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Room acoustics education in interior architecture programs: A course structure proposal

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ABSTRACT

Soundscape research alters the notion of room acoustics from a physical phenomenon to a new multidisciplinary approach that concerns human perception of the acoustic environment, in addition to the physical calculations and measurements. Many interior architecture programs include courses that specifically focus on room acoustics. Although a brief introduction to the technical aspects of room acoustics is considered mandatory, the current course structure does not deliver sufficient information on the human perception of the acoustic environment. Therefore, the aim of the study is to reconsider the structure of room acoustic courses and present a brand-new room acoustics course structure proposal for the interior architecture programs. The study consists of two main phases. In the first phase, a database of all courses that include various topics on room acoustics is prepared through examination of the course descriptions of all undergraduate and graduate interior architecture programs in Turkey. In the second phase, the revisions to the current state of the room acoustics course structures are advised through an in-depth systematic literature review on the research area of soundscapes. Preliminary results and the initial course structure model will be presented at the conference.

Keywords: Acoustic education, Soundscape, Interior architecture
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1. INTRODUCTION

Since the beginning of the 20th century, vision-centred approaches dominate the higher-education curriculums of design disciplines such as architecture, interior architecture, industrial design, and city and regional planning. The students tend to ignore the important connection between the physical environment and basic modalities throughout the design process. The process almost solely revolves around visual quality, visual style, and technical details. This approach can be easily observed in the student's architectural project

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presentations: visually impressive, colourful drawings on large-sized glossy papers. In these presentations, there is rarely a clue about the impact of remaining modalities on the environment. As a consequence, such sensual parameters are widely ignored in the professional design projects, as well. The lack of sensual parameters results in environments defined as too cold, too hot, too windy, smelly, too noisy, or in short, 'feels wrong'. The users feel alienated and isolated, as a consequence of overlooking the modalities other than the visual modality [1]. The physical environments that are experienced as a scene of our daily life's surround us with various shapes, sizes, textures, colours, sounds, and smells, which are perceived through our basic senses. Designers should not isolate themselves from the subjective and holistic environmental perception of the space we live in [2]. The holistic perception of space even differs from person to person depending on the factual, sensual, and emotional conditions. Therefore, multi-sensory design approach have to be one of the main components of design education [3].

Pallasmaa [4], in his book 'Eyes of the Skin', states that "hearing structures and articulates the experience and understanding of space", and criticises the loss of the integrity of our sonic environments. Metaphorically speaking, the perception of space and place completely disappears when the soundtrack of a movie is muted [5]. The acoustical qualities trigger the most basic instincts of humankind while significantly contributing to the atmosphere of the built environment. For instance, the sound of a city in the night reminds us our survival instincts, mortality, and loneliness, derived from humankind's struggle with nature. In the city-scale, every city, every neighbourhood, and every street need to show an acoustical identity. The subjective perception of soundmarks are enforced by the socio-cultural connections and creates the acoustical identity of regional existence. Experienced independently of the sense of vision, the cheerful sound of street vendors, the background noise of the street crowd, the sounds of high-heels impacting on the sidewalk, and other similar sound sources that carry a sonic identity contributes to the atmosphere of a given built environment. The search of a sonic identity is strongly based on the connection between such soundmarks and the socio-cultural context.

Schafer [6] defines the design and experience of our sonic environment under the term of 'soundscape'. He states that the acoustic designer should not be the only professional to control the acoustic environment. Architects, musicians, psychologists, sociologists, and other numerous disciplines shall work together to analyse and suggest improvements to the aural environment in the socio-cultural context. From the soundscape point of view, acoustic design is the orchestration of the built and natural environments we spend our daily lives.

Current architectural acoustics lecture curriculums in design disciplines aim to deliver theoretical and practical knowledge to create and sustain adequate levels of aural comfort in the built and natural environments. The main concern is to measure, inspect, and evaluate the acoustic parameters of the built and natural environments, rather than focusing on the holistic atmosphere of a given space. Therefore, a solid boundary was created between the designer and the acoustic engineer [7]. It shall not be possible to ignore hearing, one of the most dominant modalities to experience our environment, during any stage of the design process. In the built environment, visual and aural modalities do not exclude each other, in fact, they work in unity. In the modern western society where visual concerns have become the focal point, the design and creative process has been removed from the experience of a holistic and multi-sensory atmosphere, and the physical potential is not fully utilized [8].

Auditory experience should not be separated from the design process, and hence, the interior space should not be considered as living spaces that are designed with only visual concerns, independent of the sensory / emotional effects created by sound. The aural environment can be integrated into the design process as a unique design element, and thus the actual potential of the structures can be enriched by allowing them to target the ears, as well as the eyes [8]. As an example, an engineering-based acoustic designer's the primary objective in the design of a holding management building's main entrance volume is to achieve the target room acoustics parameters stated in the relevant national and international standards, laws, regulations, and directives examined on the basis of the architectural requirement program (i.e. reverberation time, clarity, definition, lateral energy fraction, equal distribution of sound pressure, and speech intelligibility). Although this approach is necessary in the context of acoustic comfort, it is insufficient and incomplete in the context of auditory environmental design. The designer should also be able to predict the auditory dimension of the desired atmosphere to be created within the architectural idea/concept, beginning from the initial stages of the project. The target objective acoustic properties suggested by the well-known standards, laws, regulations and guidelines will not be appropriate for the designer who imagines a monumental entrance area where heel sounds will reverberate and echo within the space. In this context, the designer should be able to comprehend the basic acoustic knowledge to provide acoustic comfort, as well as to be able to imagine and create a multi-sensory experience within that space. The primary goal of a modernised should be to give the student the multi-sensory awareness, and the fact that the effects of sound sources on the user's multi-sensory space perception is entirely under the control of the designer. When design education is limited to visual tools only, it becomes impossible to comprehend the totality of design. Students who are not aware of these holistic qualities cannot reflect the harmony of the modalities into their own designs [9]. The creative process of an interior architectural project should not be separated from the creative process of the aural environment. Hence, the duration of the architectural acoustics courses should be in line with the duration of the interior design studio courses, which are the keystone of every interior architecture department for the full duration of the education (4 years).

The lists of acoustics related courses included in the curriculums of interior architecture departments in Turkey are presented in Table 1 (undergraduate education curriculum) and Table 2 (graduate education curriculum). Only the must courses that contain 'acoustics' keyword in their names are included in the lists (elective courses were removed from the lists). In addition to these courses, it is observed that the topic of architectural acoustics is briefly mentioned in various building physics courses. Additionally, it is observed that topics other than architectural acoustics are also delivered in the courses listed. As presented in Table 1, eight out of the sixteen (50%) courses in the curricula of the undergraduate programs in interior architecture education include lighting, fire safety, and equipment topics, as well as architectural acoustics. In the graduate education curricula (Table 2), five out of fourteen courses (35.7%) include lighting and hygienic systems topics, besides architectural acoustics. The current status of the curricula reveals that the courses that deliver only acoustics related topics are limited. Additionally, there are no courses that deliver architectural acoustics from a creative design perspective, which requires a 14-week acoustics course running parallel to the interior design studio courses.

Table 1. The list of undergraduate acoustics courses in interior architecture education in Turkey [10].

University	Course name	Course code
Lefke Avrupa	Acoustics and lighting	INAR 438
İhsan Doğramacı Bilkent	Architectural acoustics and fire safety	IAED 341
Çankaya	Acoustics and fire safety	INAR 320
İstanbul Kültür	Acoustics	İÇM 5021
Yeditepe	Equipment acoustics	INDT 461
Atılım	Acoustics and fire safety	İÇM 352
TOBB Ekonomi ve Teknoloji	Building physics: Lighting and acoustics	İÇT 208
Zirve	Interior design construction systems: Lighting and acoustics	ICM 352
Avrasya	Architectural acoustics	ICM 303
KTO Karatay	Acoustics	IM 222
Nişantaşı	Acoustics	LICM 304
MEF	Atmosphere Design (Light & Acoustics)	INT 334
Nuh Naci Yazgan	Room acoustics	ICT 504
Karadeniz Teknik	Room acoustics	IMB 319
Kocaeli	Acoustics in interior spaces	ICM 306
Selçuk	Acoustics	2403304

Table 2. The list of graduate acoustics courses in interior architecture education in Turkey [10].

University	Course name	Course code
Lefke Avrupa	Acoustics and lighting	INAR 438
Bahçeşehir	Architectural acoustics and hygienic systems	INT 3905
Başkent	Acoustic design	İÇT 429
Yaşar	Acoustics and lighting in design	INAR 350
Kadir Has	Interior architecture design systems IV – Lighting and acoustics	IA 352
İstanbul Ticaret	Acoustic design and technologies	ICM 436
Işık	Acoustics	INAR 374
İstanbul Bilgi	Lighting and acoustic	IND 314
Gediz	Acoustical problems and solutions in architectural design	AR 378
Bursa Orhan Gazi	Building Acoustics	IAED 424
Gedik	Acoustics	SEÇ-İÇM 320
Fatih Sultan Mehmet	Acoustics in architecture	IMIM 033
İstanbul Sabahattin Zaim	Acoustic problems in design	ICM 316
Mimar Sinan Güzel Sanatlar	Acoustics	ICM 577

In this article, an interdisciplinary, holistic, and multi-sensory architectural acoustics course content is proposed, focusing on to create places and soundscapes in the socio-cultural context, rather than forcing an intense theoretical acoustics content to interior architecture students.

3. COURSE STRUCTURE PROPOSAL

In this section, the structure of the proposed architectural acoustics course will be presented. It is a criticism of the acoustic courses in the current course structure of the interior architecture departments. The main objective of the design-oriented architectural acoustics course is to create awareness of the students in the built and natural soundscapes. It is also crucial to emphasize the relationship between conceptual ideas and auditory environments, whilst delivering adequate levels of theoretical knowledge comprehendible by interior architecture students.

The architectural acoustics course structure is planned for a generic 14-week academic semester. The students are expected to create the aural environment of their design problems given in the interior design studio course. The course is structured to run in-line with the interior design studio course and these two courses will be tied together; therefore, the design details in the interior architectural design projects and aural design projects are expected to be at the same level at a given time in the 14-week course period. A comparison between proposed and traditional acoustics course structures, in-line with the interior design studio course structure is presented in Table 3. The traditional acoustics course structure and the interior design studio course structure information are taken from the current curriculum of the interior architecture department of Çankaya University, Ankara, Turkey.

In search of a contextual and holistic aural environment for their interior design studio projects, the students are expected to overcome various design phases. According to Schafer [6] the four basic principles of acoustic design is as follows:

- To be respectful to the ear and human voice (phase 1);
- To be informed about the rhythm and tempo of the natural soundscape (phase 2);
- Being aware of the symbolic meanings of sound (phase 3);
- To be aware of the balance mechanisms of the auditory environment (phase 4).

Based on the interpretations of the four main requirements of acoustics design suggested by Schafer [6], the course structure is divided into 4 main phases: the technical lecture phase (week 1), the preliminary research and soundwalks phase (weeks 2 and 3), the initial design phase (weeks 4 to 11), and the holistic soundscape design phase (weeks 12 to 14). As presented in Table 3, the four phases of acoustic design are in-line with the four phases of interior design studio (i.e. the introduction phase, the research phase, the preliminary design phase, and the improved/detailed design phase). Therefore, the outputs of two courses are expected to be a holistic and multi-sensory design presentation of a single interior architecture project, rather than being two separate outcomes of two different design courses. The evaluation procedure (mid-term and final examinations) of the two courses will also be simultaneous, as the aural environment alone cannot be evaluated in the absence of the interior design project.

Table 3. A comparison between proposed and traditional acoustics course structures, in-line with the interior design studio course structure.

Week	Proposed acoustics course structure	Interior design studio course structure	Traditional acoustics course structure
1	Introduction to architectural acoustics	Introduction to the course	Origins of sound theory
2	Research presentations	Research presentations	Fundamentals of acoustics
3	Soundwalks	Conceptual presentations	Human perception & reaction to sound
4	Studio critiques on the initial aural design ideas: keynotes	Studio critiques on the initial design ideas	Sound absorption
5	Studio critiques on the initial aural design ideas: keynotes	Studio critiques on the initial design ideas	Room acoustics I
6	Evaluation jury	Evaluation jury	Room acoustics II
7	Evaluation jury	Evaluation jury	Midterm
8	Studio critiques on the improved aural designs: signals	Studio critiques on the improved designs	Sound isolation
9	Studio critiques on the improved aural designs: soundmarks	Studio critiques on the improved designs	Mechanical system noise & vibration
10	Evaluation jury	Evaluation jury	Design of rooms for speech & music
11	Evaluation jury	Evaluation jury	National holiday – No class
12	Studio critiques on the holistic soundscapes	Critiques on the detailed designs	Electronic sound systems
13	Studio critiques on the holistic soundscapes	Critiques on the detailed designs	Regulations, standards, and design guidelines
14	Studio critiques on the holistic soundscapes	Critiques on the detailed designs	The soundscape theory
		Final examinations	

3.1 Phase 1: Technical Lectures

The sound energy produced by a sound source changes under the influence of the volumetric properties before it reaches the human ear. Whether that sound source is there because of a conscious design decision, or as part of a natural or artificial ambient noise, it remains under the influence of the volume (i.e. reflections, absorptions, diffusions, and scattering) before being perceived by the user. Hence, the possible effects of the room on sound should be predicted by the designer even at a basic level. Therefore, an interior soundscape designer is expected to accommodate adequate levels of theoretical knowledge on the basics of nature of sound and architectural acoustics. Cabrera and Ferguson [11] argue that the use and real-time experience of diversified conceptual methods such as equations, experiments, computer simulations, samplings, animations, and auralisations will increase the learning efficiency of students. However, it should be noted that the physics theories and mathematical knowledge that are the basis of architectural acoustics are not delivered effectively in both undergraduate and graduate education curricula of the design education. Meriç and Çalışkan stated that architectural acoustics does not attract the interest of the design students unless the theoretical issues are directly related to social practices and real facts [12]. The simplification of the theoretical contents of the acoustics course for the design students is an inevitable necessity [13]. Therefore, the simplified technical lectures are planned to be completed within the first week of the semester. The basics of sound theory and the basics of room acoustics (i.e. absorption, reflection, diffusion, sound isolation) will be delivered in a 3-hours long technical lecture. Students will be expected to comprehend the basics of sound theory and room acoustics. They will utilise this knowledge to predict the effects of their design decisions on the final aural environments (e.g. effects of reverberation time), throughout the design process.

3.2 Phase 2: Preliminary Research and Soundwalks Phase

Every design problem requires an extensive research on the specific topic, and every design process starts with a research phase. The preliminary research and soundwalks phases are centred around analysing the design problem given in the interior design studio course, including the context of the interior design project, the given structure, and environmental/site analysis of the given structure in proximity. The main aim of the design students will be to gather various useful information about the structure, its surroundings, and the design problem. While traditional research techniques are expected to be utilized, additional methods are needed to increase the sonic awareness of the students.

Soundwalks is a helpful method to subjectively evaluate the soundscape quality and increase sonic awareness. It is usually conducted by a selected group of individuals following a previously planned walking route [14]. In increases the aural awareness of the participants; therefore, soundwalks are considered very useful in the context of interior soundscape design. The soundwalks will be planned both in and around the given structure. The students will be encouraged to record the sounds they experience during the soundwalks for further reference. The outcomes of the research and soundwalks phase will be used in the following design phases.

3.3 Phase 3: Initial Soundscape Design Phase

In the third phase of the study, the aural environment will be designed in relation to the architectural concept of the interior design project. The soundscape of interior architecture projects will be designed under three layers: keynotes, signals, and soundmarks. The first layer, keynotes, compose the background of a sonic environment. These are the sounds that define the basic characteristics of a given space. They are continuous but does not carry alarming information about the environment. The second layer, signals, are the foreground of a sonic environment and can be considered as occasional information carrying sound sources. The third layer, soundmarks, are the equivalent of acoustic landmarks. They identify a particular sonic environment [6]. For instance, the three layers of a café interior soundscape would include the continuous human voice as a keynote, the sound of the phone rings and occasional vocal announcements as a signal, and the sound of an espresso machine or a coffee maker as a soundmark. In combination with the effects of the room acoustic properties (i.e. the level of background noise and reverberation time) of a given interior environment on the sound sources, the aural environment will be unique to the particular architectural design concept.

The students will approach the project by analysing their research outcomes. The sound sources will be selected according to the functions listed in the architectural program created in the interior design studio course. Each function will be linked to various sound sources. The students are expected to list all the potential sound sources located within their design problem. The keynotes are heavily influenced by the environmental noise. The signals in a given environment are strongly related to the socio-cultural context. The soundmarks are mostly unique to the design problem and context. The sound recordings of the environment will also be very important it this phase of the project. After finalising the list of all the sound sources, the effects of room acoustic parameters will be considered. Two main room acoustic parameters will be taken into account: reverberation time and signal-to-noise ratio. As the reverberation time is strongly correlated with the choice of finishing materials and volume of the space, the target aural environment will directly affect the visual concept of the interior architecture project. The soundscape design and the interior design will be merged together in the fourth phase of the project.

3.4 Phase 4: Holistic Design Phase

In the last phase of the design project, the soundscape design and the interior design will be merged together in order to achieve the holistic architectural design. The auralisation techniques and acoustic simulation techniques will be utilised to prepare the soundscape component of the project. The sound sources will be balanced in accordance to the architectural concept, and the room acoustic affects will be simulated accordingly. The interior design component will be prepared as computer animations created with 3D modelling software. The soundscape design will be added as the soundtrack of the 3D modelled interior design animation to create the final holistic architectural presentation.

5. CONCLUSION

This paper presented an interdisciplinary, holistic, and multimodal architectural acoustics course content proposal for interior architecture programs. The main objective of the design-oriented architectural acoustics course is to create awareness of the connection between the aural and visual environments in interior architecture education and attracting the interest of the interior architecture students. The present study aims to be a generic outline for a modernised architectural acoustics course for design.

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