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The Effect of Three-Dimensional Drawing on Learning Construction Detail Design in Interior Architecture Education

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Abstract: In the construction of the built environment, detailing is an important and inseparable part of the whole construction information. Giving practical construction information to interior architecture students is undoubtedly an important part of interior architecture education. Along with general building information, materials and detailing are included in the curricula of many interior architecture departments to strengthen students' understanding of interior architecture practice. On the other hand, the detailing solution should be considered as a design-decision model to create design alternatives according to the building elements and material properties.

The aim of this study is to show that structural and detailing problems should be considered in a holistic framework with the design in interior architecture education. The sub-purpose of this study is to show that the use of three-dimensional drawing techniques in interior architecture construction-detail education is effective in increasing a student's ability to notice and learn building details.

This study focuses on the use of three-dimensional drawing techniques in interior architecture education and the application-oriented solution of structural and detail problems. As a result, the method of the study suggests some design-decision modeling guidelines that will lead to better detail design-decision solutions for interior architecture students.

Keywords: Interior Architectural Details, Detail Design, Construction Elements, Three-dimensional Drawing.

Introduction

Models and prototypes can be thought of as fundamental tools of design education, and as bridges between design ideas and their real applications in the physical world. Relatedly, the intended learning outcome of the Detail Studio course is to enable students to see the application details in interior architecture education as a part of space design and to produce original solutions in this context.

According to Charles Eames, details reveal both an industrial product and architecture (2015). Giving practical construction information to interior architecture students is undoubtedly an important part of interior architecture education. As well as general building

information, materials and detailing for interior manufacturing is also included in the curriculum of many interior architecture departments. In written literature (Ashcroft, 1992; Ballast, 2010; Berkin, 2021; Ching and Adams, 2015; Kilmer and Kilmer, 2016), this information is mainly explained with two-dimensional technical drawings or perspective drawings when necessary. It is not always possible for students to grasp the logic in the assembly of materials and to see the application of manufacturing details apart from the construction site internship. Although visual media resources such as YouTube contain videos for application, students' experience of productions in the third dimension in the classroom environment is limited within physical possibilities. However, virtual environments and computer-aided three-dimensional modelling programs provide tools to overcome such inadequacies. Therefore, this study suggests that the detailing solution should be considered as a design-decision model to create design alternatives according to the building elements and material properties (Deniz, 2019).

Thus, the application solutions of the building elements in the project can be developed in functional, aesthetic, and creative aspects together with the design, and alternative detailing design can be realized in interior architecture education. It is insufficient to seek solutions with only two-dimensional technical drawings for detail design problems that require three-dimensional thinking. It is not uncommon for students to have difficulties in perceiving both the manufacturing method and the solution of the detail problem. Students need to be supported with three-dimensional technical drawings so that they can more readily detect the detail problem according to the design features and produce solutions.

The purpose of this research is to demonstrate that education in interior architecture should focus on addressing structural and detailing issues within the context of a holistic framework along with the design. Both two-dimensional and three-dimensional representations could be used for practice, and they could both work together to support learning outcomes and teaching inputs (Figure 1).

The secondary objective of this study is to demonstrate that the implementation of three-dimensional drawing techniques in interior architecture construction-detail education is an efficient means of enhancing a student's capacity to recognize and acquire knowledge of building details.

Considering Detail as a Design Issue

A detail problem may have multiple solutions. To achieve innovative, functional, and long-lasting solutions, it is necessary to understand business logic and to produce the most appropriate solution for the project and design in technical and aesthetic terms, taking into account building physics, material properties, material size, application conditions, and cost. Detailing determines the order of design, materials, and building features. Detail is a blend of aesthetic and functional considerations for designers. According to Emmitt (2002, as cited in Erbil, 2019), the details serve as a tool for architects to control the construction phase

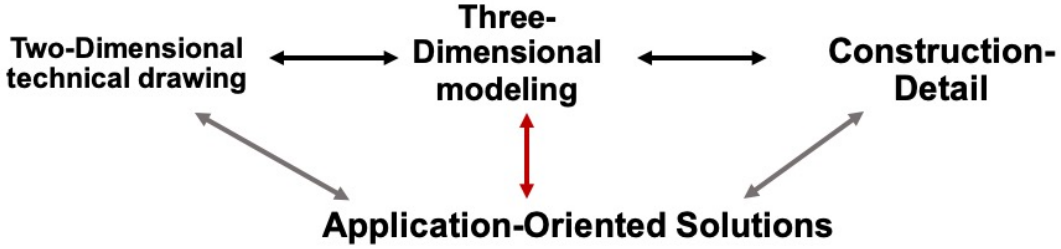

Figure 1: *Application Oriented Solutions Diagram (Drawn by the Authors, 2022)*

of the building, so they should clearly show the connection between the components, the dimensions, and the information they carry (p.79).

Time, cost, functionality, feasibility, ergonomics, aesthetics, accessibility of materials, previously tried or tested details, designer's personal characteristics and architectural perception, environmental factors, and the competencies of professionals involved in the construction process are all effective parameters in the detail creation process of architects (Erbil, 2019, p.79).

Detail and material solutions are crucial factors for ensuring design-to-production continuity and one-to-one design implementation (Erbil, 2019, p.78). When a specific detail work for the design is not completed, significant disparities between the designed and applied detail appear. In other words, the outcome of a project in which the designed project differs from the actual project. No designer wants to be in this scenario.

Detail and material solutions are critical to achieving one-to-one design implementation and ensuring a seamless transition between design and manufacturing. As a result, in detail design education, students' problem-solving and suggestion development skills are required in addition to material and structure understanding (Erbil, 2019, p.78).

In this way, rather than copying and using pre-made details, students' ability to produce design-appropriate solutions is strengthened. Because the specifics vary depending on the chosen material and building features, environmental conditions, climatic conditions, and local architectural considerations. As a result, it is not possible, for example, to propose a single solution for the joint detail of two surfaces and adapt it to all designs. Students should understand the basic rules and think and draw according to the features of the existing design in order to consider the detail solution as a design rather than memorizing the subject. Given that the application is three-dimensional, students may struggle to grasp the essence and logic of the event if the education of this subject (both as a narrative and as a drawing) is only two-dimensional. They must eventually resort to using ready-made detail solutions. This situation results in the emergence of detail solutions that are similar to one another and are not appropriate for the application, without taking into account the structure, material, and design features. In this context, theory, detail information, material descriptions, and student drawings in interior architecture education should be supported by three-dimensional hand and computer drawings in addition to two-dimensional expressions. A lecture developed using application videos and three-dimensional manufacturing models is recommended for this. The student is expected to model the structure or construction to be made in 3D (for example, using a computer-aided modelling program) before creating the two-dimensional drawing, and to perceive the surfaces and layers in the structure through sections taken from the third dimension. After that, they create two-dimensional technical detail drawings.

Tadao Ando claimed that a detail is about the whole and its constituent components (Schittich, 2000, as cited in Erbil, 2019, p. 79). The idea of detail and design should be taken into consideration as a whole in order to create details intentionally. By asking students to solve the intricacies of the materials and building components of their own designs, it is hoped that students would better understand the difference between design and detail. A crucial step in the design process that has a tight relationship to reality is the production of the details. However, by using actual detail solutions, it will be possible to guarantee continuity between design and building (production). The goal of the detailing process is to combine the materials, parts, and aspects according to standards like function, aesthetics, practicability, originality, and sustainability (Erbil, 2019, p.79).

According to Erbil (2019), the process of creating details is influenced by the designer's personality and sense of architecture (p.84). The personal ideas and solutions that are perceived and interpreted should also be expressed in the

detail design, just as the designer's individual personality is reflected in the overall design.

The goal of detail design is to generate application solutions that are appropriate for the project's structure, materials, location, and cost. For detail design, architectural designers consult a number of print and digital media. Students studying interior architecture can use standards, regulations, firm brochures, information released on company websites, and information created by public agencies as examples. There is a distinction between using the source and copying it, though. It's crucial that they develop the project in accordance with the structure-material characteristics and take advantage of them to produce an original and innovative detail rather than replicating exactly (Aksu 2010, p. 54).

Detail Design According to Materials and Structural Elements

As consider from types of models, the word "model" can be said to be a very flexible word for an architect and a designer with its many functions. The models' primary purpose is to convey the design concept to the creator and to others. As their titles suggest, spatial, structural, and detail models are helpful for studying how spaces and masses, structures, and potential materials interact in an architectural design (Delikanlı, 2020, p.14).

Material, in addition to its physical performance, is now the most competent aspect that supports the developments in new architectural trends that are reflected in the designs. With new materials and new material technologies entering the world of materials on a daily basis, pioneering architectural structural systems are formed, structures move locations, and structures respond more to the environment (Sunalp Gürçınar and Abbasoğlu Ermiyagil, 2019). Understanding which material is utilized where and how gives the ability to comprehend the application procedure for material and specific information. By observing the manufacturing stage, it is believed that the subject of detail in this process would be comprehended more clearly (Gündüzlü, 2019).

Architecture faculties offer classes or studios for theoretical and/or practical application in detail design instruction. Deniz (2019) created a systematic design-decision-making methodology that may be used for the detailed design of architectural building elements. It is a preliminary analysis method for detail drawing generation, not an educational model. The suggested detail design model's outputs are aimed at discovering the most suitable detail design alternatives for the building elements, and it is anticipated that these outputs can be refined later and used as data in the process of detailing the building elements' junction points (Deniz, 2019, p. 646). Elgewely et al.'s (2021) study incorporates virtual reality and building information modelling (BIM) into AEC (Architecture, Engineering, and Construction) education by presenting a system that can function as a mainstream supplemental construction detailing learning method for architecture students. The suggested VR system enables a virtual construction site that fits learning goals by allowing students to explore and develop in a real-world context. Details of their proposed BIM based VR prototype are produced from specified materials previously uploaded in the system (Figure 2). This strategy may be limited, especially given the range of materials utilized in interior design.

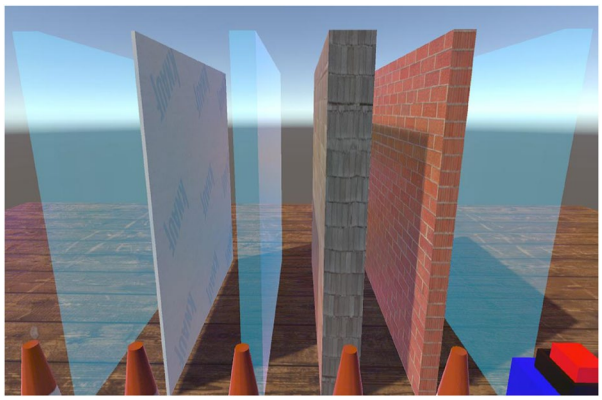

Figure 2: *Showcase of construction material selection of BIM based VR prototype (Elgewely et al., 2021).*

Through an ethnomethodologically informed ethnography of North American design-build architecture education, Nicholas and Oak (2020) investigate the tension of the "make or break" aspects of architectural detail(s) in the learning and practice of design. The lessons of the detail, they contend, have ramifications for professional practice even though their work has only been centered on architecture education environments, where risk and failure are essential components of the learning process (Nicholas and Oak 2020, p. 51). According to Köknar (2019), the "Design and Make!" Studio at MEF University in Turkey offers first-year students the chance to engage in an enhanced and inclusive experience of learning by doing, which is an integral part of architectural education and the studio (p.42). This opportunity is provided by the faculty's architecture and interior architecture departments. Students gain knowledge through trial and error when working on projects that call for wooden materials, applying material, structure, and detail design.

In addition to computer-aided modelling, cardboard models, and sketches, one of the approaches utilized by architects when developing details is the "on-site trial" (1:1 scale mockup). In general, by creating a realistic model with three-dimensional design software, both the problem and the necessary answer may be easily observed. Working with the firms who make the material that will be utilized in the project and integrating the details they produce expressly for their own products into the project is also part of the detailing job. This procedure is not just carried out through drawing. Requesting a sample of the product from the manufacturer and seeing and touching the material is a crucial aspect of detail design (Erbil, 2019, p.86).

Methodology

This study has established a methodology for teaching interior architecture students about the adaption and unique detail designs stated above. In this sense, study focuses on demonstrating that the detail solution should not remain in two dimensions and the use of three-dimensional drawing techniques in interior architecture education and the application-oriented solution of structure and detail problems.

Models, which are key teaching tools in design education, can be categorized in a variety of analog and digital model-making methods, including scale models, 1/1 mock-up systems, and digital model-making, which takes into account flexibility, possibilities, time management, and material. Digital model-making was chosen for this research technique even though there are alternative options available because it allows for quick modification, intervention, and allows students to carry out different experiments (Acar, 2020, p.9). The value of the model-making process for design, structure, and detail education is increased by the fact that models serve as both a representation tool for designers as well as interaction tools (Delikanlı, 2020, p.14). In contrast to the model-making in design and computer drawing courses, the approach of this study uses a computer modelling feature that focuses on modelling the structural system detail in line with design and material.

These teaching techniques for detail design primarily highlight the research conducted in the architectural departments. There is no technique recommended in the literature for teaching detail design to interior architecture students in particular. As a result, this research provides a novel proposal. This study investigates the application of three-dimensional drawing techniques in the field of interior architecture education as well as the problem-solving strategies that are geared toward the practical implementation of structure and detail issues. The participants were third-year undergraduate students from Başkent University who took the İÇT311 coded Detail Studio course in the 2021–2022 Fall Term. This study analyzes the impact of the addition of three-dimensional modelling in detail design to two-dimensional technical drawing techniques in teaching. The analysis sets out to elucidate the efficacy of this dual approach on the students' perception skills and capacity for practical detail analysis.

Although being able to use three-dimensional drawing programs was determined as a prerequisite in this study, the contributing factor of the difference among the students' knowledge and skill levels is one of the limitations of this study. Another limitation was the students' reluctance to use this new method. Among students, there was a propensity to reach for ready-to-copy information instead of seeing detailing as a design problem.

The method of this study consists of two stages that are visualized in the diagram below (Figure 3).

The first stage can be defined as an explanation of the detailing drawing rules and techniques while the second stage consists of student drawings. In the first stage of the study, structural details and finishing material information were explained both with two-dimensional detail drawings and three-dimensional drawing samples (Fig 4).

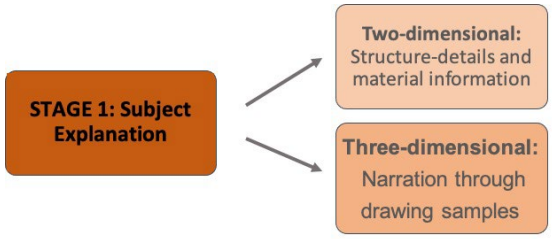

Figure 4: *The first stage of the research diagram (Drawn by the authors, 2022).*

The goal of this stage is to introduce the topic, describe the material, explain the 2D and 3D details in accordance with the features of the material and the design, provide examples from actual construction sites during and after the application, and also introduce the resources that can be effectively used. Therefore, it is

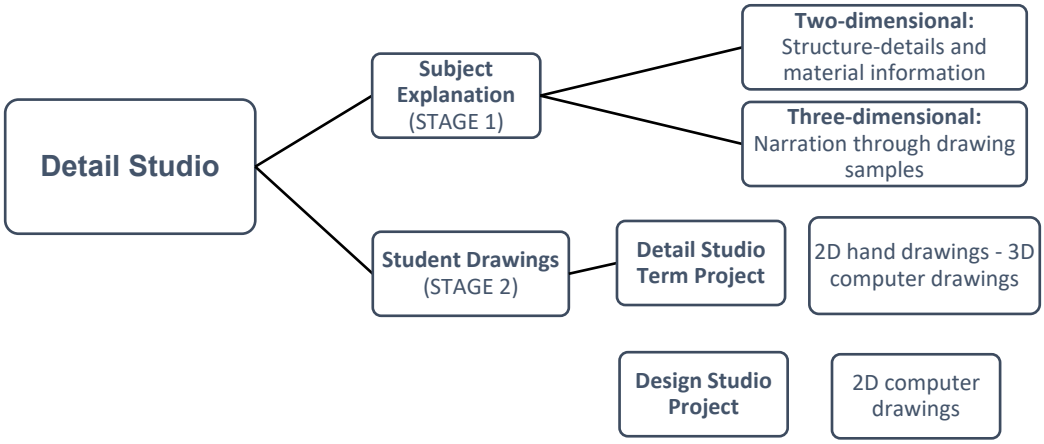

Figure 3: *The stages of the research diagram (Drawn by the authors, 2022).*

anticipated that the supplied data will be used to produce the drawings and specific solutions required in the second stage (Figure 5 and Figure 6).

In the second stage, the students were required to design a bedroom with a study area that showed the three-dimensional layers of the structural system and their interior components. The participants used computer-aided drawing programs such as SketchUp or 3Ds Max for their three-dimensional models. Despite the fact that SketchUp is less user-friendly than other computer-aided modelling programs such as AutoCAD and Rhinoceros, a study comparing the usability perception of these three programs discovered that the majority of interior architecture students intend to use SketchUp as a three-dimensional modelling program in the future. (Yong, Kusumarini and Tedjokoesoemo, 2020).

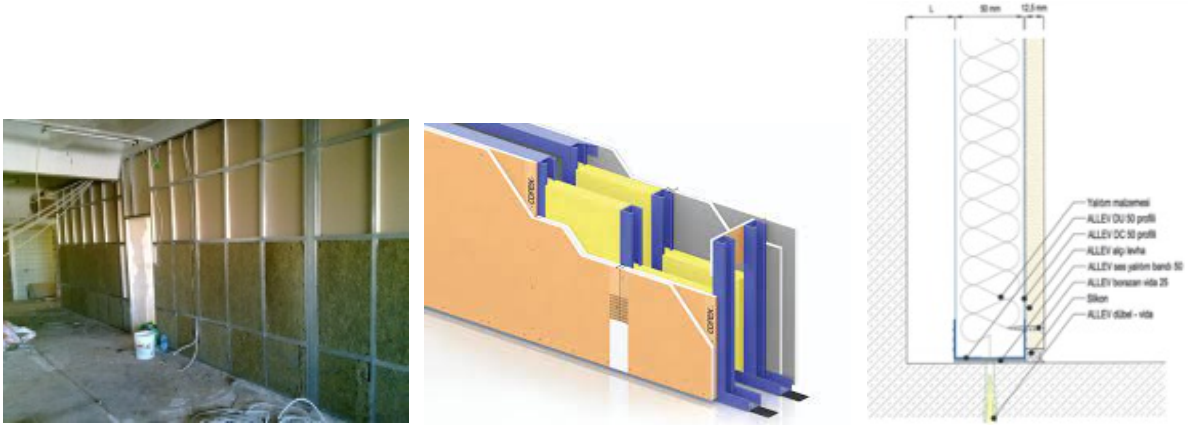

Figure 5: *Samples of site application and 2D and 3D construction detailing models (Author 2 archive, 2021) (https://tr.pinterest.com/pin/367817494547579613/) (http://www.dalsan.com.tr/mimaridetaylar/Cizim?kategoriId=25)*

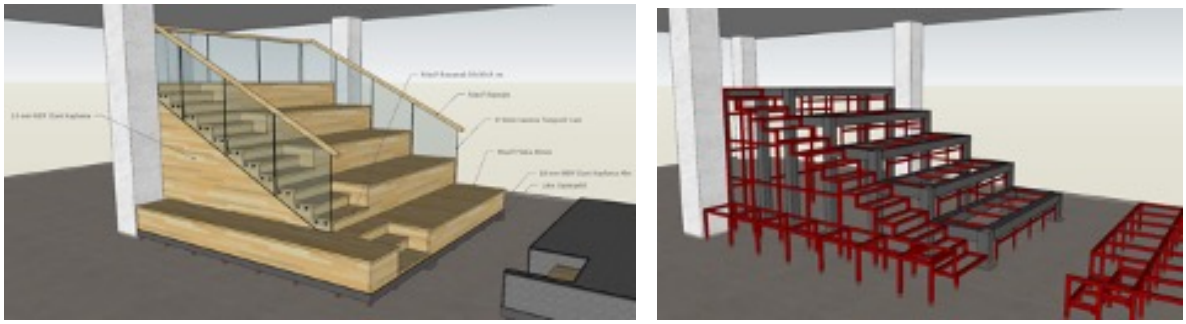

Figure 6: *Samples of 3D construction detailing models (Modeled by the author 2, 2021)*

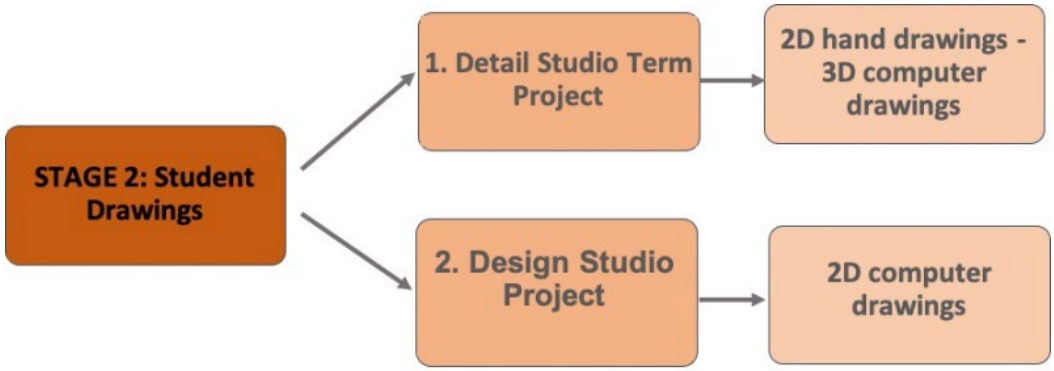

Figure 7: *The second stage of the research diagram (Drawn by the authors, 2022).*

Moreover, in addition to the term project of the Detail Studio course, built-in-furniture and construction details of the Design Studio course project were required too. In this project, the students decided on the materials they would use in the interior space. Each student produced their own genuine design and required manufacturing detail solutions by modelling and three-dimensional drawings. While doing this, they examined the three-dimensional modelling samples given in the lecture part, that is, in the first stage of the study.

The goal of this strategy is to assist students apply their knowledge to the project they designed, to address detail issues as design problems. The following section will provide details and case studies on the two projects of second phase.

Case Study and Findings

Students can use three-dimensional drawing programs to create a realistic model using two-dimensional detail information, allowing them to see both the problem and the solution clearly. Material decisions are made based on the design characteristics, and the special details of the appropriate companies are incorporated into the project. Thus, in creating details in the studio, students benefit from the on-site trial method, three-dimensional sketching, and modelling methods.

Within the parameters of the Detail Studio course, two project assignments were provided to the students as term projects. The first project required students to create a rest and study area. There will be a separate bathroom/toilet area in this room with a 30 m2 total area, and the interior will have a 45 cm level difference between the resting and working functions. Plans and section drawings in 1/50 scale were created in addition to the overall room design. Every week after the lecture, the students created a three-dimensional model in SketchUp (or 3Ds Max) of the layer of interest (Figure 8).

Figure 8: *Student 3D construction detailing model samples from the Detailing Studio room project (The projects of students Nursena Sandıkçı and Oğuzhan Dağdelen, 2021).*

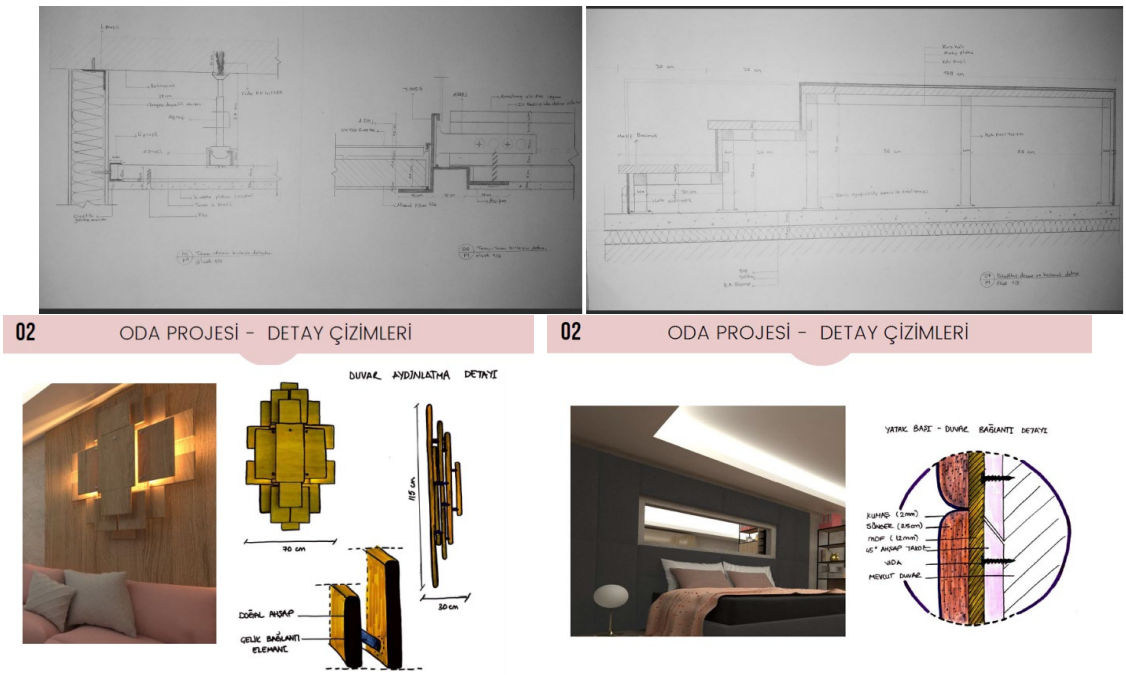

Figure 9: *Student 2D technical detailing drawing samples from the Design Studio project (The projects of students Oğuzhan Dağdelen, Elif İlayda Yılmaz and Nursena Sandıkçı, 2021).*

Then, after learning about the layers and material characteristics, they created suitable detail solutions for two-dimensional detail problems. Here, students developed solutions to three-dimensional difficulties while learning to connect their two-dimensional technical drawings. They created unique detail designs by combining an evaluation of the structural components and the material attributes they utilize in interior design, keeping in mind the comfort and requirements of the customers (Figure 10).

With this strategy, they were able to obtain the detail solutions by modifying the material and form in the design at the essential stages since they were continually considering the integration between design and detail solution. The table below shows the link between the narrating and sketching stages (Table 1).

Table 1: *Expression and drawing stages in the first project of the method (The room project) (Drawn by the author 1, 2021)*

Structural elements	2D Detail Explanation	3D Detail Explanation	Design (Room Project)	3D Drawing	2D Drawing
General Description	Detail drawing rules	Detail drawing rules	Room design (work and rest section)	3D modeling of the room (SketchUp / 3Ds Max)	1/50 Scale Plan / Section (Hand drawings)
Floor surface	General flooring materials and combinations / raised floor details	Flooring application videos / Sample SketchUp models	Floor layers, material combinations and raised flooring	Modeling of flooring layers (SketchUp / 3Ds Max)	Flooring point details (Hand drawings)
Wall surface	General wall types, materials and finishes / skirting	Wall application videos / Sample SketchUp models	Design of wall surfaces (using different coatings and materials)	Modeling of wall layers (SketchUp / 3Ds Max)	Wall point details (Hand drawings)
Column cladding / Niche / Door	Column cladding / niche creation / door types and details	Column coating and door application videos / Sample SketchUp models	Niche application in a wall, door design, column cladding	Modeling of Column Cladding / Niche / Door layers (SketchUp / 3Ds Max)	Column cladding / Niche / Door point details (Hand drawings)
Ceiling surface	Types of suspended ceilings / coating materials and joint details	Suspended ceiling application videos / Sample SketchUp models	At least 2 suspended ceiling designs / connection solutions / wall connections	Modeling of suspended ceiling layers (SketchUp / 3Ds Max)	Suspended ceiling point details (Hand drawings)
Furniture	Built-in furniture details	Furniture application videos / Sample SketchUp models	Headboard, bookcase, structural table or seating unit design	Modeling of built-in furniture (SketchUp / 3Ds Max)	Built-in furniture point details (Hand drawings)

As the final assignment, the students were asked to provide detailing solutions for the second project, the Design Studio project. The difference between this level and the previous one is that the project is a finished project drawn by the student within the scope of the Design Studio course. While the students were creating detail solutions without making any changes or interventions to the design, they first discovered that they needed to show the details that were appropriate for the existing design. They understood that they had to design according to the building elements, the material properties they chose, and the detail solutions that could be implemented from the very first stage of the project when they couldn't generate solutions based on structure, form, or material properties.

The most significant contribution of this learning process for the students was that they began to grasp the relationship between material qualities, production dimensions, and materials while drawing the three-dimensional detail layers of the spaces they planned. However, because it was their own project, they began to question material decisions during the detail solution process and produced original features based on the architectural aspects and material properties. During this method approach, students produced material and detail judgements based on user and function requirements. They have obtained the ability to make a link between design and manufacturing and to view design as a whole. Instead of replicating ready-made elements, they

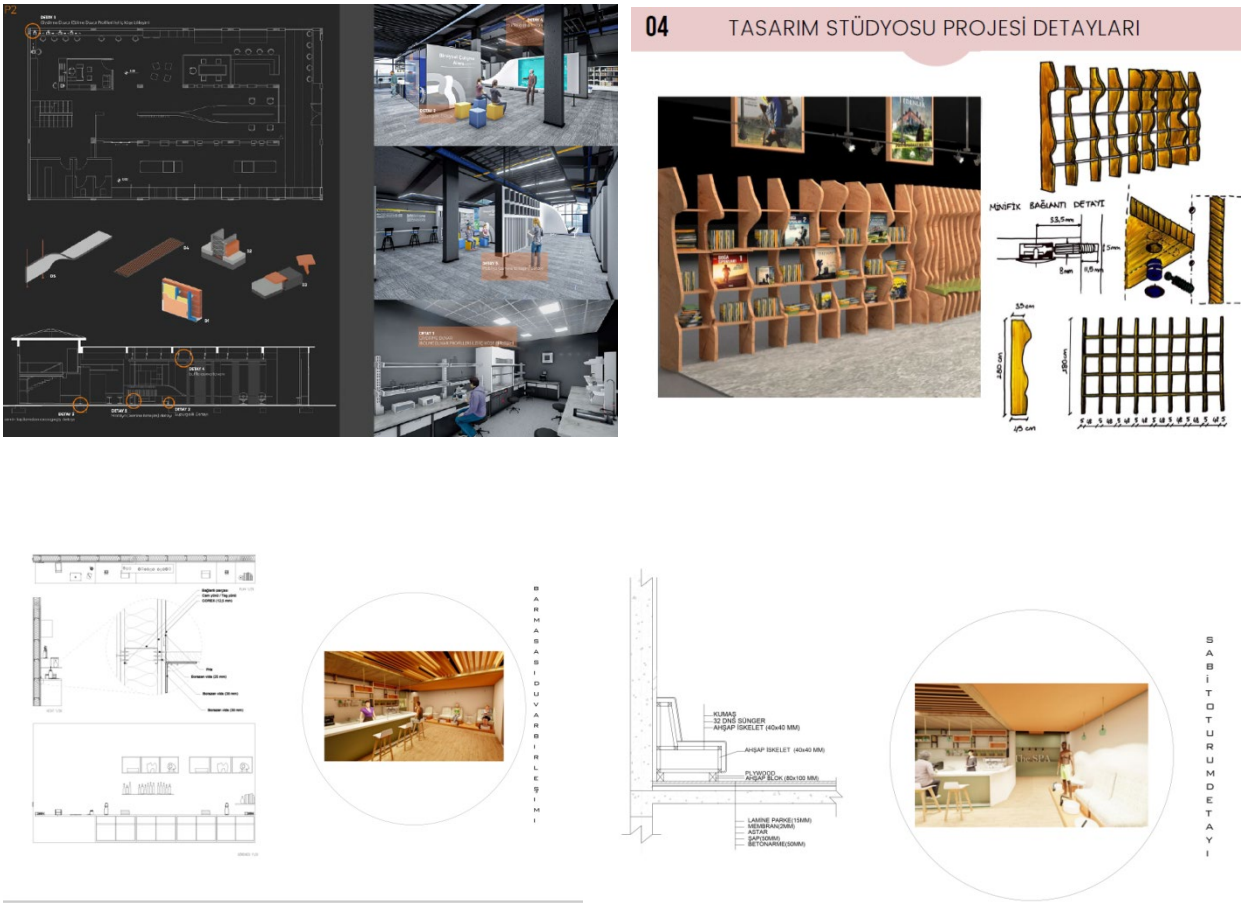

Figure 10: *Student 2D technical detailing drawing samples from the Design Studio project (The projects of students Oğuzhan Dağdelen, Elif İlayda Yılmaz and Nursena Sandıkçı, 2021).*

recognized that detail design is a component of overall space design and sought new and appropriate solutions.

Students used three-dimensional drawing programs to turn their theoretical detail knowledge into a realistic model. They were able to clearly perceive both the problem and the solution this way. They selected material options based on the design qualities and tailored the manufacturing details of the companies they deemed suited for their ideas to their projects. As a result, pupils had the opportunity to virtualize their intricate designs. They used three-dimensional drawing and modelling in the studio setting to evaluate not only industrial items, but also production details of structural reinforcements that require unique manufacture.

In this study, it has been observed that students who cared more about three-dimensional detail modelling and perceived it as a detail design could give clearer information about manufacturing in two-dimensional detail drawings.

Conclusion and Recommendations

The three-dimensional modelling technique was used to illustrate to the students the design difficulty that constitutes the study's core problem, detailing. The students recognized the importance of considering elaboration without straying from the context of the overall design. Through 3D modelling, students learned how to modify pre-made details for their own projects or produce unique ones. They abandoned the notion that technical detail drawings are information to be memorized and embraced the notion that detailing is a significant design issue that expresses production and materials. This is seen by the students' precise layering of their 3D models, subsequent 2D drawings, and the focus on detail in their creations. It has been found that the suggested teaching strategy helps students understand how 3D manufacturing reality and its 2D technical expression are related.

The main objective and contribution of this study to the literature in this field is to propose a design-decision model for detailing in interior architecture education. In the development of the model, it was aimed to show the effect of the three-dimensional design details on the design-decision perception of the students. As a result, along with design, students' ability to think three-dimensionally about interior application solutions and their ability to produce details were strengthened and improved. Detail design is not limited to 2D drawings and expressions. The method used in this study differs from others since it increases students' speed in problem-solving and sketching, fosters 3D thinking abilities, and is customizable. Table 2 demonstrates the competencies that students should gain as a result of the proposed teaching strategy.

Table 2. *Competencies that students should gain (Drawn by the author 1, 2021).*

Detailing in Interior Architecture	**Design Decisions**	**3D Layers**	**2D Detail Solutions**
Structural Elements	✓	✓	
Design Purposes	✓	✓	✓
Material Properties		✓	✓
Unique Solutions	✓	✓	✓
Application and Construction		✓	✓

This study suggests seven design-decision modelling guidelines as presented below, that will lead to better detail design-decision solutions for interior architecture students:

1. Students should develop both two-dimensional technical drawing and three-dimensional modelling of construction and detailing skills simultaneously.
2. When it comes to detail design, students should be shown with examples of three-dimensional models where alternative solutions are possible.
3. Students should develop their three-dimensional drawing techniques on larger scales in detail and construction courses in addition to design studio courses.
4. Students should strengthen their theoretical knowledge of the detail design of building elements, together with design and application, and their skills to produce solutions.
5. Students should be able to imagine and produce unique spatial solutions for structural and detail problems.
6. Students should create detailing solutions that are simple to read and comprehend.
7. Students should express their ideas, individual thoughts, and solution proposals in detail designs in order to develop original and inventive solutions.

Future research can examine the impact of this teaching strategy on students' perceptions of detail design. If this approach is used in other schools, it can be looked into whether similar results can be attained. In this way, one might aid in the advancement of this methodology.

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