dalgası				
Ses frekansı				
Oktav				
Hertz				
Ses tonları				
Ses şiddeti				
Ses basınç seviyesi				
Desibel (dB)				
İnsan duyma eğrisi				
Ses yutumu				
Ses geçişi				
Ses yansıması				
Ses kırılması				
Ses sapması				
Ses yansışması				
Ses yayınımı				
Yankısız oda				
Çınlama				
Yankı				
Ses yayılımı				
Hava doğumlu ses				
Strüktür doğumlu ses				
Darbe sesi				
Gürültü				
Ses maskeleme				
İşitsel algı				
Akustik konfor				
Gürültü rahatsızlığı				
Gürültü yönetmeliği				

Bu dönem yaptığım INAR 401 stüdyo projemde...

	Kesinlikle katılmıyorum	Katılmıyorum	Biraz katılmıyorum	Biraz katılıyorum	Katılıyorum	Tamamen katılıyorum
Mekanları ana fonksiyonu akustik/ akustik değil olarak ayırdım						
Mekanların işitsel ortamının önemli olduğunu düşünüyorum						
Mekanların işitsel ortamını tasarladım						
Mekanlarda oluşabilecek sesleri ön/arka plan sesleri olarak sınıflandırdım						
Mekanlarda oluşabilecek sesleri mekanik, doğa, teknoloji vb. olarak sınıflandırdım						
Mekanları tasarlarken akustik hedefler koydum						
Komşuluk ilişkilerini akustik açıdan ele aldım						
Mekanlar arası gürültü iletimini hava/katı doğuşlu olarak sınıflandırdım						
Mekanlar arası ses izolasyonu uyguladım						
Mekanlar arası ayırıcılarda malzemelerin ses iletim katsayısını dikkate aldım						
Mekanlar arası ayırıcıların konstrüksiyonlarında gürültü iletimini dikkate aldım						
Mekanların fonksiyonlarına göre ses iletim ihtiyaçlarını dikkate aldım						
Ses iletim yollarını dikkate alarak gerekli önlemleri düşündüm						
Tasarımımda hava doğuşlu ses iletim yollarını tespit ettim						
Tasarımımda hava doğuşlu ses iletimine karşı önlem aldım						

	Kesinlikle katılmıyorum	Katılmıyorum	Biraz katılmıyorum	Biraz katılıyorum	Katılıyorum	Tamamen katılıyorum
Tasarımımda ses iletimine karşı duvarlarda önlem aldım						
Tasarımımda ses sızıntılarına karışı önlem aldım						
Tasarımımda katı doğuşlu ses iletim yollarını tespit ettim						
Tasarımımda katı doğuşlu ses iletimi için önlem aldım						
Tasarımımda ses iletimine karışı döşemelerde önlem aldım						
Tasarımımda ses iletimine karışı tavanlarda önlem aldım						
Tasarımımda pencere, kapı gibi açıklıklardan iletilebilecek gürültüye karşı önlem aldım						
Tasarımımda planlama yolu ile ses iletimine karşı önlem aldım						
Tasarımımda mekanlar arası ses iletimine karşı tampon bölgeler oluşturdum						
Tasarım sürecimde akustik yönetmeliğe başvurdum						

Tasarımınızda akustik konusunun değerlendirilmesiyle ilgili eklemek istediklerinizi kısaca belirtiniz:
