Journal of
Design Studio
v:2 n:2 December 2020

An Introduction to Design Studio Experience: The Process, Challenges and Opportunities

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Received: October 20th 2020, Revised: November 6th 2020, Accepted: November 8th 2020
Refer: Cenani, S., Aksoy, Y., (2020), An Introduction to Design Studio Experience: The Process, Challenges and Opportunities, Journal of Design Studio, V.2, N.2, pp 57-69,

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DOI: 10.46474/jds.813689 https://doi.org/10.46474/jds.813689

Abstract: This paper explores design education in studio settings and presents insights from a design studio based on parametric design thinking. The first-year design studios are essential parts of the architectural education. In these studios, design decisions are taken on a more abstract level, there are less constraints, and the exercises are designed to explore the potentials of design, within the framework of various scales, ranging from human to building, and then to urban. The Introduction to Design course is constructed with interconnected exercises based on concepts such as modularity, the parameters of the human body and spatial perception. The first exercise is designing an architectural structure through parametric thinking. The second exercise is about exploring the design potentials of cube modules with each other, with a rule-based design approach. To better understand the importance of ergonomics in design, the third exercise focuses on the concept of movement through the human body. The aim of the fourth exercise is to study a physical environment and to investigate spatial perception in the built environment. The main aim of this design studio is to teach design with parametric design thinking while focusing on improving the cognitive skills of the students. An Introduction to Design studio experience that is formulated according to these features is described in this study.

Keywords: Design Studio, Parametric Design Thinking, Computational Design Approach, Design Education.

1. Introduction

The studio culture is an essential part of the design education. A report prepared by Koch and colleagues (2002) on studio culture explores current studio education and suggest a change in studio culture. They propose a studio culture that promotes several features as can be seen on Table 1. Hacihasanoglu’s study (2019) examined a correlation between these studio culture’s features and the studio culture approaches of 10 architectural schools of the USA at bachelor and graduate level. Similarly, Table 1 shows the scores of the university explored in this paper based on Koch and colleagues’ study (2002). Please note that the below-mentioned scores are given by the authors based on the contents of the first-year design studio curriculum. (URL-1; URL-2). For example, “Interdisciplinary and cross-disciplinary learning” was scored as 1, because the contents of the first-year design studio curriculum as well as the aim of all four exercises done in this studio were designed to achieve cross-disciplinary learning. These exercises were specifically designed for students from different disciplines. On the other hand, "Collaboration over competition" and "Leadership development" were scored as 0, because the first-year design studio curriculum and all exercises were organized as individual assignments, and no group assignment was done. Among the universities analysed on Hacihasaoglu's study, the university explored in this paper and MIT have the most similar scoring (only three features have different scores), based on their studio culture policies.

diagrams are used to express and improve a design idea during the critiques. Design critiques create an essential moment in the students' design learning experience. These critiques contain several steps such as students presenting their designs, tutors giving feedback on their designs and both discuss potential problems and solutions (Oh et al., 2013).

When developing a curriculum targeting a new approach for teaching how to manage/handle the design process, the role that design thinking plays within a design-based learning environment is of particular interest (Saulnier, Bagiati and Brisson, 2016). The Introduction to Design studio described in this paper, which is held in the first semester of the first year, is constructed with interconnected exercises based on concepts such as modularity, the parameters of the human body and spatial perception. In this studio, it is intended to improve students' "computational thinking" (Wing, 2006), "parametric design thinking" (Oxman 2017; Rowe, 1987) and "algorithmic thinking" (Denning, 2009) processes via explicitly designed exercises. These three methodologies seem similar, however there are minor

Table 1. Studio Culture Evaluation Parameters (Koch et. al., 2002) and scores of the case study university

Design-thinking skills	1
Design process as much as design product	1
Leadership development	0
Collaboration over competition	0
Meaningful community engagement and service	0
The importance of people, clients, users, communities, and society in design decisions	1
Interdisciplinary and cross-disciplinary learning	1
Confidence without arrogance	0
Oral and written communication to complement visual and graphic communication	1
Healthy and constructive critiques	1
Healthy and safe lifestyles for students	1
Balance between studio and non-studio courses	1
Emphasis on the value of time	1
Understanding of the ethical, social, political, and economic forces that impact design	0
Clear expectations and objectives for learning	1
An environment that respects and promotes diversity	0
Successful and clear methods of student assessment	1
Innovation in creating alternative teaching and learning methodologies	1

As Milovanovic and Gero (2020) states, design studio pedagogy is project-based and functions as a mentorship between tutors and students. Accordingly, first-year design studios are essential parts of the architectural education. In these studios, design decisions are taken on a more abstract level, there are less constraints, and the exercises are designed to explore the potentials of design, within the framework of various scales, ranging from human to building, and then to urban. Schön (1985) describes a design studio as a prototype of collective and individual learning by doing, influenced and mentored by the feedback of a tutor. Sketches are often used early in the design process (Purcell and Gero, 1998). Sketches and differences between them. According to Wing (2006), “computational thinking builds on the power and limits of computing processes, whether they are executed by a human or by a machine”. Moreover, Wing (2006) states that computational thinking uses abstraction and decomposition for solving a complex task or designing a large complex system. Parametric design is a subcategory of algorithmic design and is based on the construction of logical sequences (Betancourt et al, 2014). We can say that computational thinking is the umbrella term that includes other terms; also, it is not necessary to use a software to apply computational thinking in a design. In this design studio, the students did not use any software, they were instructed to use these methodologies and to construct logical sequences in their designs. In this paper, four design exercises will be explained and be discussed through student projects. The first exercise is designing an architectural structure through parametric thinking. The second exercise is about exploring the design potentials of cube modules with each other, with a rule-based design approach. To better understand the importance of ergonomics in design, the third exercise focuses on the concept of movement via the human body. The aim of the fourth exercise is to study a physical environment and to investigate spatial perception in the built environment. Briefly, the main aim of this introductory studio is to teach design with parametric design thinking while focusing on improving the cognitive skills of the students. Another important feature of the Introduction to Design studio is, the syllabus of the course is completely the same for students from the department of architecture, the department of interior architecture and environmental design, and the department of urban design and landscape architecture. Therefore, each design exercise is aimed to focus on one of the above-mentioned programs. The impact of recent advances in technology (such as BIM, digital fabrication and learning by making) and changes in pedagogy (gamification, design thinking and computational design approach) on design education is undeniable. Today, these new priorities are guiding design education and studio culture.

The rest of the paper is organized as follows. An “Introduction to Design” studio experience that is formulated according to these recent advances and changes in design studios is described in the following section. Each sub-section, respectively, describes one exercise. Finally, the last section discusses the impact of design exercises and draws some conclusions.

Methodology

Based on the learning objectives of the course, Introduction to Design studio introduces the fundamental skills, concepts, and approaches essential for understanding and engaging with architecture, interior architecture, product design, landscape architecture and urban design. The course learning objectives are aligned with the content of the studio exercises, and the objectives of the tasks. Below-mentioned design exercises involve knowledge acquisition and the preliminary development of skills to conceptualise, resolve and present well-reasoned design ideas through drawing and model making. This design studio introduces techniques of analysis and critique of design outcomes as well as parametric design principles applicable to all above-mentioned design disciplines. The studio engages students with learning to design through iterative processes incorporating considerations of human, building and urban scales. In this section, four exercises will be explained and discussed, based on these learning objectives.

Exercise 1: Parametric Design Explorations

As the first project of the first semester, students were asked to create a rule-based composition by using wooden rods up to 2 mm in diameter (Table 2). The time given for this project was approximately four weeks. The design area was composed of two 20x40 cm rectangular plates perpendicular to each other. The printout of rectangular and diagonal grid was given to the students to cover the rectangular plates (Figure 1).

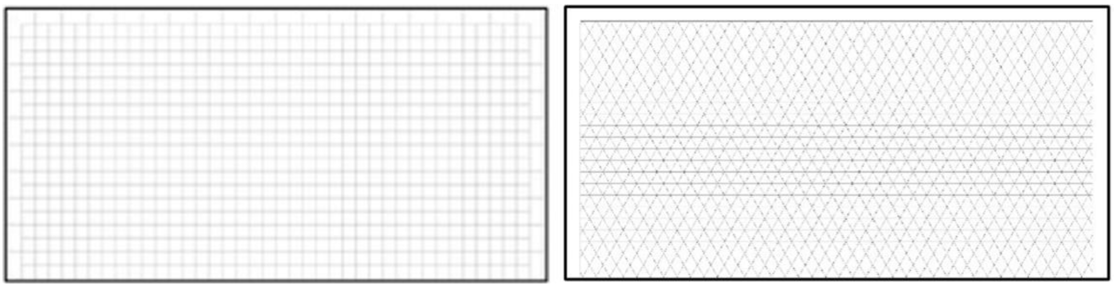
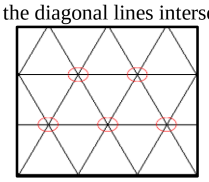
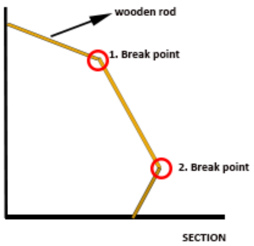
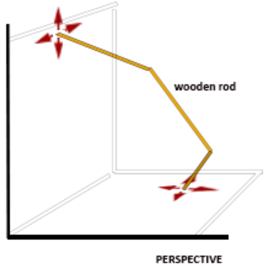
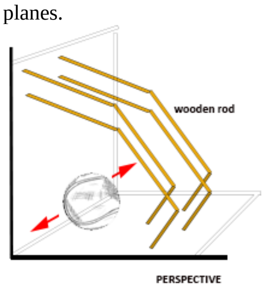


Figure 1. The 20x40 cm rectangular and diagonal patterns given to cover each rectangular plate

At the first stage, rectangular grid was used to create linear compositions. At the second stage of the exercise, diagonal pattern was used to create curvilinear compositions. At first, students were asked to place rods on the rectangular grid. Then each student started to make compositions according to the rules given in Table 2. They could adopt some principles and add new rules to their composition such as repetition which opened the doors of creating a rhythm. It was the point that each composition started to differentiate from each other.

In design, rhythm is made with repetitions. If the basic element is repeated in a sequential sequence, a pattern will be created and defined as a rhythm. Such a phenomenon of visual attraction will create a pleasant solution (Chan, 2012). This exercise had two stages. First productions were focused only on linear structure by using wooden rods by using a rectangular grid, no other flexible materials were added. The aim of the first stage is to create a structural system by using ruled based exploration that produces parametric compositions of the rods. By the help of iterations of the rules, the students develop expertise to engage creatively in design in an unexpected way. Secondly, students tried refining the solution by using flexible elements and diagonal grid cover instead of the linear rods. And then, improving the system with necessary supporting elements such as covering materials, was experienced during the design process. Discovering the possibilities of the structural systems by the help of parametric exploration, gave students new visions for their for their future designs, and how to incorporate structural systems with other materials.

Table 2. Contents of Exercise 1

Duration	Title	Keywords	Rules	Objectives	Materials
Four weeks	Linear Elements	Point, Line, Surface, 3D Cartesian Grid, Structure, Rhythm	1. Rods only can touch each rectangle surface from one point where the diagonal lines intersect.  2. A node can have up to two rods. 3. The profile to be formed in the side view can be broken in several points, which means rods can have several break points.  4.The linear profiles to be placed from the horizontal plane to the vertical plane only can move on the same axis according to a repetitive movement rule defined by the student.  5.At least the tennis ball must be able to pass through the gap between the planes.  	1- To create a composition according to the given rules 2- To start design with model instead of a sketch 3. To draw a completed 3d composition in 2d 4. To do collages by using final product as a place	**Stage 1** 1- 2 pieces of 5mm 20x40 cm photo-block 2- Wooden rods up to 2mm **Stage 2** 1- 2 pieces of 5mm 20x40 cm photo-block 2.Flexible linear materials, plastic rods 3- Strings 4- Covering materials such as acetate paper, sketches paper, tulle, etc.

Free hand and technical drawings were done afterwards. Technical drawings showed a major progress during the exercise. And finally, a collage was designed by each student to represent his/her project as a human scale passageway. At the end of this period, students exhibited their models, technical drawings and collages which summarized their ideas and design process. Figure 2 demonstrates final products of both first, second and final stages of student projects.

challenge traditional design practice. The research community sought to achieve rigorous design logic models based on hard analytical design science rather than soft traditional strategies such as intuition and use of formal knowledge (Goldschmidt, 2001). The teaching methodology is loosely based on the concept of grammatical design developed by Stiny. He thought that calculating with shapes would help to address a visual approach to education. It is possible to be formal with eyes without losing

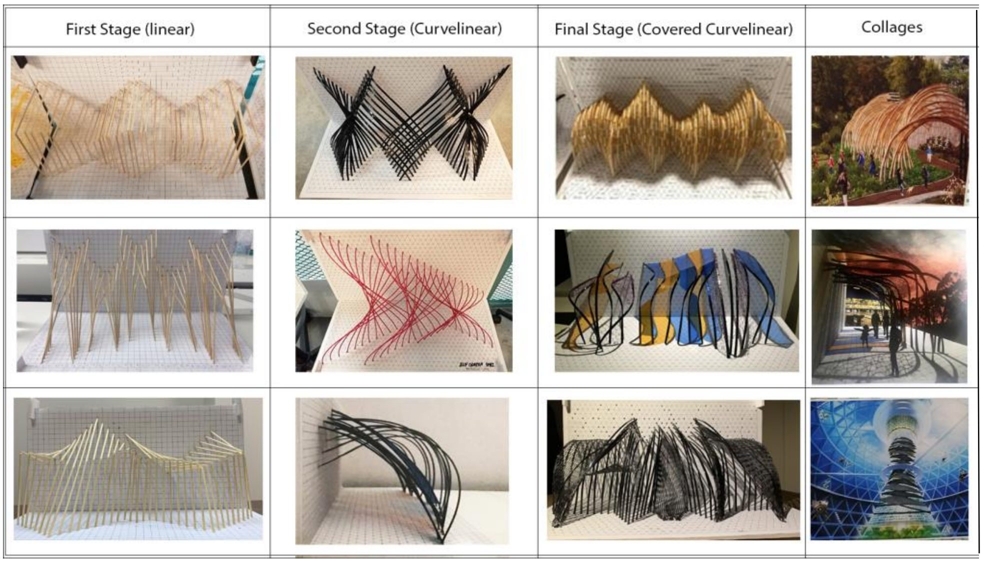


Figure 2. First stage and second stage and final examples of student models and collages

The goal of the exercise was not only to introduce students to parametric design also to introduce students to the major structural principles of design. Designing an architectural structure through parametric design thinking made the students be aware of the different design principles.

Exercise 2: 3D Shape Grammar Based Design Explorations

Second exercise aims at introducing new ways of thinking as well as introducing students to the new pattern of design (Table 3). A grammatical approach was chosen to develop the model, based on the shape grammar rules in general, and on one of its basic skills of perceiving shapes by extracting elements of the visual models. In the past forty years, formulating design science efforts has produced ideas that anything that is creative in the process (Stiny, 2006).

At first, students were asked to design at least four, at most six different modules by using 2x2x2 cm cubes according to the rules given. Modules should consist of more than one cube combination (can consist of minimum three, maximum nine cubes). These modules were the building blocks of the 3D labyrinth. Different colours used for the elements of the module family. Each module repeats at least two times during the creation of the labyrinth. It was mandatory to make a minimum of ten, which makes it easy for students during the trial phase.

Table 3. Contents of Exercise 2

Duration	Title	Keywords	Rules	Objectives	Materials
Three weeks	3D Labyrinth	Cube, Volume, Modularity, Shape parameters	**Production rules:** 1- New modules can be produced using minimum 3 and maximum 9 cubes. 2-At least 4 and at most 6 different modules can be designed. 3- Each module should be used at least 2 times. **Colouring Rule:** Different modules should be in different colours. **Neighbourhood Rule:** Modules can be neighbours with each other in certain directions. Neighbourhood rules are **Rotation Rule:** Modules can be combined by rotating from certain points. **Add / Subtract Rule:** New modules with a new join rule from modules derived.	- To design at least 4, at most 6 different modules by using 2x2x2 cm cubes -To design a 3D labyrinth using produced modules	1. 2x2x2 cm Styrofoam cubes 2. Acrylic paint

Evaluation of the second exercise was done according to the space relations, accuracy of the 2D expressions, care and quality of models, presentation sheets and technical drawings. Figure 3 shows final designs and drawings of student projects.

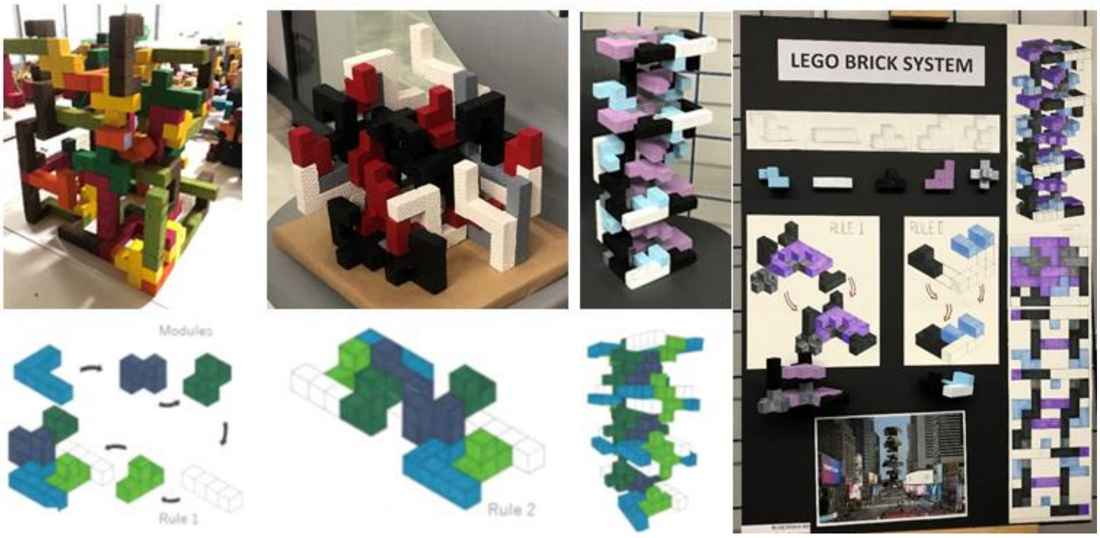


Figure 3. Student models and drawings

In this exercise a teaching method was devised on the basis of shape grammars. Teaching design using the "form generation" method provided students practical design experience. In addition, students practiced the manipulation of forms and volumes and spatial perception.

Exercise 3: Folding as a Form-Finding Design Process

To better understand the importance of ergonomics in design, the third exercise focuses on the concept of movement through the human body. The aim of this exercise is to design a cover for an arm, while using folding technique as a form-finding design process (Table 4). As Lebee (2015) states that the link between origami and mathematics is deep and therefore, in the last decades, origami has emerged as a new field of research. Many innovations merging mathematics, kinematic and structural properties of folding techniques are called Origamics (Stewart, 2007). Lebee (2015) mentions that, at the end of the 19th century, building and designing objects begin to be driven by the fabrication process and not only by formal questions. Even though mastering at folding techniques is time-consuming, the folding process is simple. Furthermore, it is a fast and easy way to teach structural design properties and material performances. During this exercise, to learn specific folding techniques, Jackson's (2011) book called *Folding Techniques for Designers-From Sheet to Form* and his "how to" videos are used by most of the students.

The most important challenges of this design task were as follows; students were allowed to use only one type of material (i.e. Kraft paper, 120-160 gr.), and they were allowed to use an interlocking system as an assembly method for connecting different parts of the cover. This means that using glue, staples, or sewing were not allowed. The natural Kraft paper had a natural brown colour, and any decoration or colouring were not permitted. However, the students could combine different folding techniques. Merging different folding techniques with cutting techniques or origami techniques were also allowed.

Briefly, during this exercise, the students measured their own arms and then based on the constraints and specifications related to human ergonomics, they designed an arm cover specifically for their arms by using craft paper as the material. The arm posture, the movement abilities of three joints (the shoulder, the elbow, and the wrist) were studied with diagrams. At the end, they designed a wearable arm cover prototype by using folding techniques as a form-finding design process.

Table 4. Contents of Exercise 3

Duration	Title	Keywords	Rules	Objectives	Materials
Three weeks	Wearable Arm Cover	Ergonomics, body, movement, flexibility, material performance	- Origami or folding techniques must be used to design the arm cover - Colouring is not allowed - Sewing, using staple and glue are not allowed - Adding/combining different folded surfaces are allowed - Connections can be made by clamping or similar techniques	- to design an arm cover that covers the parts from the wrist to the neck, - to design a cover based on the movement limitations of the three joints (shoulder, elbow, wrist)	Kraft paper (120-160 gr)

At the beginning of the exercise, the students studied human movements, Labanotation (Laban, n.d.), and they focused on three joints of an arm. They studied limitations and ergonomics of an arm. As can be seen in Figure 4, the students used different representation techniques such as diagrams and photographs for analysing human movements. Furthermore, they used different representation methods to describe design stages of the used folding techniques (Figure 5).

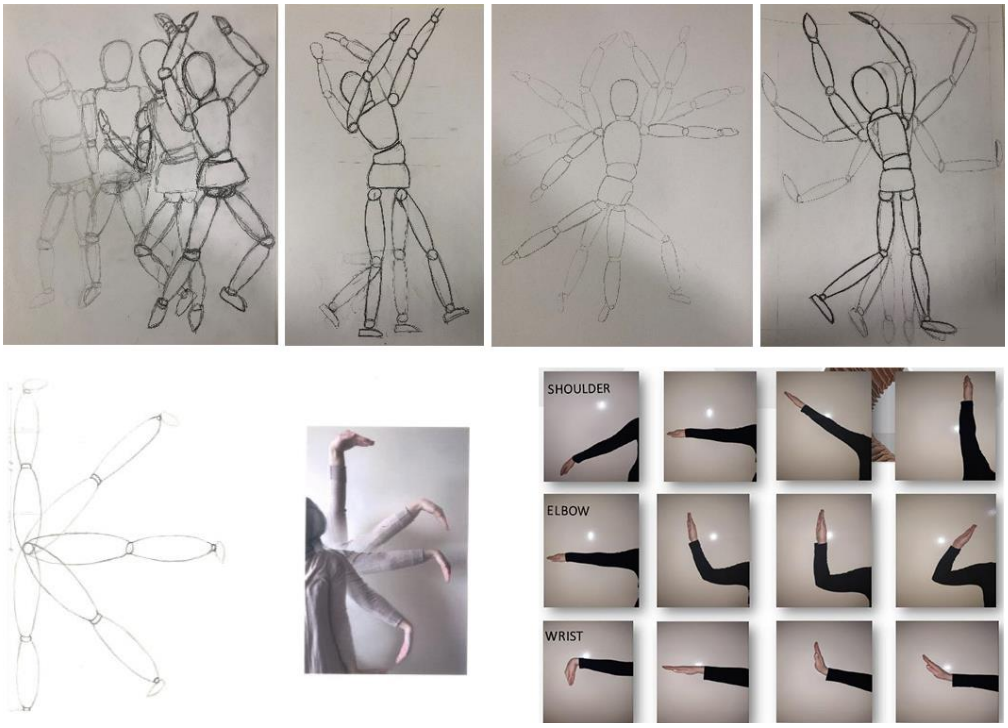


Figure 4. Top: Analysis of human movements (student drawings); Bottom: Analysis of arm movements (student projects)

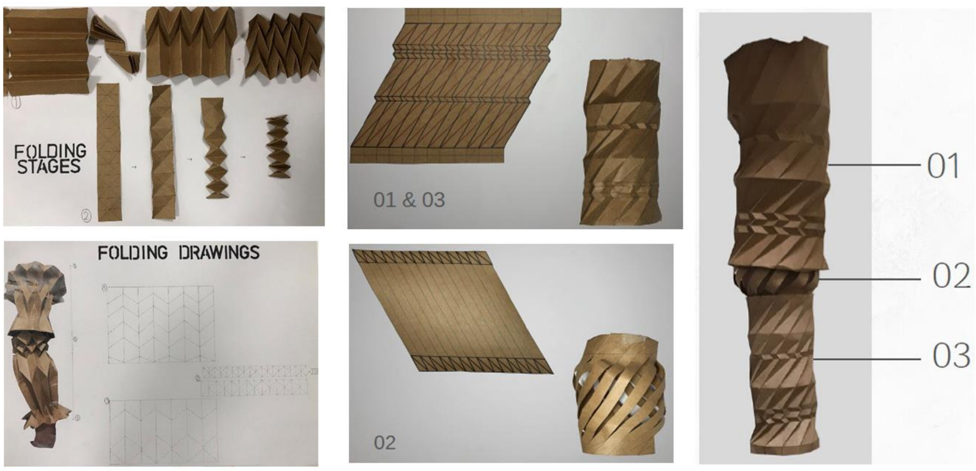


Figure 5. Design stages of a folding technique (student projects)

Today, the use of parametric design software such as Rhino's Grasshopper, eases the design process and improves the quality of the end products. However, the main aim of this design studio is teaching design principles by using parametric approach without the help of any design software. Even though the students do not use any software, they use algorithmic design thinking and systematic approach during developing their designs.

different parts were tested. It appeared that such a design task needs more time. However, since each exercise is based on similar computational design principles, students get familiar with parametric design thinking and they understand how to analyse and represent human movements, the importance of ergonomics, material durability as well as the importance of time management.

Figure 6. Wearable prototypes (student models)

Due to the time limitations of the exercise (three weeks), using folding as a form-finding design process was a challenging task. Analysing arm movements, experimenting different folding techniques, combining different folding techniques in order to accommodate specific requirements of different parts of their arms (such as using different techniques for joints, and resizing the folding technique based on the part of the arm), finding the best representation technique to explain their design process were the main challenges. During the final jury presentation, they wore the prototype and did certain movements asked by the jury members (Figure 6). By this way, the durability of the prototype, the solution used for connecting

Exercise 4: Topography of Sound

The aim of the fourth exercise is to study a physical environment and to investigate spatial perception in the built environment (Table 5). The main objective is to design an artificial topography using sounds of the city. First, the students are asked to record a video that should contain at least five different sounds. This 20-second video recording should be recorded at the same point and recorded without changing the angle and the position of the recorder. By this way, they could observe different sounds during the video recording. To accurately measure and analyse a sound, the difference between the types of sounds should be understood. Therefore, students separated

Table 5. Contents of Exercise 4

Duration	Title	Keywords	Rules	Objectives	Materials
Three weeks	Topography of sound	Sound level, noise, frequency, topography, space, time	- the 20-second video recording will be recorded at the same point and recorded without changing the angle and position - the recording sound should contain at least five different sounds	- to design an artificial topography using sounds of the city	Cardboard, acetate, metal plates, paper, wire, plastic or wooden plates, etc.

different sounds on their recordings based on the types and the origin of these sounds. For example, they separated natural (birds, sea waves, wind, human noise, animal, etc.) and unnatural sounds (vehicles, alarms, machinery, announcements, etc.). They also classified these sounds based on duration, such as continuous sound, intermittent sound, impulsive sound. Continuous sound can be caused by a machinery that keeps running without interruption (respiratory apparatus in a hospital, generator, or a highway noise). Intermittent sound can increase and decrease rapidly. This might be caused by a train passing or an ambulance. Impulsive sound can be defined as a sudden noise like a dog's barking, car brake or horn, or a child scream. The students studied spectrogram, the differences between outdoor and indoor sound levels, and they measured sound levels by different apps. Afterwards, they transformed the results of their analyses into an artificial topography. Some of the students used their sound graphs as a base for developing the topography, and some of them transformed sound level estimates into a topography. The student models of this exercise can be seen in Figure 7.

Figure 7. Student projects

Through this exercise, students developed a better understanding of the built environment and their surroundings, and acquired spatial skills related to urban planning, geography, and landscape design.

Conclusion

This paper explained the process, challenges, and opportunities of developing a curriculum based on parametric design principles in fine arts, design, and architecture undergraduate degree program. This curriculum was used on first year first semester architecture (N = 196), interior architecture (N = 184) and urban planning (N = 18) students. It was a challenge to design four different design exercises that aim different undergraduate programs. All exercises served different purposes; the main aim was to better understand spatial perception and develop critical design thinking through different scales such as human scale, building scale and urban scale. While doing so, computational approach was integrated into these exercises. The first-year design teaching and incorporating new knowledge, behaviours, and skills to students' learning experience are challenging tasks. The experiments gained from these four exercises showed that the method has improved students' intellectual and cognitive design skills and also such innovative ways of developing a design project can give studio teachers wider perspectives in architectural education.

To conclude, in this study, a non-computerized method to integrate parametric design thinking in early design studios is described. This method provides a systematic way to understand parametric thinking from an early stage in design education. Beyond tools and technology, educating students in a new process-driven way of thinking and exploration is needed to develop new skills to solve challenging design problems, collaborate effectively, and express ideas in new ways. Parametric design is a new tool for a more analytical type of thinking which develops the ability to analyse, synthesize and respond to design problems. We think that the use of our method has empowered students to be ready for the new era of architectural design. Therefore, we believe that sharing our experiences with broader international educators and academicians provide all of us with some clues for improving the first-year design education system.

References:

Betancourt, M. C., Quintero, L. M., & Cereceda, G. (2014). A Discussion on Algorithmic Thinking in Product Design Process. In DS 77: *Proceedings of the DESIGN 2014, 13th International Design Conference*, 1035-1042.

Chan, C. S. (2012). Phenomenology of rhythm in design. *Frontiers of Architectural Research*, 1(3), 253-258.

Denning, P. (2009). The profession of IT beyond computational thinking. *Communications of the ACM*, 52(6), 28-30. doi:10.1145/1516046.1516054.

Hacihasanoglu, O. (2019). Architectural Design Studio Culture, Journal of Design Studio, 1(1), 5-15.

Jackson, P. (2011). *Folding Techniques for Designers-From Sheet to Form*. Laurence King Publishing.

Koch, A., Schwennsen, K., Dutton, T.A., Smith, D. (2002). The Redesign of Studio Culture: A Report of the AIAS Studio Culture Task Force, Washington DC.

Laban, R. (n.d.) Labanotation (online). Available at: https://labaninstitute.org/about/laban-movement-analysis/ (accessed 04 July 2020).
2

Lebée, A. (2015). From folds to structures, a review. *International journal of space structures*, 30(2), 55-74.

Milovanovic, J., & Gero, J. (2020). Modeling design studio pedagogy: A mentored reflective practice. In Proceedings of the Design Society: DESIGN Conference (Vol. 1, pp. 1765-1774). Cambridge University Press.

Oh, Y., Ishizaki, S., Gross, M. D., & Do, E. Y. L. (2013). A theoretical framework of design critiquing in architecture studios. *Design Studies*, 34(3), 302-325.

Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. Design Studies, 52, 4-39.

Purcell, A.T. and Gero, J.S. (1998). "Drawings and the design process", *Design Studies*, 19(4), 389-430.

Rowe, P. G. (1987). Design thinking. MIT Press.

Saulnier, C. R., Bagiati, A., & Brisson, J. G. (2016). A comparison of student design activity preferences before and after a design-based wilderness education experience. In *Proceedings of the 2016 ASEE Annual Conference & Exposition*.

Schön, D.A. (1985). *The Design Studio*, RIBA, London.

Stewart, I. (2007). Mathematics: some assembly needed. *Nature*, Vol. 448, No. 7152, pp. 419.

Stiny, G. (2006). *Shape: talking about seeing and doing*. MIT Press.

URL-1: https://www.medipol.edu.tr/akademik/fakulteler/guzel-sanatlar-fakultesi/bolumler/mimarlik/program-bilgileri/ders-detayi?DersBolumID=338602#DersProgramYeterlilikleri

URL-2: https://www.medipol.edu.tr/en/academics/undergraduate-schools/fine-arts-design-and-architecture/departments/architecture/program-information#programYeterliligi

Wing, J. M. (2010). Computational Thinking: What and Why?, *The Link - The Magazine of the Carnegie Mellon University*, School of Computer Science, 1-6.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, 49(3), 33-35.