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BUILDING EMPATHY IN INTERIOR ARCHITECTURE EDUCATION:
EXPLORING EMPATHIC DESIGN AND ITS REFLECTIONS

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BUILDING EMPATHY IN INTERIOR ARCHITECTURE EDUCATION:
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A Ph.D. Dissertation

by

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By Melis Yeşiltepe

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy in Interior Architecture and Environmental Design.

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ABSTRACT

BUILDING EMPATHY IN INTERIOR ARCHITECTURE EDUCATION: EXPLORING EMPATHIC DESIGN AND ITS REFLECTIONS

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Integrating empathy to design education enhances students' universal design solutions since empathic design provides a feeling and understanding of a wide range of users' needs in the designed environment or products. This study investigates how using empathic design techniques as instructional design methods influence students' improvement in the multiple dimensions of empathy, design process and end products, and perceptions of their learning experience. The empirical research is conducted with three groups and a control group who are asked to experience different empathic design techniques (direct contact between designers and users, indirect contact between designers and users, and role-playing) obtaining in the redesign of an existing kitchen and reflecting their learning and design outcomes on an online session in virtual meetings. Qualitative data collection methods consist of behavioral observations, the researcher's logbook, interviews, and design conversation protocols obtained by video recordings of the Zoom meetings. Quantitative data collection methods include using a questionnaire and survey as instruments and assessment of end products. Thematic analysis was conducted to study data from interviews and design. Results indicated that an empathic design process positively indicated students' perceptions of their learning experience and enhanced their self-awareness and design awareness. In addition, empathic design improved students' problem-solving skills, helped them attain universal design solutions easily, and shortened the design process time. The role-playing technique was the most efficient compared to other techniques for raising students' empathy and proposing universal design solutions.

Keywords: Architectural Design Process, Empathic Design, Ergonomics, Kitchen Design, Universal Design

ÖZET

İÇ MİMARLIK EĞİTİMİNDE EMPATİ: EMPATİK TASARIM VE YANSIMALARININ ARAŞTIRMASI

Yeşiltepe, Melis

Doktora, İç Mimarlık ve Çevre Tasarımı Bölümü

Danışmanı: Prof. Dr. Halime Demirkan

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Empatiyi tasarım eğitime entegre etmek öğrencilerin evrensel tasarım çözümlerini artırır, çünkü empatik tasarım tasarlanan ortamda veya ürünlerde kullanıcıların ihtiyaçlarını hissedebilmeyi ve anlayabilmeyi sağlar. Bu çalışma bir öğretim tasarımı yöntemi olarak empatik tasarım tekniklerinin, öğrencilerin empatilerinin çoklu boyutlarındaki gelişimlerine, tasarım süreçlerine ve ürünlerine ve öğrenme deneyimlerine ilişkin algılarını nasıl etkilediğini araştırmayı amaçlar. Deneysel çalışma, mevcut bir mutfakın yeniden tasarımında farklı empatik tasarım tekniklerini (tasarımcılar ve kullanıcılar arasında doğrudan iletişim, tasarımcılar ve kullanıcılar arasında dolaylı iletişim ve rol-alma) deneyimlemeleri, öğrenme ve tasarım sonuçlarını sanal toplantılarda çevrimiçi ortamda yansımaları istenen, üç grup ve bir kontrol grubu ile yapılmıştır. Nitel veri, davranışla ilgili gözlem, araştırmacının kayıt defteri, görüşmeler, ve Zoom toplantılarının video kayıtları ile elde edilen tasarım konuşmaları tutanaklarını içermektedir. Nicel veri toplama yöntemleri ise, anket ve ürün değerlendirmelerini içerir. Görüşme ve tasarım sürecinde elde edilen verilerin analizinde tematik analiz kullanılmıştır. Bulgular, empatik tasarım sürecinin öğrencilerin öğrenme deneyimleri üzerindeki algılarında olumlu bir etkiye sahip olduğunu göstermiştir ve onların öz farkındalıklarını ve tasarım farkındalıklarını artırdığını göstermiştir. Ayrıca, empatik tasarım, öğrencilerin problem çözme becerilerini geliştirmiş, evrensel tasarım çözümlerini kolayca bulma yönünde yardım etmiş ve tasarım sürecinin süresini kısaltmıştır. Rol alma tekniği, diğer tekniklere kıyasla öğrencilerin empatilerini artırmada ve daha fazla evrensel tasarım çözümü öneriminde bulunma konularında daha etkili bulunmuştur.

Anahtar Kelimeler: Empatik Tasarım, Ergonomi, Evrensel Tasarım Mutfak Tasarımı, Mimari Tasarım Süreci

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LIST OF ABBREVIATIONS

ADA: Americans with Disabilities Act
BADL: Basic Activities of Daily Living
DfA: Design for All
EC: Empathic Concern
ED: Empathic Design
EM: Empathy Map
FS: Fantasy
HCD: Human-Centered Design
HF/E: Human Factors/Ergonomics
IADL: Instrumental Activities of Daily Living
ID: Inclusive Design
IDP: Interaction with Disabled Person Scale
IHCD: The Institute for Human-Centered Design
IRI: Interpersonal Reactivity Index
M: Mean
Md: Median
SD: Standard Deviation
SEDM: Systematic Empathic Design Method
SPSS: Statistical Package for Social Sciences
NCSU: North Caroline State University
PD: Personal Distress
PT: Perspective Taking
UD: Universal Design
UK: United Kingdom
UPDEM: Universal Product Design Evaluation Model
USA: United States of America
USAP: Usability, Safety, Attractiveness Participatory

CHAPTER 1

INTRODUCTION

In today's world, the design of products or environments influence people's daily life activities, lifestyles, and psychology. Ease or difficulty in use of environment or product depends on designers' ability and emotional sensitivity. Each person, especially persons with diverse abilities (e.g., people who have sensorial or physical impairments, people who have short or long stature, children with autism, pregnant, elderly, children etc.) have various needs, expectations or problems in product or environment use. Designers' one of the essential goals is answering all those requirements regarding the universal design (UD) and human factors/ergonomics (HF/E) principles in their designs.

Universal design is described as 'the design of products and environments to be usable by all people, to the greatest extent possible, without adaptation or specialized design' (The Center for Universal Design, 1997). The seven principles of UD (The Center for Universal Design, 1997) are developed by several experts from different design disciplines to lead designers to create universally usable designs. According to the definition which was developed by the International Ergonomics Association and has been adopted by the Human Factors and Ergonomics Society "Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance" (*Human Factors and Ergonomics Society*, n.d.). Previous studies have shown that designers should make designs to meet the needs of all people

and empathy is a crucial quality for designers and helps them to learn about people's needs, wishes, feelings, expectations, possibilities and limitations, preferences and behaviors and understand them in their contexts (Frascara, 2017).

Empathy is the process in which a person puts himself/herself in the other person's place and looks at things from his/her point of view, understands and feels the feelings and ideas of that person correctly and transfers this situation to him/her (Rogers, 1970). There are two components of empathy; affective (emotional) and cognitive empathy should be taken into consideration (Dökmen, 2008). "From a cognitive perspective, empathy consists of either understanding the psychology of others (i.e., their thoughts, intentions, feelings etc.) or, more specifically, their feelings" (Strayer, 1987, p.128). Affective (emotional) empathy is appreciation of other's feelings and reacting to and sharing feelings (Dökmen, 1988). Empathy is our intuitive ability that can be taught and developed (Decety & Chaminade, 2003).

In designers, empathic awareness is increasing to feel and understand a wide range of users' needs and expectation from the environment or product. Researchers have been studying empathic design (ED) techniques for integrating empathy in the design process. Kouprie and Visser (2009) classified these techniques as "techniques for direct contact between designers and users (research), techniques for communicating findings of user studies to design teams (communication), techniques for evoking the designer's own experiences in a domain relevant to the user (ideation)" (Kouprie & Visser, 2009, p. 439). They also developed the framework based on four phases of empathy. "These phases are (1) discovery, (immersion), (3) connection, and (4) detachment" (Kouprie & Visser, 2009, p. 444).

Considering design education, teaching the relations between empathy and design enhances students' awareness (Altay & Demirkan, 2014; Altay, 2014) and plays a significant role on students' design projects (Altay et al., 2016). Use of ED as instructional design methods provide many advantages to the design instructors and students.

Building empathy in design practice and education provide the following advantages for both designers and students:

- Empathic design delivers deep understanding of people’s feelings, thoughts, problems, needs and expectations of product and/or environment (Altay & Demirkan, 2014).
- Empathy has three main opportunities as:
 - “expanding our understanding of the people and situations we study
 - helping us to develop effective working relationships with our sponsors and implementation colleagues
 - helping us to communicate the important ergonomic issues to implementers, by facilitating their empathy with users” (Suri, 2001, p. 1282).
- Empathic understanding allows designers to create more accessible and universally designed products and/or environments for all people whether having diverse abilities or not (Altay & Demirkan, 2014; Altay, 2014).
- Empathy promotes students’ awareness of user’s needs and reveals positive impacts on students’ designed projects (Altay, 2017; Altay et al., 2016; Altay & Demirkan, 2014; Gomez-Lanier, 2018; Kocaoğlu & Demirkan, 2019; Torrens, 2000).
- Empathy allows designers to increase their social relationship with people (Devecchi & Guerrini, 2017; Ho et al., 2011).

1.1 Problem Statement

Reflecting UD approach into the design projects is not straightforward for interior architecture students. It is challenging for them to design by considering the needs of all users and keeping UD approach and HF/E principles throughout the design process. However, previous studies showed that empathic understanding is an essential ability

for students to feel and understand a wide range of users' needs and expectations from the environment or product (McDonagh & Thomas, 2010; McDonagh et al., 2011). Consequently, this study is based on empathic design approach in interior architecture education.

In recent decades, many studies have investigated the role of empathy on industrial design or engineering education (Bairaktarova et al., 2016; Hess & Fila, 2016; Lam & Suen, 2015; McDonagh, 2015; McDonagh et al., 2011; Rasoal et al., 2012; van Rijn et al., 2011), and on interior architecture education (Altay, 2017; Altay et al., 2016; Altay & Demirkan, 2014; Gomez-Lanier, 2018; Kocaoğlu & Demirkan, 2019). However, some deficiencies are identified in these existing empirical studies:

1. There are few studies that have experimented with and analyzed the effects of all three empathic design techniques as (1) direct contact between designers and users, (2) indirect contact between designers and users and (3) role-playing on interior architecture education. And most instructional studies focused on only role-playing technique.
2. There are few studies comparing and investigating the extent to which empathic design techniques have an impact on students' end products.

1.2 Aim and Scope

This study has a human-centered positional design theory, and the focal point of the theory is humans and the environment. Therefore, it is significant to explore the relationship between psychology and design education disciplines through a human-centered perspective. There are two foundations of this theory (1) systematic inquiry into the effects of building empathy (psychology) in interior architecture education, and (2) doing critical analysis on the relationship between these two variables.

To explore the effects of building empathy and its reflections on interior architecture education, the aim of this study is to investigate the influences of empathic design

process on students' improvement in the multiple dimensions of empathy, their design process and end products and perceptions of their learning experience. Therefore, it is also essential to answer the research questions; (1) 'how does experiencing empathic design process affect interior architecture students' improvement in the multiple dimensions of empathy?', (2) 'To what extent does empathic design process reflect the interior architecture students' design process and end products in terms of applying HF/E and universal design principles?', (3) 'how does experiencing empathic design process reflect on students' perceptions of their learning experience?'

The methodology of this study involved mixed method research with quasi-experimental design. The purpose of this methodology was to increase student learning in diverse ways (Altay, 2014). Undergraduate interior architecture students from second year were asked to experience diverse ED techniques (Group A, direct contact between designers and users, Group B, indirect contact between designers and users and Group C, role-playing, Group D, control group) by conducting different learning activities as participants, which were based on Kouprie and Visser's (2009) four phases of empathy framework. They were also asked to redesign an existing kitchen for the user who has a broken arm and reflect their learning and design outcomes on an online session in virtual meetings. Since it is an education issue, the educational objectives of this study were designed and analyzed according to Merrill's First Principles of Instruction (Merrill, 2002). The principles are "problem-centered/task-centered, activation, demonstration, application and integration" (Merrill, 2002, p.45).

The Covid-19 Pandemic affected this study's methodology since that period changed the system of education, design research, and Ph.D. process. All over the world, universities closed, and education was online. If the pandemic had not happened, the participants would have done this experiment in face-to-face meetings. The participation of 40 students (they would form four groups of 10 each) had been planned, but this could not happen. The pilot study was decided to be conducted with ten undergraduate students, but it did not happen either, only eight volunteer Ph.D. students participated. Also, the user would be selected as people with various abilities (physical and sensorial) and the number would be five, but only a user with a temporary limitation (a broken arm) participated in this study. Group A would have visited the users at home twice. At the first visit, they would interview and observe the

user, and at the second, they would codesign with the user. Group B would attend a lecture in the classroom, learn communication tools for obtaining information about the user, and watch the user's video recording. Group C would conduct role-playing activities with diverse users in the kitchen of the dormitory on campus, but it could not happen. All groups would redesign users' kitchen collaboratively in the design studio classroom on campus, and the group interview would generate in the classroom environment.

This study was primarily qualitative but was supported with quantitative data. The data collection methods of qualitative research were observations, interviews, video recorded meetings and researcher's logbook and for quantitative research are the Interpersonal Reactivity Index (IRI; Davis; 1980, 1983) and the kitchen survey adapted from Afacan and Demirkan (2010). The qualitative data analysis method of this study was thematic analysis. The meetings' video recordings including group interview, and design conversation protocols among students in the design process were analyzed by thematic analysis. The quantitative data analysis methods of this study were descriptive analysis and checklist analysis of design assessment sheets.

1.3 Structure of the Thesis

The chapters of the thesis were organized as follows. In Chapter 2, universal design and its principles were dwelled upon. First, the definition of UD, its developments in the principles and guidelines made throughout the past few decades were mentioned. Then, each UD principle was described by indicating related examples. This chapter also focused on the studies about teaching UD in design education. At the end of Chapter 2, evaluation methods in UD were explained.

In Chapter 3, building empathy in design education and design practice was explored. Human-centered design (HCD) approach was explained by comparing other approaches used in the design process. Definition and features of ED, which is one of the approaches of HCD were explained. The significance and advantages of ED were

mentioned, and the strategies and techniques used for promoting empathy in design were described with examples. The empathic model applications in design education and design practice as methodological research and as a design thinking model were indicated with their relevant studies. To give detailed information about the applications in design education, information about design pedagogy and interior architecture design process was introduced. The models were analyzed with a critical approach and the link between the models and this study's model was explained. The chapter ended with information about reflection/reflexivity in design studies. The meaning of 'reflection' in design research, different types, and levels of reflection in design education and its' relationship with ED were investigated.

In Chapter 4, the main study research methodology was presented. In the light of the aim and scope, the research questions, hypotheses, proposed model, data collection and analysis methods, participants, experimental setting, instruments, and procedure were presented. This chapter ended by giving detailed information about the pilot study and the main study.

In Chapter 5, detailed information of the results on the quantitative and qualitative analysis was presented. The results on the quantitative analysis included the results on IRI, the kitchen survey. The results on the qualitative analysis involved thematic analysis of design process and end products.

In Chapter 6, the discussion and interpretation of the results gathered from the experiment in relation to the literature review were presented. The results on the quantitative and qualitative results were discussed from both designer's and educator's points of view.

In Chapter 7, the conclusion of the thesis with a summary of study was given. This was followed by limitations of the study and suggestions for further studies.

CHAPTER 2

UNIVERSAL DESIGN

In this chapter, firstly, the definition of universal design and its progress were presented. In addition, seven universal design principles were explained in detail with comparative examples. Then, awareness and integration of universal design in design education were presented by indicating academic studies from different universities. This chapter ended with presenting evaluation methods such as checklist evaluation, holistic evaluation, heuristic evaluation, value-driven evaluation, pre-and-post evaluation in universal design evaluation and discussing these evaluation methods.

In the 1990s, the initial term *barrier-free design* aiming to remove the barriers for people who have disabilities in built environments appeared (Ostroff, 2010). Between 1970 and 1990s, the basis of UD approach on the *disability rights* had developed in the United States (Erkiliç, 2011). Ron Mace, an architect with mobility limitations, coined the term '*universal design*' as 'the design of products and environments to be usable by all people, to the greatest extent possible, without adaptation or specialized design' (The Center for Universal Design, 1997). The Center for Universal Design emphasized that remodeling-built environments and products from the origins and making them usable for all people is essential in their Factsheet (NCSU, 2006). UD is not just a trend or design style for people with diverse abilities, it is an approach to design by thinking all people. Over years, the terms *design for all* (DfA) and *inclusive design* (ID) have come to be the customary in the United Kingdom (UK) and in much

of northern and central Europe (Ostroff, 2010). The terms *all people* and *design for all* emphasize anti-discrimination regardless of sex, age, capabilities, and abilities and underlines the rights of those who have different abilities. In contrast to DfA and UD approaches, ID focuses on the needs of the product design and maximize product performance. The needs and capabilities of people with diverse abilities, especially the elderly, is an essential part of ID (University of Cambridge, 2017; Johson et al., 2010).

2.1 Universal Design Principles

Several experts (Bettye Rose Connell, Mike Jones, Ron Mace, Jim Mueller, Abir Mullick, Elaine Ostroff, Jon Sanford, Ed Steinfeld, Molly Story and Gregg Vanderheiden) at the University of North Carolina developed the seven principles and twenty-eight guidelines to express the idea of UD in comprehensive way (The Center for Universal design, 1997; Story et al., 1998) (see Table 1). “[t]hese principles are focused on equality, flexibility, comprehensibility, perceptibility, safety, low physical effort, and accessibility for all people when using the environments, products, communication and information and other services.” (Ceresnova et al., 2017, p.122).

These principles have been used as a guide by design professionals such as architects, engineers, product designers, educators etc. Since, if these principles are included in the design of a product or environment, the design embraces the use of a wide range of people.

The seven principles and the related guidelines are summarized in Table 1.

Table 1 The Principles of Universal Design (The Center for Universal Design, 1997, version 2.0 (4/1/97))

Principles	Descriptions and Guidelines
1. Equitable use	The design is useful and marketable to people with diverse abilities. -Provide the same means of use for all users: identical whenever possible; equivalent when not. -Avoid segregating or stigmatizing any users. -Provisions for privacy, security, and safety should be equally available to all users. -Make the design appealing to all users.
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities. -Provide choice in methods of use. -Accommodate right-or left-handed access and use. -Facilitate the user's accuracy and precision. -Provide adaptability to the user's pace.
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. -Eliminate unnecessary complexity. -Be consistent with user expectations and intuition. -Accommodate a wide range of literacy and language skills. -Arrange information consistent with its importance. -Provide effective prompting and feedback during and after task completion.
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. -Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. -Provide adequate contrast between essential information and its surroundings. -Maximize "legibility" of essential information. -Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions). -Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

(cont'd)

Table 1 (cont'd)

5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions. -Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded -Provide warnings of hazards and errors. -Provide fail safe features. -Discourage unconscious action in tasks that require vigilance
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue. -Allow user to maintain a neutral body position. -Use reasonable operating forces. -Minimize repetitive actions. -Minimize sustained physical effort.
7. Size and space for approach and use	Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. -Provide a clear line of sight to important elements for any seated or standing user. -Make reach to all components comfortable for any seated or standing user. -Accommodate variations in hand and grip size. -Provide adequate space for the use of assistive devices or personal assistance.

In the *UD principle 1, equitable use*, “the design is useful and marketable to people with diverse abilities” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). For example, automatic sliding doors (see Figure 1a) are usable by all people such as individuals using wheelchairs or walkers, parents with baby strollers, people carrying packages, people who have visual impairments, or people with no vision etc. Automatic sliding doors (see Figure 1a) minimize sustained effort, however, vestibule doors with two wings (see Figure 1b) are not equitably used by all users since it is heavy to open and has the risk of the door wings shutting on one's face.

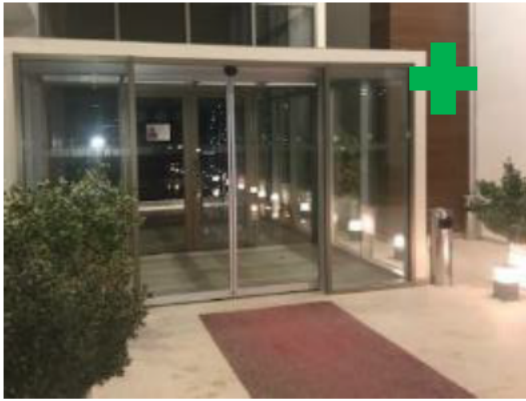


Figure 1a. An automatic sliding door (*photo by the author*)



Figure 1b. Vestibule door with two wings (*photo by the author*)

In the *UD principle 2, flexibility in use*, “the design accommodates a wide range of individual preferences and abilities” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). As seen in Figure 2a, the desks allow left and right-handed use. However, in Figure 2b, left-handed and right-handed students cannot write comfortably when they sit together.



Figure 2a. Desks for left-and right-handed person (*photo by the author*)



Figure 2b. Desks for three people (*photo by the author*)

In the *UD principle 3, simple and intuitive use*, “use of the design is easy to understand, regardless of the user’s experience, knowledge, language skills, or current concentration level” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). For instance, using a forehead thermometer in Figure 3a is easier than the digital one (see Figure 3b). The reason is that it is faster and more hygienic and has a larger screen and accommodates a wide range of literacy.



Figure 3a. A forehead thermometer
(photo by the author)



Figure 3b. A digital thermometer
(photo by the author)

In the *UD principle 4, perceptible information*, “the design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). As seen in Figure 4a, the street signs are easy to read thanks to the usage of fonts and different color. This color coding maximized the legibility of the street signs and increases attractiveness. However, the street signs in Figure 4b are not readable as the street sign in Figure 4a, because of its small fonts. If a person wants to see the signs better, he/she must get closer to the signs. So, the example in Figure 4b is not so suitable for people who have lower vision and old age.

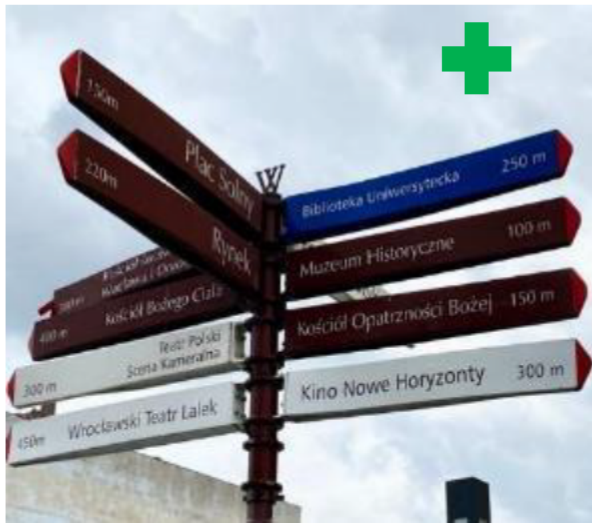


Figure 4a. Street signs (*photo by the author*)



Figure 4b. Street signs (*photo by the author*)

In the *UD principle 5, tolerance for error*, “the design minimizes hazards and the adverse consequences of accidental or unintended actions” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). For instance, gas cooktop in Figure 5a minimizes risk of burning rather than induction cooktop (see Figure 5b).



Figure 5a. Gas cooktop (*photo by the author*)



Figure 5b. Induction cooktop (*photo by the author*)

In the *UD principle 6, low physical effort*, “the design can be used efficiently and comfortably and with a minimum of fatigue” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). In Figure 6a, the disinfection with sensor allows users to maintain a neutral body position, minimizes repetitive actions and minimize sustained physical efforts. However, the other disinfection as seen in Figure 6b does not and a person who use walker/wheelchair or have a broken leg cannot use it.



Figure 6a. The disinfection with sensor (photo by the author)



Figure 6b. The disinfection (photo by the author)

In the last *UD principle 7- size and space for approach and use*, “an appropriate size and space is provided for approach, reach, manipulation, and use regardless of user’s body size, posture, or mobility” (The Center for Universal Design, 1997, version 2.0 (4/1/97)). As seen in Figure 7a, sinks with varied heights provide for approach of user’s body size, posture, or mobility. If the cabinet under the sink is removed, it would provide an adequate space for the people who use assistive devices or wheelchair. However, the child in Figure 7b has difficulty reaching the sink and he uses the step, but this situation could be dangerous for him.



Figure 7a. The sinks with two heights
(photo by the author)

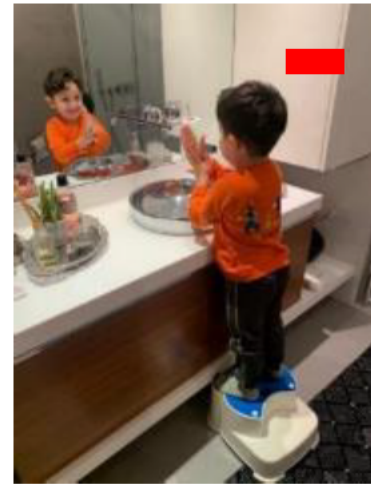


Figure 7b. The sink with single height
(photo by the author)

In 2012, the seven principles of UD were updated and expanded by the Center for Inclusive Design and Environmental Access at the University at Buffalo. The 8 goals of UD (body fit, comfort, awareness, understanding, wellness, social integration, personalization, and cultural appropriateness) which are more action based than the principles, and include social participation, cultural inclusion health and wellness was published (Steinfeld & Maisel, 2012). Furthermore, each goal is supported by an interdisciplinary knowledge (anthropometry, biomechanics, perception, cognition, human performance, and social participation). The goals accompaniment the seven principles of UD, and still stand them as general principles.

The first four goals are adjusted to human performance: anthropometry, biomechanics, perception, and cognition. Wellness is related to human performance and social participation. The others are oriented with social participation outcomes. The first goal is centered on accommodating a wide range of body sizes and abilities. The second is related to keeping demand within desirable limits of body function and perception. The third one is based on awareness, care about ensuring that critical information for use is easily perceived. For the fourth one, making methods of operation and use intuitive, clear, and unambiguous is essential. Social integration is fundamental in the fifth goal with treating all groups with dignity and respect. In addition, for the seventh

goal which is called personalization, incorporating opportunities for choice and the expression of individual preferences are essential. The last goal focuses on cultural appropriateness, respecting and reinforcing cultural values, and the social and environmental context of any design project (Steinfeld & Maisel, 2012).

2.2 Universal Design in Design Education

In many countries, there is an awareness of UD both between design instructors and practitioners to respond to the needs of people with diverse abilities' needs (Olguntürk & Demirkan, 2009). However, models, pedagogic strategies, and methods in teaching UD need to be developed and tested in the design process (Vavik, 2011).

It is significant to emphasize UD issues as innovative teaching strategies and UD needs to be considered as one of the fundamental aspects of design education (Afacan, 2011). The UD courses could not be theoretical add-on courses; they should be incorporated into the whole education program (Ergenoğlu, 2015) with various teaching strategies (Dong, 2010; Vavik, 2011). Students need to provide creative design solutions to environmental design problems in making the built environment universally usable for all human beings. Since UD principles are considered to enrich the function and quality of built environments or products in design education (Olguntürk & Demirkan, 2009). UD education should have a holistic perspective, while emphasizing the dimensions of the user relationships rather than only focusing on the design scale (Ergenoğlu, 2015).

There are growing numbers of studies that are related to teaching UD in architectural education area. Those studies implement UD approach and/or principles into the design process and evaluate the design process. For instance, Olguntürk and Demirkan (2009) asked students to evaluate public buildings according to the seven principles of UD and HF/E principles and found that students learned UD approach and its principles more effectively when evaluating buildings' universality and, students found more feasible design solutions. Likewise, Busby and Harrison (2018) integrated

UD into the curriculum named it as *live project*, which aimed to promote age-friendly housing. Second year architecture students experienced incorporating UD principles into their housing design solutions. Similarly, in Hidayetoğlu and Műezzinoğlu (2018)'s study, the UD principles were introduced. Then, students were asked to incorporate these principles into their designs such as spaces, products, and services, considering the needs of people with diverse abilities' needs. Their study groups enabled the active involvement of people with diverse abilities. Vavik (2011) designed a course that includes user participation in UD process as learning strategy and had positive feedback from students about building direct contact with the user. Ergenoğlu (2015) proposed a learning method consists of 6 modules namely as "(1) pre-evaluation, (2) basic disability and diversity information and case study, (3) the relationship between universal design concept and architectural design, (4) case study, (5) review, (6) searching and sharing (being up to date)" (pp. 1401-1402) as UD education model.

There are also various research studies assessing either the attitudes of students and instructors towards UD (Afacan, 2011) or only students' attitudes on DfA approach (Memikoğlu, 2014) and on disability (Hitch, et al., 2016). Besides, some studies focused on the prioritization of awareness on UD concept in design education (Ergenoğlu, 2015). Afacan (2011) analyzed the significance of UD education both from students' and instructors' point of view. She interviewed with 79 fourth year interior architecture students and 23 instructors from I.D. Bilkent University, Turkey. According to the statistical analysis, most of the students (41 out of 79) were aware of UD values; and most of the instructors (16 out of 23) were aware of UD and they considered the UD concept in evaluating the design projects. A similar study was conducted by Memikoğlu (2014), as she interviewed 30 interior architecture students from Çankaya University, Turkey about students' attitudes to the DfA approach and their capability to incorporate this concept into their design projects. However, it was found that most of the design students at Çankaya University need to encourage strategy to understand the DfA concept to integrate this approach into their design projects. Moreover, the findings indicated that the DfA approach should be incorporated into the design curriculum, as an elective course or within the context of design studios. Moreover, in UD education, understanding and responding to the needs of diversity of users is essential. Hitch et al. (2016) researched how UD education has

an influence on the attitudes of students towards people with diverse abilities. A total of 147 Australian undergraduate architecture students completed the Interaction with Disabled Person Scale (IDP). According to the results of their study, students who had taken the UD education had more positive attitudes towards people with diverse abilities.

Many studies highlighted the standing of UD education to meet the needs of the people with diverse abilities and create more inclusively designed environments for them and developed a pedagogical framework for UD education. They proposed several teaching strategies, models, and techniques about integrating UD approach into design education curriculum as an elective/distinct course and/or within the design studios (Ergenoğlu, 2015; Olguntürk & Demirkan, 2009; Vavik 2011) and proposed using mixed methods as passive and active methods in teaching UD concept (Ergenoğlu, 2015). Critical reflection, self-awareness of learning, observing, experiential learning are the tools that researchers emphasized besides lecturing, discussing, and searching. After the course, a case study, workshop etc., about UD should be conducted. Also, the assessment needs to be completed to understand if there is any improvement in students' awareness of the needs of people with diverse abilities.

2.3 Evaluation Methods in Universal Design Evaluation

Sanford (2009) categorized the UD evaluation into the *potential demands* and *actual demands* of individuals in buildings. “Evaluations based on potential demands enlist existing standards and guidelines as the objective basis from which to measure the success of a building. Evaluations based on actual demands analyze how people perform in a given building verified by direct observation or testimony” (Shea et al., 2016, p. 6). List and checklist evaluations, value-driven evaluations, heuristic evaluations, and pre-and post-evaluations are the common evaluation methods that are used in UD process in the literature.

2.3.1 Checklist Evaluation Methods

A checklist is defined as “a list of all the things that you need to do, information that you want to find out, or things that you need to take somewhere, which you make in order to ensure that you do not forget anything” (Collins English Dictionary, “Checklist, n.d.”). Checklists are used as a type of evaluation tool in various UD studies. They are mainly focused on potential user needs that involve building surveys and document analysis as guidelines, regulations physical building layout and/or professional experts (Shea et al., 2016).

The Center for Universal Design (2006) prepared a list about UD features in housing as a guide with the idea of “the more universal design characteristics or features included, the more usable the house” (p.3). The list of characteristics is elements, features, ideas, or concepts of universal housing. The researchers explained the goal of preparing universal product characteristics as; “to promote the selection and use of products that are well designed, attractive, and have easy-to-use features that results in a convenient, comfortable and safe home environment for people of all ages and abilities” (The Center for Universal Design, 2006, p. 13).

In the UD literature, there are several checklists prepared to guide and used by students, architects, consumers, developers, stakeholders and who are interested in universally designed products and environments. For instance, ‘ADA Checklist for Existing Facilities’ which was based on the 2010 ADA Standards for Accessible Design. It was prepared by the New England ADA Center, was a project of the Institute for Human Centered Design (2016) and a member of the ADA National Network. In addition, many housing checklists as Universal Design and Green Home Survey Checklist prepared by Sandler (2016), AARP Housing Checklist prepared by AARP Housing Options Outreach and Service/Livable Communities (AARP, 2008) were prepared for designing livable, comfortable, safe and energy efficient homes. Additionally, some researchers developed various checklists in their UD evaluation studies. Afacan and Demirkan (2010) used UD principles as the checklist items to assess the design solutions. In their study, they developed UD plug-in interface to assist designers as a guide for universal kitchen design solutions. Besides, Afacan and

Demirkan (2010) utilized prioritization technique in engineering design to a universal kitchen design. The authors stated that prioritization of requirements is needed to satisfy people with diverse abilities' needs, capabilities, and expectations in home design. Moreover, the authors developed the survey instrument with 87 items for universal kitchen design features. The kitchen users with several abilities (adults, elderly, adults with impairments) were asked to rank their importance levels of the features.

2.3.2 Holistic Evaluation Methods

Holistic evaluations focus on potential demands and actual demands of individuals (Sanford, 2009) in the buildings. The actual/potential users' needs are significant in measuring the physical features of a building. Mostly, the holistic evaluation assesses the synergy between users and the building. The questionnaires, interviews and workshops are the type of instruments that are used in holistic evaluation. Evaluation of buildings is based on existing knowledge and generated new knowledge as the outcome of the holistic evaluation (Shea et al., 2016). To illustrate, Gylling et al. (2011) developed a holistic evaluation method for sustainable buildings through qualitative and quantitative evaluations. Zallio et al. (2017) utilized a holistic evaluation tool for the analysis of adaptive environments for older adults. Architectural accessibility, interior design features and interactive technologies were investigated to facilitate safe adaptive and technology-based housing for older adults.

2.3.3 Heuristic Evaluation

Heuristic evaluation, which is “an informal method of usability analysis where a number of evaluators are presented within an interface design and asked to comment on it” (Nielsen & Molich, 1990, p. 249), has been common since the early 1990s. In the UD process, heuristic evaluation could be used to identify the usability problems of a built environment. To illustrate, Afacan and Erbuğ (2009) studied an interdisciplinary heuristic evaluation method in terms of UD principle as a set of heuristics for universal usability evaluation. Researchers focused on usability

evaluation method in architectural design context and took seven UD principles as a set of evaluation heuristics in a shopping mall, in Ankara, Turkey. In that study, five evaluators with different design professional backgrounds analyzed the shopping mall, whether it demonstrated the characteristics of a universally designed or not. Evaluators visited the shopping mall and conducted five task scenarios including seven principles of universal design to evaluate each floor (Afacan & Erbuğ, 2009). At the end of the study, heuristic evaluation was found practical in the analysis of universal usability in architectural design context.

2.3.4 Value-driven Evaluation

Value-driven evaluation is one of the types of evaluation methods that focuses on the actual user needs (Shea et al., 2016) and chooses a single parameter (Waldner, 2004) and evaluates the system/building based on that parameter. The common tools that are used are questionnaires, interviews, and workshops in value-driven evaluations. Besides, user feedback and testimony are used as the data sources (Shea et al., 2016). In addition, based on the rating values of users on product/environment utilization, Singh and Tandon (2016) proposed Universal Product Design Evaluation Model (UPDEM). The user-value based evaluation model was built to examine the universality of the products and provide functional and usable products for a wide group of people. Fourteen user values were obtained and tested using the model to discover the relevant principles of UD. The model was tested in a case study related to the production of staplers and the results indicated that the model helps the designer in the decision-making process as well as in both pre- and post-design phases.

2.3.5 Pre- and Post- Evaluation Methods

Some studies (Afacan & Erbuğ, 2009; Ergenoğlu, 2013; Gomez- Lanier, 2018) utilized pre- and post-evaluation methods in their experiments about UD. Afacan and Erbuğ (2009) conducted pre-and post-interviews with design experts in their study about the analysis of the shopping malls using heuristic evaluation methods. The study consisted of three sessions: pre-interview, task scenarios and post- interview sessions. In the pre-

interview session, the semi-structured interviews about construction drawings of the site were done by each expert in their own office environments. After the site visit, the post-interview session was conducted to produce a more detailed evaluation. Researchers emphasized the importance of post-interviews on detecting usability problems and design recommendations for the mall (Afacan & Erbuğ, 2009).

Ergenoğlu (2013) applied pre-evaluation of accessibility awareness, which was related with the accessibility, disability, and the design criteria, in the preliminary study phase. In that phase, the architecture students filled out a questionnaire form about their knowledge level about disability and then they answered the questions related to the ranking of design criteria. After the activities that increased their awareness in UD, a post-evaluation study was conducted involving observations, submitted works and anonymous student comments (Ergenoğlu, 2013). After the experiment, students' responses (about disability and diversity) given to the same design criterion-ranking question was found different compared to the pre-test ones.

Moreover, in another experiential study (Gomez-Lanier, 2018) conducted in interior design education, residential renovation project was designed with families who have members with diverse physical abilities. In their study, ten interior design students had interviews with their respective families to understand their clients' needs and problems and conducted pre-and post-project survey about the design process. According to the statistical analysis of the pre- and post-project responses, it was understood that students' understanding of user's needs and skills on proposing possible design solutions had increased.

2.3.6 Discussion on Universal Design Evaluation Methods

Checklist evaluations are practical and easy to analyze, but inadequate for evaluating the universality of building holistically (Shea et al., 2016). Holistic evaluations require specific and general synthesis with a wide range of participants and much time but provide evaluation of the buildings in a comprehensive way. Heuristic evaluations could be used as usability evaluation method in building design practice with the

concern of UD principles. And interdisciplinary heuristic evaluation could save both the budget and required time as well as reduce the error rate in universal usage of the built environment (Afacan & Erbuğ, 2009). However, the heuristic evaluations do not deal with the actual user needs as far as value-driven evaluations are concerned. Value-driven evaluations, which contain questionnaires, interviews, and workshops, are significant “in establishing indicators of a building’s empathy toward its users” (Shea et al., 2016, p. 18). Moreover, pre-and-post evaluation methods could be utilized to understand the level of awareness, knowledge, and skills of students in UD process. Each evaluation method could be used in UD studies, but in this study a combination of the methods of evaluations (Shea et al., 2016) are used to analyze the process and the projects in the light of UD approach. The evaluation methods that are used in this study are checklist evaluation, value-driven evaluation, and pre- and post-evaluation.

Universal Design is an approach for embracing all human beings to the greatest extent possible with no special and adaptable design (The Center for Universal Design, 1997). Over the years, UD has developed and expanded DfA approach and underlined anti-discrimination against people with diverse abilities. To respond to diverse people’s needs, the approach of UD and its’ seven principles are emphasized with their application in design education. Also, how the products and buildings are assessed according to the UD evaluation methods is mentioned. Like the UD approach, the HCD method that uses the seven UD principles and supports the DfA approach also gives emphasis to building empathy in design process.

In the following chapter, building empathy in design education and practice were investigated. The Human-Centered Design approach was explained by comparing other approaches used in the design process. The definition of empathy and empathic design were explained. Furthermore, the significance and advantages of empathic design were mentioned, and the strategies, techniques and models used for promoting empathy in design were described with examples.

CHAPTER 3

BUILDING EMPATHY IN DESIGN EDUCATION AND PRACTICE

In this chapter, the HCD approach was explained by linking other design approaches in the design process. Empathic design, which is one of the HCD approaches, was presented in detail by expressing growing awareness of empathic understanding among the design educators and designers. In addition, experiential studies about ED integration in design courses from different universities were indicated. Three main empathic design techniques were explained in detail. The empathic model applications in design education and design practice as methodological research and as a design thinking model were indicated with their relevant studies. To give detailed information about the applications in design education, information about design pedagogy and interior architecture design process was introduced. The models were analyzed with a critical approach and the link between the models and this study's model was explained. The chapter ended with information about reflection/reflexivity in design studies.

In the late 1960s, there were problems with modernism in architecture and urban development. "At that time, architects, planners, and social scientists, often laboring in obscurity, began advancing the idea that design could be human-centered and truly dedicated to usefulness" (Steinfeld & Maisel, 2012, p.34). Simon's (1969) definition of design involves human-centered approach; "[e]veryone designs who devices courses of action aimed at changing existing situations into preferred ones. The

intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devices a new sales plan for a company or a social welfare policy for a state” (p.130). Besides, Institute for Human Centered Design (IHCD) (2019) emphasized the UD approach with its principles (The Center for Universal Design, 1997) and DfA approach since 1990s.

According to Simon (1969), the usage of the term *people* rather than *user* is essential in human-centered design. In user-centered design (Cardoso & Clarkson, 2012; Torrens, 2000) the focus group is the customer/user group to create better consumer products, systems, and services. HCD approach embraces all potential people who desire to use the product, environment, or the system. It is understood that, in HCD all human beings’ needs and abilities need to be considered in the design process. In this thesis, HCD approach was studied as an approach that could be used in interior architecture process for building empathy considering all human beings. In architectural design education, how to design products/environments based on the HFE issues and UD principles must be taught.

IDEO, which is an award-winning global design firm supported that there is a relation between HCD, empathy and creativity, HCD is at the point of intersection of empathy and creativity and published a book as Human-Centered Design Toolkit. The proposed phases H (Hear), C (Create) and D (Deliver) promote empathic approach to the design process (IDEO, 2009). IDEO (2019, para.1) describes HCD as “[i]t’s a process that starts with the people you’re designing for and ends with new solutions that are tailor made to suit their needs. HCD is all about building a deep empathy with the people you’re designing for, generating tons of ideas; building a bunch of prototypes; sharing what you’ve made with the people you’re designing for; and eventually putting your innovative new solution out in the world”. Besides, IDEO justified three methods of HCD as: (1) Inspiration, (2) Ideation and (3) Implementation (see Figure 8).

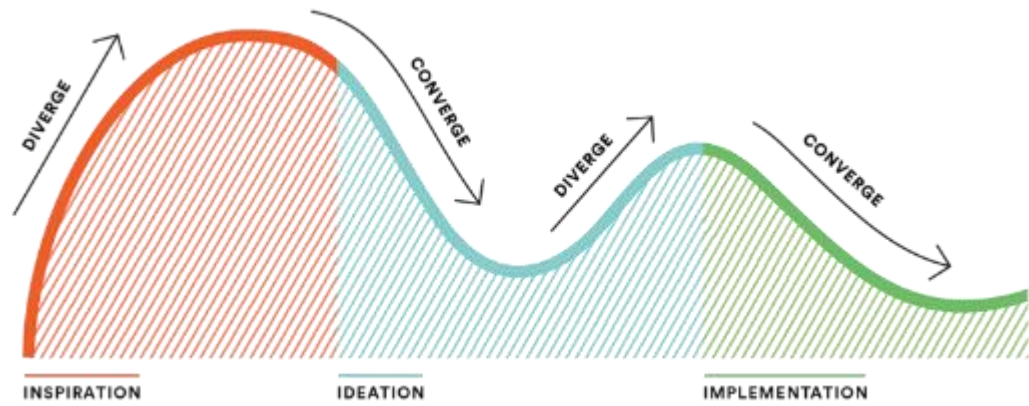


Figure 8. IDEO's HCD methods

(Retrieved from <https://www.ideo.org/tools>)

In *Inspiration*- designer is related with the people for whom that is designed for to understand them deeply. In *Ideation*- designers need to be compatible with what they have learned and transfer them to their design solutions. In *Implementation*- designer delivers their solutions to life. That explanation includes empathic understanding, which is emphasized as one of the HCD approaches, namely as *empathic design* (Steen, 2011).

3.1 Empathic Design

The English word *empathy* is coming from the German term '*emfühlung*' and was initially used in the scientific theory of *Einfühlung* ("feeling into") by German psychologist Theodor Lipps (1851-1914) in 1909 (Lipps, 1909). Then British psychologist Edward Titchener (1867-1927) translated this term into English language as the word "*empathy*" according to the Greek language '*empathia*', '*em*' (*inside*), '*patheia*' (*perception*) in 1909 (Titchener, 1909).

Cambridge Dictionary (2019) defined empathy as "the ability to share someone else's feelings or experiences by imagining what it would be like to be in that person's situation" ("Empathy", n.d.). Suri (2003) clarified empathy as "our intuitive ability to identify with other people's thoughts and feelings- their motivations, emotional and mental models, values, priorities, preferences and inner conflicts" (retrieved from

McDonagh, 2006, p. 12). Carl Rogers (1970) explained empathy as the process in which a person puts himself/herself in the other person's place and looks at things from his/her point of view, understands and feels the emotions and ideas of that person correctly and transfers this situation to him/her. In Roger's explanation there are three key elements in defining empathy; firstly, person who desires empathy needs to be involved in the other's phenomenological area, then try to understand the other person's feelings and thoughts in a right way and lastly, should transfer the empathic understanding that is formed in person's mind to the other person (Rogers, 1970; retrieved from Dökmen, 2008, p. 157). To expand the second key element, Dökmen (2008) added that cognitive and affective (emotional) components of empathy should be taken into consideration. "From a cognitive perspective, empathy consists of either understanding the psychology of others (i.e., their thoughts, intentions, feelings etc.) or, more specifically, their feelings" (Strayer, 1987, p. 128). Affective empathy is a process of appreciation of other's emotions and responding to and sharing emotions (Dökmen, 1988). To empathize, a person should not be ego-centric, should be an adult and interested in other people's lifestyles and their needs as Dökmen, (2008) stated.

While achieving empathy with other people (who could be also users), designers would aim to appreciate (cognitive empathy) them and feel (affective empathy) as if they are the users (van Rijn et al., 2011). Designers try to empathize with user by experiencing empathic strategies and techniques in empathic design process. Designers from different disciplines have utilized ED strategies for over 30 years (Leonard & Rayport, 1997, Suri, 2001). A designer, interior architect or architect should focus on universally designed environments or products that could ease people with disabilities' utilization. In design process, design solutions need to encompass for all users who have impairment or not in a comprehensive way (Demirkan and Olguntürk, 2013). ED has a human-centered approach (Steen, 2011) and pays attention to understanding people with diverse abilities by simulating their physical abilities in their daily life activities.

In ED literature, various practicing, and training experiences are suggested as simulations of daily life activities of people with diverse abilities. Researchers and

instructors both agree that the ED process provides in-depth understanding of people's problems that they could face while using the designed products or environments (Altay, 2017; Altay & Demirkan, 2014; Gomez-Lanier, 2018; Torrens, 2000). Empathic design and its research techniques and strategies are used as an educational method in design process as well as a design thinking process in industrial area. Previous studies in architectural, industrial design and engineering design education mentioned that using ED in design process provides positive outcomes on students' design projects. Additionally, creating direct contact with user improve students' *empathic horizon* (McDonagh et al., 2011; McDonagh-Philp & Denton, 1999) and ED could be integrated into the design process as an innovative and additional method.

3.2 Empathic Design Techniques

In ED literature, some research strategies and techniques have been used to increase empathic understanding and obtain detailed information about user's needs from built environment or product. Mainly, three main empathic design techniques as (1) direct contact between designers and users, (2) indirect contact between designers and users and (3) role-playing in the design process have been studied.

3.2.1 Direct Contact Between Designers and Users

Creating direct contact between designers and users was stated as the first phase of promoting empathy in design process as *research* activity (Kouprie & Visser, 2009) which includes the techniques as observing, interviewing, and participating in user's activities and co-design.

Designers could observe people's activities either in their living environment or observe them in any public area (café, campus environment, transportation, museum etc.). To illustrate, Altay (2017) gave an assignment to the interior architecture students to better understand the elderly's problems and needs by visiting their grandparents' homes and observing their physical activities in utilization of living environments. Students interviewed their grandparents in their home environment,

asked questions about utilization of the home environment. The results indicated that students gave positive feedbacks about understanding elderly's needs and problems and expressed that their empathic awareness was developed by this experience. Similarly, van Rijn et al. (2011) analyzed different sources of information in ED process among international graduate design students from the Faculty of Industrial Design Engineering, Delft University of Technology. In their study, students were divided into six design teams and worked together to develop product concepts for children with autism. One of the design teams used direct contact technique to observe children with autism in a real environment in their homes. Students observed how children were using the products (their attitudes, difficulties etc.) and got direct feedback about the functioning of these products. Researchers found direct contact technique to be the most successful way of expressing empathy.

In architectural context, architects observed the bodily experience of physically and visually impaired persons during a visit to a museum building (Heylighen et al., 2013). The aim of their study was the analysis of how people have diverse abilities experience the museum environment and how architects' intentions were related to those experiences. As a result of the study, visitors criticized the museum entrance and lighting and architects found this experience valuable, because it built the bridge between architecture and the human body. Architects cared about visitor's critical comments and learned much from their experience (Heylighen et al., 2013). Likewise, in another study (Gomez-Lanier, 2018) conducted in interior architecture design education, residential renovation project was designed with families who had members with different physical abilities. In their study, interior design students interviewed their respective families to understand their clients' needs and problems. In Bairaktarova et al.'s (2016) study, some engineering students interviewed users who have experience in hand-washing clothes and live in developing countries to design washing machine. Researchers found that students who interviewed people had better performance in the assignment.

Co-design as is one of the approaches of HCD (Steen, 2011) could be experienced as a design strategy in ED process, since it involves direct contact between designers and users. "[i]n codesign one can invite people who have never met before and start with an idea for a novel technology or a putative opportunity (*what could be*) and then

jointly develop a product that will be targeted a larger mass market” (Steen, 2011, p. 52).

To illustrate, in Emmanouil’s (2015) study, students from the Department of Visual Communication Design did studio projects by co-design with visually impaired children in museum environment. The aim of her study was to make the museum exhibition more accessible for visually impaired people. Another study by Bernardi and Kowaltowski (2010), which had a goal of creating accessible environments in architectural context for particularly visually impaired people, used co-design among students and active partners in design process. Thereby, students learned from their active partners how to integrate UD principles in their projects, which required designing a university community service building. Likewise, in redesigning the Brussels metro transport system, ED was used as a method to analyze and reflect on co-design process among people with or without disabilities and designers. In this study, artifacts and built environments were designed for and with people who have impaired vision and no vision (Strickfaden & Devlieger, 2011). Ho et al. (2011) integrated co-design practice in teaching participatory product-design. They analyzed co-design process with when students who divided into groups were worked for and with people have diverse abilities/elderly active design partners. Ghajargar et al. (2017) organized participatory sessions in innovative Smart Home project for energy consumption in an empathy workshop. The aim of the workshop was gathering feedback on the use and quality of interactions and the system performance from the trial users, while assessing the empathic communication between trial users and project team. In Hess and Fila (2016)’ study, nine design students worked with project partners to design a zip-line and tree house structure as a service-learning design projects for children with limited mobility. That study is focused on how empathy functions in a product-based design process through applying ED techniques that affect design students’ final design decisions.

Some models were also generated to strengthen the relationship between people with diverse abilities and designers in the UD process. For instance, a participatory design model called the Usability, Safety, Attractiveness Participatory (USAP) proposed to guide designers to facilitate safe, functional, and universal product designs for aging

population (Demirbilek, 1999; Demirbilek & Demirkan, 2004). To test the proposed model, a case study was conducted to design door and door accessories. The model consisted of five phases involving two different participatory design sessions. In the first phase (*concept development*), during the first participatory session, active dialogues were held between designers and elderly. Designers came together with the elderly and indicated their initial ideas (sketches) and discussed them by generating different scenarios (scenario building), and then the designers analyzed the problem and made the preliminary drawings. In the second phase (*concept refinement*), designers presented their drawings and got feedback (critics, comments, modifications) from the elderly. In the third phase (*prototype construction*) the designers worked as a team in modifying their designs according to the feedbacks, comments and critiques obtained from the elderly and constructed a prototype. In the third phase (*trial of the prototype*), the elderly takes a user trial in experiencing the prototypes while communicating with the designers. The feedbacks from the elderly were analyzed again in detail. In the last phase (*production*), the artefacts were manufactured and presented to users.

In addition, participatory design, which “[o]ne can involve a group of people who currently work together and take their current practices (*what is*), and often a specific problem, as starting point to develop a product that these people will actually be using in the future” (Steen, 2011, p. 52), could be seen in ED process (van Rijn et al., 2011).

3.2.2 Indirect Contact Between Designers and Users

The second empathic design technique includes obtaining indirect information about users. Designers use some communication tools as storytelling techniques, personas, empathy map (EM), scenarios, storyboards, literature, original quotes, photos and/or videos of user in their home environment to understand the experience of users (Bairaktarova et al., 2016; Tschimmel, 2012; Ferreira, et al., 2015, van Rijn et al., 2011). To illustrate, in Bairaktarova et al. (2016)’s study, some engineering students observed people through videos or photographs that they found online to better understand their needs of washing machine. In another study (van Rijn et al., 2011) industrial design engineering students observed children with autism through video

and try to appreciate their needs and conditions and then designed a product according to their background information and video observation. Researchers found that showing videos has a potential for gaining empathy with user (van Rijn et al., 2011).

Visual thinking was found an essential practice in ED, for instance a Storyboard which is a series of images like drawings, illustrations or photographs show in an order to visualize a process (Tschimmel, 2012) were created by students. Engineering students preferred to elaborate their storyboard with their hand drawings, but the draft storyboard also could made with Post It notes because of its mobility (Tschimmel, 2012). Students used their storyboards to further understand the user's daily life and explored the use and environment of their product and the role of the user (Bairaktarova et al., 2016). Moreover, in professional practice, designers could use storyboards in presentations to clients of a new project or product (Tschimmel, 2012). Storytelling is another tool that designers could use to create stories that generally are symbolic, illustrative, and easily memorable for indicating and sharing their new concepts and give detailed information about the product.

Designing persona and EM are the other communication tools that designers could use while trying to understand the user's needs and their problems (Ferreira et al., 2015; Tschimmel, 2012). The persona technique is used for describing the user's characteristics (e.g., name, age, occupation, family etc.), aims, abilities, interests (Ferreira et al., 2015) and aids to make the abstract knowledge of a group of users personal and human (Tschimmel, 2012). There are ways to design a persona, but the commonly used way is representing persona in textual form including insight and a photo (Ferreira et al., 2015). To organize the information from the persona, empathy map (EM) technique, which as another visual tool was originally created by Dave Gray, founder of X-PLANE could be used. Besides, EM could be generated through observation and interviews (Tschimmel, 2012). EM techniques provide designers to create a great empathy with the user, thus this technique promotes them to understand user's needs. The EM (see Figure 9) consist of six categories; (1) *think and feel*- what does user think and feel, (2) *see*- what does user see in his/her environment, (3) *say and do*- what does he/she say and do in public, (4) *hear*- what does he/she hear from the environment, (5) *pain*- the fears, frustrations and difficulties that the user

experience, (6) *gain*- wants and needs of users, and measures of success of his/her goals (Bairaktarova et al., 2016; Ferreira et al., 2015; Tschimmel, 2012).

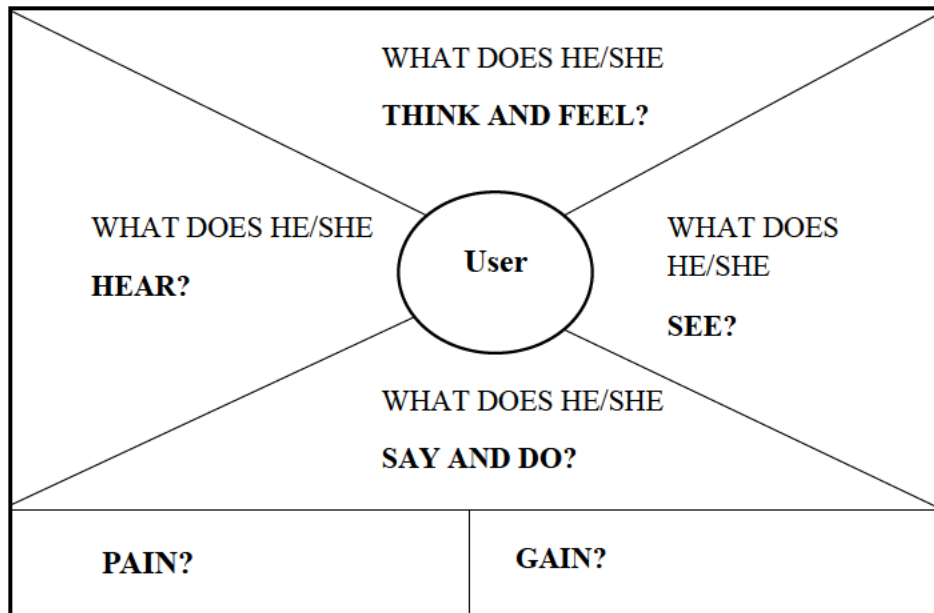


Figure 9. Template of the EM *(drawn by the author)*

Engineering students used the EM technique to combine their thoughts about user's (Indian Dhobi women) usage of washing machine (Bairaktarova et al., 2016) and students stated that EM technique assisted them to more aware of user's needs. In Ferreira et al. (2015)'s software product design study, which was related to the assessing the influence of creating EM in organizing the Persona, EM technique was found useful and easy way to create Personas by students.

3.2.3 Role-playing (Simulation)

Role-playing technique (simulation) allows designers to look at products or environments from the user's point of view through experiencing daily life activities. To understand people with diverse abilities' spatial or product experience, designers take perspective of users, and act as a user.

Role-playing technique has been widely used in previous studies (Altay et al., 2016; Altay & Demirkan, 2014; Boes, et al., 2007; Kocaoğlu & Demirkan, 2019; McDonagh & Thomas, 2010; Nicolle & Maguire, 2003; Torrens, 2000) in course assignments or workshops where students were simulating visual, mobility and hearing-impaired users. Patricia A Moore who is gerontologist and designer, when she was 26 years old, she disguised and experienced elderly women's (more than eighty years) daily life activities by travelling in the United States and Canada, over a period of three years (1979-1982) (Bühning & Moore, 2018) (see Figure 10). "This experience helped illuminate the missed opportunities in broadening the design and innovation focus, consequently helping to define what is commonly known as Universal Design" (Bühning and Moore, 2018, p. 9).



Figure 10. Patricia A Moore simulated elderly woman's physical conditions
(Source: Bühning & Moore, 2018, p. 9).

Since 1999, the role-playing technique has been applied in design teaching and design process, at the TU Delft University (Boess et al., 2007). Instructors observed and recorded the role-playing activities of students, reviewed the success of the activities, and interviewed with the students then analyzed the influence of this technique on students' design process. Researchers stated that their consideration as "is particularly

focused on whether the exercises were help in ideation, clarification, empathizing, reflection with the respect to social change and accessing user research data in an experiential way” (Boess et al., 2007, p. 280). Altay and Demirkan (2014) gave an assignment to the second-year interior architecture students about experiencing role-playing technique in the campus environment. The goal of that assignment was enhancing students’ empathic awareness on human diversity. Students used wheelchair, crutch and blindfolding to experience people who have diverse abilities’ obstacles and problems (see Figure 11).

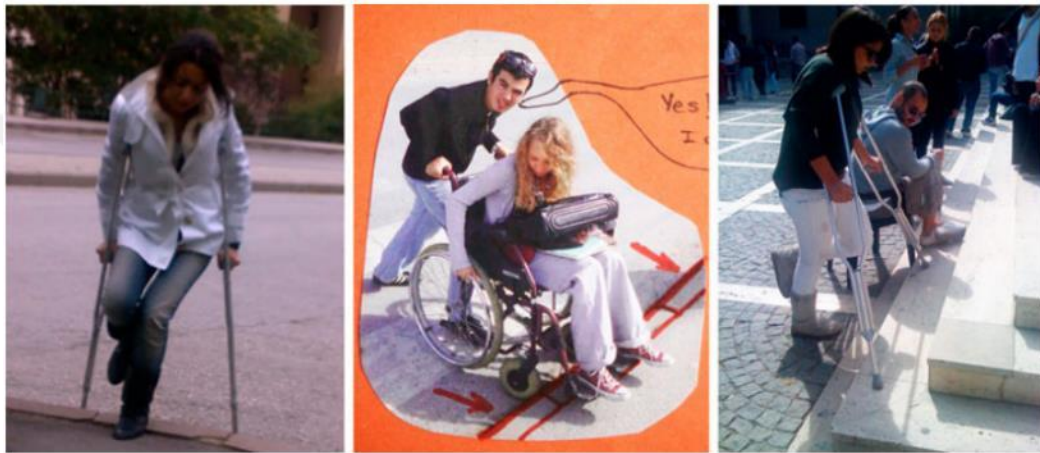


Figure 11. Students simulated differently abled people’s conditions with obstacles (Source: Altay, 2014, p. 145).

Similarly, in Altay et al.’s study (2016), interior architecture students (from 2nd to 4th year) took the role of people with no vision and pregnant women in the campus environment. In Kocaoğlu and Demirkan’s (2019) study, nine graduate interior architecture students simulated people have visual impairments’ role and conducted role-playing activities in a café on campus environment (see Figure 12).



Figure 12. Graduate students simulated people have visual impairment's conditions (Source: Kocaoğlu & Demirkan, 2019, p. 21).

In Bernardi and Kowaltowski's (2010) study, students simulated people have visual impairments', people have orthopedic limitations' and elderly people's conditions. In McDonagh and Thomas' (2010) study, students from industrial design department took the role of students from non-design department with physical and sensorial disabilities by using a wheelchair and mechanical devices in the course called 'Disability + Relevant Design' at University of Illinois at Urbana-Champaign, USA. Role-playing activities (e.g., restricted arm movement, walking with line wearing visual impairment goggles, taking ear protectors, masking tape to decrease hand mobility and using hand device to simulate hand tremor) were practiced as people with different abilities and elderly on their daily life activities in personal, public and classroom environments. Additionally, Nicolle and Maguire (2003) carried out role-playing workshop (blindfolded, visual, hearing and mobility and dexterity tasks) with university students through activity-based approach in UK.

All mentioned studies found that simulating diverse users' abilities have profound effect on students' empathic understanding. This technique would be useful for students by being in contact with real users (Woodcock et al., 2018a) and reflect positively on their performance on the course assignments.

In architectural practice, the application of these techniques is not mainly common unlike other design disciplines (Vander Linden et al., 2016) such as industrial design, industrial engineering etc., and there are limited studies. For example, several ED techniques were investigated in engineering students' design solution process, in the design assignment of engineering education in Purdue University, USA (Bairaktarova et al., 2016). In the distance learning program, 100 graduate students were asked to design a washing machine to be used in developing countries. They also required students to adopt ED techniques in their design with visual thinking. Students used such as text-based testimonies, observation through videos or photographs, EM technique, interviews of focus groups, and immersive practices. At the end of the course, it was found that interviews of focus group and immersive practices improved students to understand of user's needs in depth, in developing world context and provide them to think more possible solutions; also, visual thinking found an essential practice in ED. In interior architecture education, similar studies using similar techniques need to be conducted.

3.3 Building Empathy in Design Education

In this section, the application of empathic design models as methodological research and as design thinking model in design education from different design disciplines (industrial design, engineering design and architectural design education) were presented.

3.3.1 Applications in Design Education as Methodological Research

There are certain pedagogical studies in engineering and architectural design programs. For instance, Zoltowski et al. (2012) used a phenomenographic framework as a guide in their research on HCD in design education. Researchers categorized students' experiences in seven categories including ED. Researchers found ED to be a more comprehensive way of expressing HCD than the other categories. The authors also assessed understanding, empathy, rapport, consensus, and dialogue in human-centered relationships through case studies. In their study, thirty-three student

designers were interviewed about their experiences within the context of “designing for others”.

Bordas (2017) emphasized the interdisciplinary methods in design research by focusing empathy-based architecture in universal accessibility. She supported that empathic approach is needed for designing accessible urban environments for people with different abilities. By empowering empathy, designer understands the diversity of needs and designs more accessible built environments. In her doctoral thesis, she practiced an empathic approach with architectural students through workshops, surveys and role-playing techniques in a case study called *LOCUS IP (Let's Open Cities for US Intensive Programme)*. The feature of the model (Bordas, 2017) is that they support the empathic approach, which emphasizes understanding of people with diverse abilities' physical and psychological needs in creating universally accessible environments.

As a deduction from these models, it was understood that more universally accessible environments could be generated by addition of empathic models into architectural design process.

3.3.2 Application in Design Education as a Design-Thinking Model

The Stanford Design Thinking Model was proposed by the Hasso - Plattner Institute of Design at Stanford. Researchers put emphasis on ‘empathy’ and started the design thinking process with ‘*empathize*’ stage and continued with ‘*define*’, ‘*ideate*’, ‘*prototype*’ and ‘*test*’ stages (Stanford d. school, 2010). In the first stage, “designers observe users and their behaviors, interact with, and interview them, and immerse themselves in understanding the experience and perspective of the users. In the second stage, designers use insights gathered from empathizing to focus on a problem. In the third stage, designers explore a wide variety of solutions and ideas. In the fourth stage, designers generate ideas, and put them into action. In the last phase, designers test the prototype with actual or representative users” (Henriksen et al. 2017, pp. 142-143).

Henriksen et al. (2017) used The Stanford Design Thinking Model in their qualitative study of a graduate teaching course as an approach creatively to the educational problems of practice. Their findings indicated that the empathize phase might be a persuasive new strategy in understanding of students. “As a strategy for problem solving, it *led them to question, recognize, and challenge their own assumptions*-often with surprises. Moreover, it was an *applicable skill across different educational problems of practice*” (Henriksen et al., 2017, p. 150). The Stanford Design Thinking Model is significant since it was generated to solve educational problems of teaching practice or teach it to students as a framework for their design projects. It is based on HCD approaches to develop design-thinking skills of educators and students. Besides, the design process started with ‘empathize’ mode, since research supported that designer must gain empathy for specific groups of individuals before they start to design. They must try to understand who they are and what is crucial to them.

Lam and Suen (2015) inspired by the IDEO’s design thinking model and the Design Council (2005)’s double diamond model and came up with a pedagogical approach and generated a “3EMs” Framework as, ‘empathy’, ‘embrace’ and ‘empowerment’, respectively, at the center of design process in design education (see Figure 13). Lam and Suen (2015) used this framework as a teaching approach in the learning process. In the ‘empathy’ stage, design students observed and took part in the real users’ daily living activities (role-playing exercise) to recognize their distresses. In the second stage called ‘embrace’ students defined and re-defined target users’ concerns according to role-playing exercises and self-explorations. In the ‘empowerment’ stage, students produced a reflective report. Furthermore, students worked with a group of real users, thus, the users became co-designers. Students designed a product or a service for real users and had a chance to build face-to-face interviews and focus group discussions. The 3EMs framework (Lam & Suen, 2015) is useful for interior design process, in educational context.

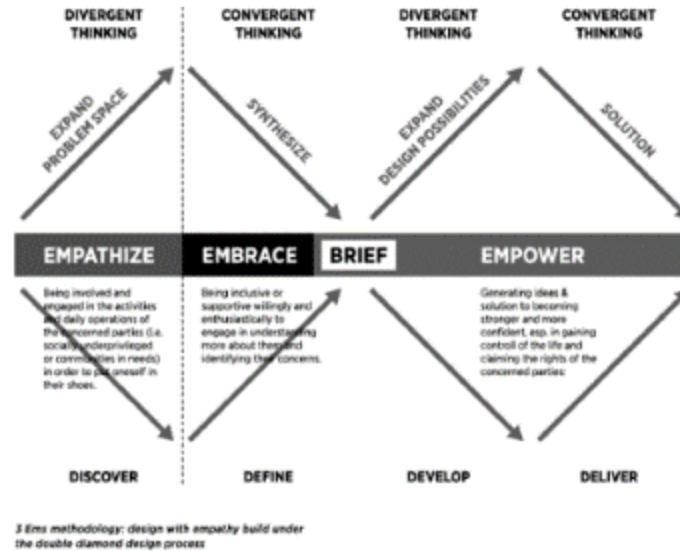


Figure 13. “3EMs Framework built upon the design thinking framework of the IDEO and the double diamond model of the British Design Council” (Lam & Suen, 2015, p. 56).

Students could develop their empathic ability and relations with real users by applying this framework into their design assignments. Since researchers suggested that learning with real users is an efficient approach that supports students for the real world in the future (Altay, 2017; Altay & Demirkan, 2014).

To conclude, empathy was included as a design-learning tool in the models in industrial and educational fields either as in methodological research or as design thinking method. These models were commonly generated to create prototypes in industrial design and engineering programs (Leonard & Rayport, 1997; McDonagh, 2006), and in architectural design context (Bordas, 2017). All the mentioned models illuminated this study’s proposed model with their useful and testable approaches.

3.4 Building Empathy in Design Practice

In designing, there are three basic activities: analysis, synthesis, and evaluation (Simon, 1969). Yet, in architectural designing, there are other activities that include

recurrent relations since design has dynamic actions. Gero and Kannengiesser (2004) explained this dynamism by designer's way of thinking like; "by observing and interpreting the results of their actions, and then they decide on new actions to be executed on and the environment which means that the designer's concept may change according to what they are 'seeing', which itself is a function of what they have done" p. 376). Demirkan (1998) stated that there are specific characteristics of architectural design process, "[t]he first characteristics of architectural design processes is the generation of new states from the current ones. The second characteristics that guides the search lies not only on the information internal to the particular problem, but also on the information that is external to it, such as cultural norms or style" (p. 229). Moreover, the interior design studio where design process is practiced is the focal point of the interior architecture education, since the other courses in the curriculum are associated with the design studio (Uluoğlu, 1990; Demirbaş, 2001; Demirbaş & Demirkan, 2003). In interior architecture design studio education, several assessment tools are used as homework and studio work during the design process.

Firstly, in *define* phase, generally the design problem is given to students as a design brief with its orthographic drawings and the requirements of the project. Then, in the second phase called *collect* includes collecting information about the project and people who the design is for, this phase includes library research, site analysis and interview with people. Thirdly, in the *brainstorm and analyze* phase, students try to shape initial ideas through sketching, bubble diagrams or making process models. Then, in the fourth phase, *develop*, students begin to make drawings and try to develop solutions to the given problem. In the fifth phase, *feedback*, students present their projects in pre-jury and final jury sessions and get feedback from design instructors or other guest jury members who are related with the design project. In the last phase, *improve* students redesign their projects based on the critics that they gained from the jury feedbacks (Chicago Architecture Center, 2019).

"Traditional views of learning offer learners relatively few roles, most of which are passive as listening, note-taking, following instructions and practicing the design skills discussed in critiques" (Sagun et al., 2001, p. 334). Practical and experiential basis of empathic design approach could be incorporated into the traditional design education

process. By integrating ED into the design process, students' awareness of human experience could be improved, and universally designed environments or products could be generated.

Many ED studies in design education field were not based on the empathy definition of the psychology discipline (Kouprie & Visser, 2009). Besides, to integrate empathy to design process, the design strategies or techniques that are generated and applied should be investigated.

For many years, ED models were used in various industrial and educational studies. In design practice, empathy was incorporated as a design-learning tool in the frameworks. Since the 80s and 90s, empathy-related models were generated by designers and educators, however the majority were seen in the 21st century particularly in industrial design and engineering programs.

3.4.1 Applications in Design Practice as Methodological Research

Previous studies described several steps, strategies, and phases about ED in design practice. To illustrate, Leonard and Rayport (1997) suggested that ED includes a five-step process as "Observation, Capturing data, Reflection and Analysis, Brainstorming for solutions and Developing Prototypes of Possible Solutions" (pp.108-112), and requires collaborative skills between interdisciplinary teams. They argued that ED, as a set of techniques, could be integrated in engineering / design companies' strategies. The reason behind this was that "empathic design is a relatively low-cost, low-risk way to identify potentially critical customer needs. It is an important source of new product ideas, and it has the potential to redirect a company's technological capabilities toward entirely new business" (Leonard & Rayport, 1997, p. 104). The authors described ED through steps and each step refers to the process. In addition, the authors emphasized the reflection and analysis step that this study also underlined.

Fifteen years later, Luh et al. (2012) criticized the five-step process (Leonard & Rayport, 1997) of ED and generated five-step Systematic Empathic Design Method

(SEDM) which aims to understand the needs of customers to design customer-centered products. Luh et al. (2012) used the five-step process as a fundamental of the SEDM that consists of five steps namely: Participation Observation instead of Observation, Laddering Interviews rather than Capturing Data, Implication Matrix instead of Reflection and Analysis, Hierarchical Value Map instead of Brainstorming for solutions, and Mind Mapping rather than Developing Prototypes of Possible Solutions. The authors explained the reason for SEDM generation, as adapting ED in Leonard and Rayport's model (1997) took significant time and experience in application. They proposed that SEDM which is more systematic and helps designers in idea generation rather than solution generation to meet customer's needs. The SEDM process could shorten the design time and is easy to practice with its analysis methods (Luh et al., 2012).

McDonagh (2006) argued that designers need to improve their research methodologies to explore user's needs and experiences in her doctoral dissertation. She indicated several published studies in design research, and she proposed 'The Empathic Design Research Model' (see Figure 14).

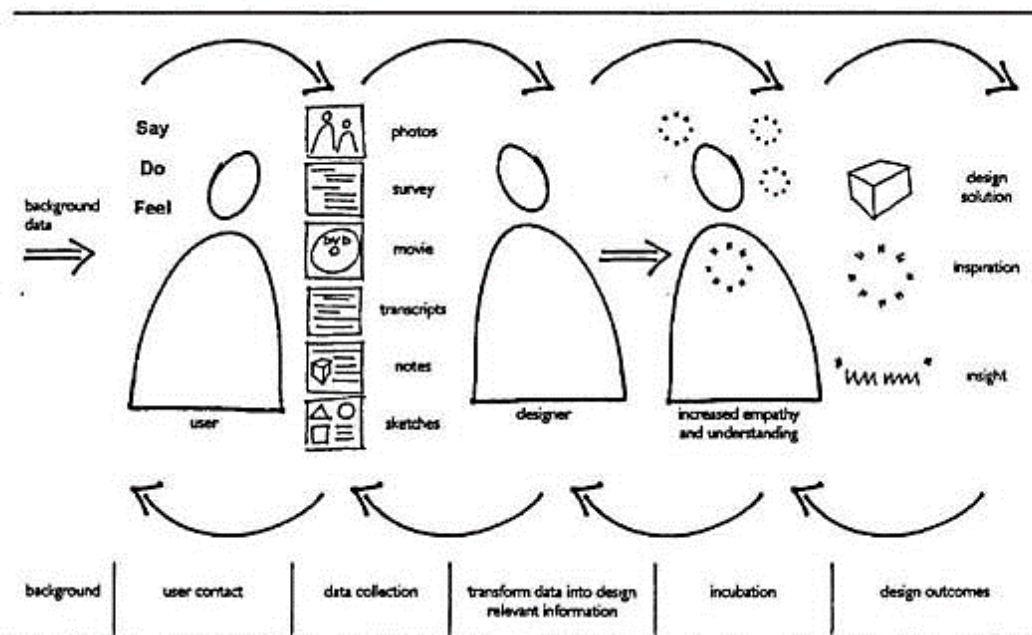


Figure 14. The Empathic Design Research Model (McDonagh, 2006, p. 12)

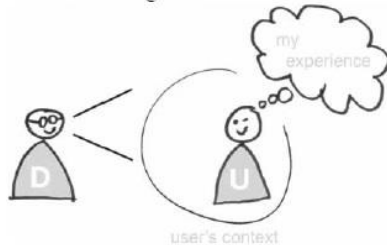
McDonagh (2006) described ‘The Empathic Design Research Model’ as; “[t]his process involves imagining a design solution/outcome that may transcend what already exists, and this may require designers to suspend reality to develop more visionary ideas and concepts. This model emphasizes transformation within the designer for empathy and deep understanding to develop” (McDonagh, 2006, p. 12). This model has been used in Industrial/Product Design educational context. However, it could also be helpful for studies about building empathy in interior architecture education, since it has relevant phases that could be used while integrating empathy into the design process. Especially, data gathering, incubating, and transferring periods are valuable in ED process and those provide the requirements for building empathy.

Kouprie and Visser (2009) underlined the process of empathy in design practice and proposed a framework (see Figure 15), which could be utilized in design practice. The authors recommended that this framework could be used in three areas of design: namely research, communication, and ideation. The framework is based on two components of empathy, which are affective and cognitive components, and “... it is based on the principle that a designer steps into the life of the user, wanders around for a while and then steps out the life of the user with a deeper understanding of this user” (Kouprie & Visser, 2009, p. 444). The authors deduced this idea from the different explanation of phases of empathy from different psychotherapists and found common approach as stepping into and stepping out of the user’s world is significant to achieve empathic understanding. The framework consists of four phases: “(1) discovery- entering the user’s world, achieve willingness, (2) immersion- wandering around in the user’s world, taking user’s point of reference, (3) connection- resonating with the user, achieve emotional resonance and find meaning, (4) detachment- leaving the user’s world, design with the user perspective” (Kouprie & Visser, 2009, p.444). Researchers also added that both cognitive and affective components of empathy is vital for phase 3.

This framework is valuable and could be applied to this study’s proposed model while integrating empathy since it has an exploration of the concept of empathy through making research in psychology literature. The framework is based on four phases of empathy, which are relevant to the three necessary key elements in defining empathy (Rogers, 1970; Dökmen, 2008). Besides, two components of empathy which need to

be considered in the second key element which is ‘trying to understand the other person’s feelings and thoughts in a right way’, are emphasized in that framework.

Discovery
Entering the user’s world
Achieve willingness



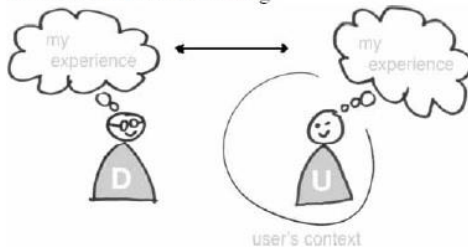
The process starts with the designer approaching the user. He makes a first contact with the user, either in person or by studying provoking material from user studies. The designer’s curiosity is raised, resulting in his/her willingness to explore and discover the user, his/her situation and experience

Immersion
Wandering around in the user’s world
Taking user’s point of reference



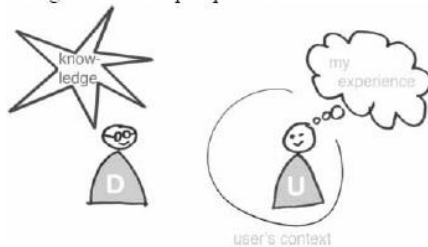
After the first encounter with the user’s experience, the designer takes an active role by leaving the design office and wandering around in the user’s world (data from qualitative user research). The designer expands his knowledge about the user and is surprised by various aspects that influence the user’s experience. The designer is open-minded, interested in the user’s point of reference. He is being pulled into the user’s world, and absorbs without judging

Connection
Resonating with the user
Achieve emotional resonance and find meaning



In this phase, the designer connects with the user by recalling explicitly upon his own memories and experiences in order to reflect and be able to create an understanding. He makes a connection on an emotional level with the user by recalling his own feelings and resonates with the user’s experience. At this phase both affective and cognitive components are important; the affective to *understand feelings*, the cognitive to *understand meanings*

Detachment
Leaving the user’s world
Design with user perspective



The designer detaches from his emotional connection in order to become ‘in the helpful mode’ with increased understanding. The designer steps back into the role of designer and makes sense of the user’s world. By stepping back out to reflect, he can deploy the new insights for ideation

Figure 15. Four phases of empathy (Kouprie and Visser, 2009, p. 445).

Woodcock et al. (2018a) developed an empathy framework based on Kouprie and Visser's (2009) study and focused on *ideation* in design and introduced as the pre-stage called *receptivity* (see Figure 16).

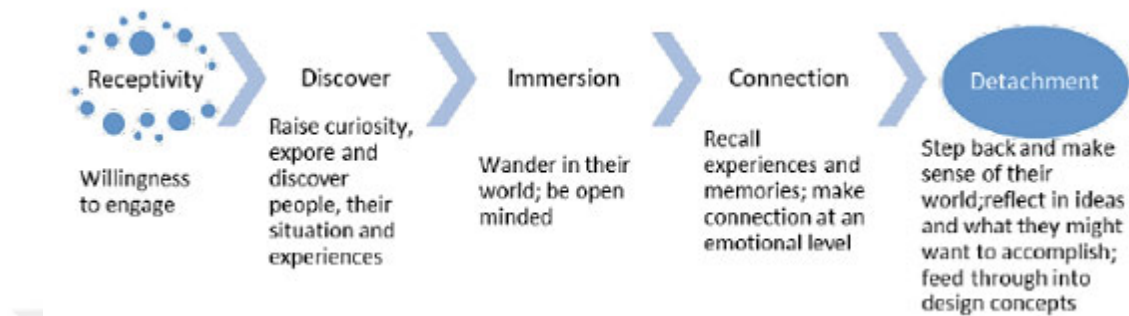


Figure 16. Development of Empathy Framework by Kouprie & Visser (2009), (Retrieved from, Woodcock et al., 2018a, p. 27)

The reason why they added *receptivity* into the framework was explained as, “[t]o support this we have applied Schön’s (1987) principles of reflection in, on and through action to encourage students to think more deeply before, during and after their experimental simulations” (Woodcock et al., 2018a, p. 27). In addition, they stated that a good empathic experience needs to provide an opportunity to reflect, communicate and act, besides experience and empathize (Woodcock et al., 2018a). The researchers (Woodcock, et al., 2018b) applied the Kouprie and Visser’s framework as a case study where students experienced travelling like a senior person with mobility limitations and found that student were struggling and reported that it was difficult than they expected. The authors emphasized merely supporting ED experiences is not sufficient for student designers, so that role-playing activities need to be studied within a reflective cycle (Schön, 1987), which is the beneficial method, to provide students to think more deeply before, during and after the role-playing experience (Schön, 1987). This point of view is valuable since after role-playing experiences are conducted, the outcomes/reflections of students could be analyzed.

As Woodcock et al. (2018a) emphasized, Broadley (2013) underlined the importance of reflexivity in design process and developed, tested, and critiqued the framework with the five-stage participatory-reflexive methodology (*orientation, participation, evaluation-in-action, tool response analysis and reflexive analysis*) in her practice-led research in HCD process. Broadley (2013) claimed that human-centered designers are reflexive so that she investigated how human-centered designers get a relationship between participants through visual and participatory tools and techniques. Likewise, in ED process, which is one of the human-centered approaches, reflexive analysis needs to be practiced before, during and after the design process.

3.4.2 Applications in Design Practice as a Design-Thinking Model

Various design thinking models, such ‘The Double Diamond Model’ (Design Council, 2005), and ‘The design thinking rationality framework’ (Kim & Ryu, 2014) embrace empathy in the design process. Design Council (2005) illustrated ‘The Double Diamond Model’ which was a simple visual map of the design process and divided into four phases; Discover, Define, Develop and Deliver (see Figure 17).

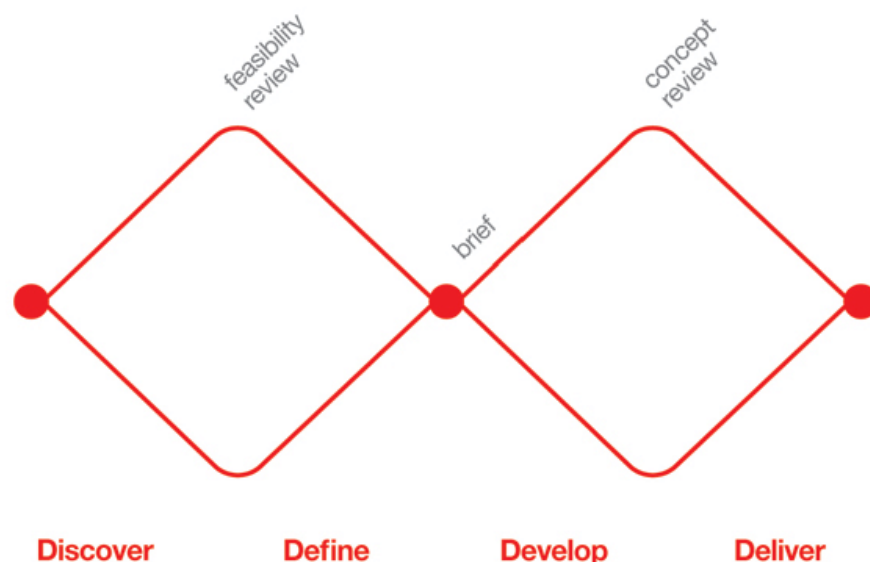


Figure 17. The ‘Double Diamond Design Process Model’ (Design Council, 2005)

In the first phase, designers try to discover the world, be aware of new things and intuitions. In the second phase, designers attempt to make sense of all possibilities identified in the ‘discover’ phase. The third phase includes development of solutions or concepts that are created, prototyped, tested, and iterated. Lastly, in the last phase, the resulting projects are finalized, produced, and launched (Design Council, 2005). Also, Design Council (2005) stated the four core design principles involved in this framework, which are ‘put people first’, ‘communicate visually and inclusively’, ‘collaborate and co-create’ and ‘iterate, iterate, iterate’. Those principles consist of HCD method and could provide a deep understanding of people’s needs. Moreover, they support designers in creating universally designed products and living environments. Also, promote them to work together and iterate again and again to realize errors earlier.

Kim and Ryu (2014) proposed a design thinking rationality framework (see Figure 18) that consists of the relationship between two versions of self (the simulated self and mediated self) of designer and the problem framing and solving in design thinking process.

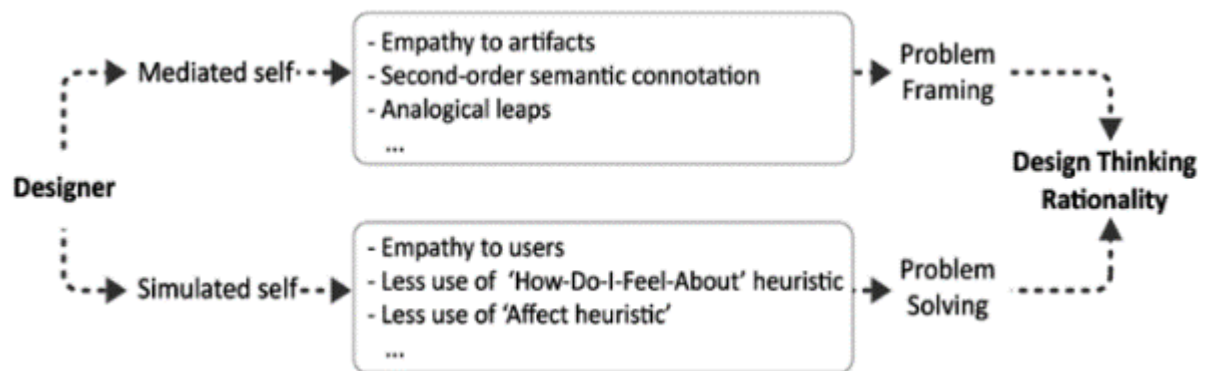


Figure 18. The design thinking rationality framework (Kim and Ryu, 2014, p. 542)

The framework focuses on the cognitive process of designers in the design process. Researchers explained “[t]he framework represents designers’ prominent cognitive processes (e.g., heuristics, second-order semantic connotations, defamiliarization, etc.)

and proposes ways of regulating or simulating these processes in an actual design activity” (Kim & Ryu, 2014, p. 547). This framework is specifically concentrated on the cognitive process of designers during their early design activities; therefore, the cognitive process of designers needs to be considered with the aim of exploring their empathic attitudes towards users.

Based on the models described and criticized previously ED, as one of the approaches of HCD (Broadley, 2013; Design Council, 2005), is a necessary and beneficial design-learning tool for design education. Some models (Lam & Suen, 2015; Stanford d. school, 2010) emphasized empathy and started the process with *empathize* stage and some of them (Bordas 2017) highlighted the significance of empathy to understand people with diverse abilities’ physical and physiological needs to promote health and well-being of users and create more accessible environments. Moreover, definition of empathy (Rogers, 1970; Dökmen, 2008) was emphasized and researchers (Kouprie & Visser, 2009; McDonagh, 2006) structured their process models according to the cognitive and affective components of empathy as the essentials (Kouprie & Visser, 2009). Observing and interviewing the users (McDonagh, 2006) were underlined to build strong empathy with users as well as working with them as active participants of the design projects (Lam & Suen, 2015). In some models, considering student designer’s cognitive processes (Kim & Ryu, 2014) and interviewing them (Zoltowski et al., 2012) after the ED was experienced and were mentioned as important stages of the ED process. Furthermore, some researchers stated that human-centered designers are reflexive (Broadley, 2013) and reflexive analysis (Leonard & Rayport, 1997; Broadley, 2013; Lam & Suen, 2015) is needed to be achieved by Schön’s (1983,1987) principles (Woodcock et al., 2018a; Kim & Ryu, 2014).

3.5 Reflection/Reflexivity in Empathic Design Process

After empathic modeling is conducted, the impacts of ED techniques on students’ knowledge and its reflections on their final design solutions are crucial. To analyze the ED reflection in design process, the meaning of *reflection* in design research needs to be investigated. “In educational design research, reflection involves active and thoughtful consideration of what has come together in both research and development

(including theoretical inputs, empirical findings, and subjective reactions) with the aim of producing new (theoretical) understanding” (McKenney & Reeves, 2018, p. 193). Schön’s (1983) theory on the ‘reflective practitioner’ has subclasses as ‘reflection-in-action’ (happening in the moment), ‘reflection-on-action’ (happened in the past), and ‘reflection-through-action’ (might happen in the future). “Schön’s approach is steeped in practice, particularly in building theory from practice. His ideas about improving practice through reflexivity and theory-in-use have inspired much debate around the role of espoused theory and theory-in-use” (Ryan, 2013, p. 145). He also analyzed the design process as reflection-in-action in architectural design studio and stated that reflexive conversations as protocols should be examined to see how the teaching and learning processes have gone (Schön, 1987).

In literature, different types, and levels of reflection in education are studied. For instance, Reymen et al. (2006) described design reflection has three phases as preparation, image forming and conclusion drawing. Bain et al. (2002) proposed a model consisting of five different levels of reflection as reporting, responding, relating, reasoning, and reconstructing. Ryan (2013) used the five ‘R’s’ (Bain et al., 2002) to analyze and discuss reflective practices of students from multidisciplinary departments. Hutchinson and Tracey (2015) underlined reflective writing as a learning activity in design education and investigated how graduate students used reflection for idea generation by reflective writing in their design-based study. Moreover, Tracey and Hutchinson (2016) analyzed how graduate students reflected their experience and beliefs concerning uncertainty in their qualitative study.

In ED, reflection from design students is crucial for evaluating ED awareness (McDonagh & Thomas, 2010). Students should reflect their empathic understanding through their projects and verbally share with people who design for them, otherwise the ED process could not be accomplished. Previous studies indicated design students’ positive reflections on their increased empathic design awareness for designing universally (Altay et al., 2016).

The previous studies investigated empathy in design education and practice. The reflection of empathic design in the design process was explained. However, there are limited number of studies exploring the role of building empathy and its effects on

design process and end products in terms of architectural education context. Therefore, this study aimed to find the role of empathic design in interior design education by proposing a research model that is inspired by previous studies. The following chapter presented the research.



CHAPTER 4

METHODOLOGY

In this chapter, the research methodology of the study was presented. Firstly, the aim, research questions, hypotheses and proposed model were introduced. Then, data collection and analysis methods, participants, experimental setting, instruments, and procedure of the study were presented. This chapter ended with detailed information about the pilot study and the main study.

4.1 Aim of the Study

The goal of this study was to develop a theoretical measure for understanding and assessing ED process in interior architecture education concerning pedagogical reflections. In this respect, this study aimed to research the impacts of ED process on participants' multiple dimensions of empathy, design process, end products and their perceptions of learning experience. With the outcomes of this study, design educators can understand how empathy could be integrated as a supportive learning tool in design education and which ED technique was more effective in proposing UD solutions. Also, they can assess how empathy influenced student's perceptions of their learning experience. The assumption was there was a strong relationship between increased empathic understanding and universally designed interior projects. To analyze the relationship between building empathy (independent variable) and universally designed interior projects (dependent variable), it was hypothesized that building empathy in design education affects universally designed projects indirectly

by increasing the student's multiple dimensions of empathy, design process and end product and perceptions of their learning experience (see Figure 19).

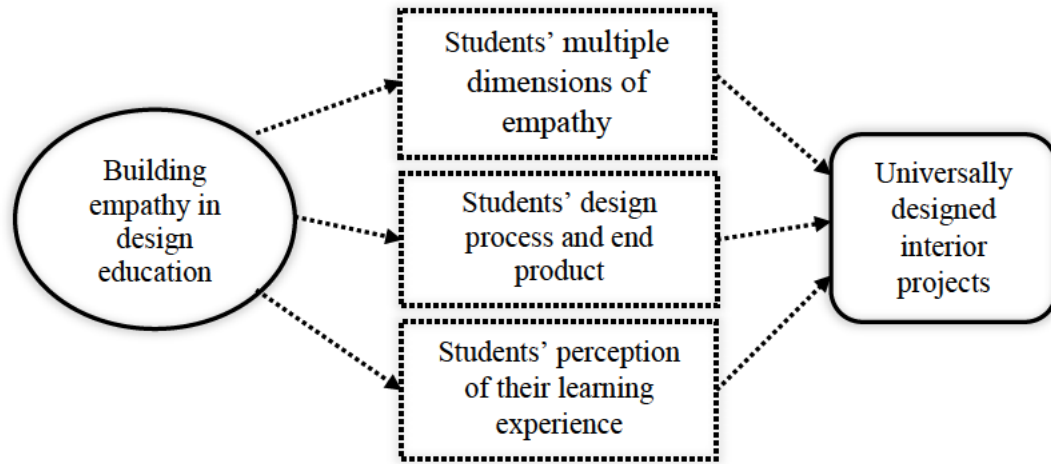


Figure 19. Relationship between building empathy in design education and universally designed interior projects *(drawn by the author)*

4.2 Research Questions and Hypotheses

Research questions of the study were as follows:

RQ1: How does experiencing empathic design process affect interior architecture students' improvement in the multiple dimensions of empathy?

RQ2: To what extent does empathic design process reflect the interior architecture students' design process and end products in terms of applying HF/E and universal design principles?

RQ3: How does experiencing empathic design process reflect on students' perceptions of their learning experience?

Related hypotheses of the study are as follows:

- H1:** Experiencing empathic design process reveals improvements on multiple dimensions of students' empathy.
- H2:** Integrating the empathic design approaches to design process produces more universally designed end products with the correct application of HF/E principles.
- H3:** Experiencing of empathic design process positively reflects on students' perception of their learning experience.

4.3 Proposed Model

The proposed model (see Figure 20) was structured by the four phases of empathy framework (Kouprie & Visser, 2009) and Merrill's First Principles of Instruction (Merrill, 2002) and organized learning activities in ED process. This model aimed to analyze interior architecture students' empathic design learning activities during the experiment. Participants experienced ED techniques in discovery, immersion, and connection phases and redesigned a kitchen and reflected ED experiences in detachment phase.

The proposed model was designed around *principle 1: problem/task centered* (as seen in the middle of the model). For principle 1, Merrill (2002) stated that "Learning is promoted when learners are engaged in solving real-world problems" (p.44). In this study, participants were asked to solve the real kitchen problems. The most important requirement in the design problem was replanning the kitchen by considering the needs and expectations of a person with a broken arm specifically, and all human beings in general.

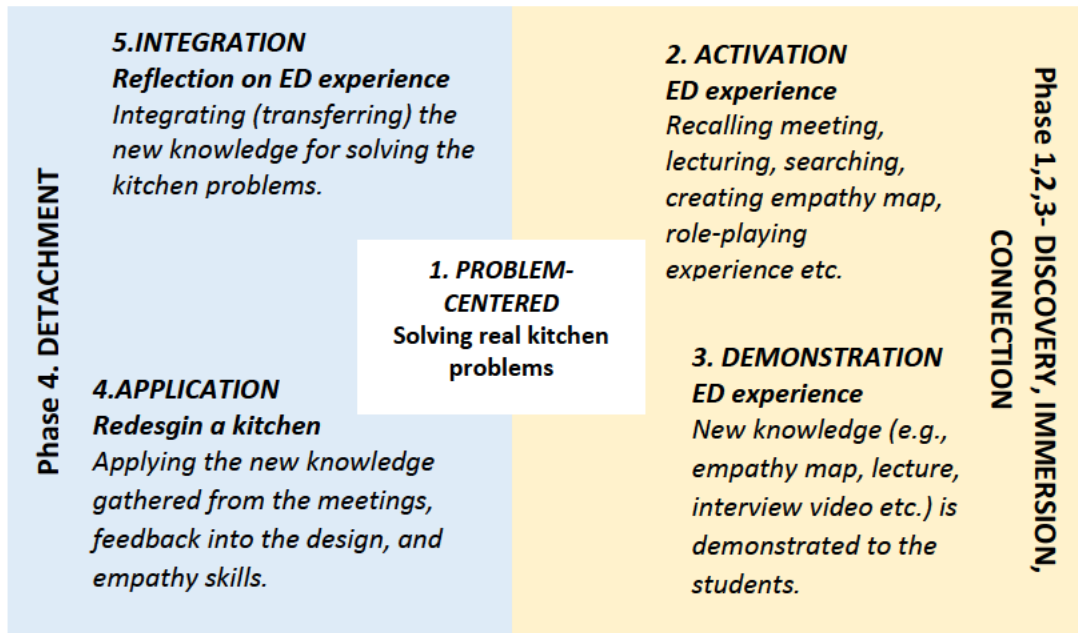


Figure 20. Proposed Model based on Kouprie & Visser’s (2009) four phases of empathy and Merrill’s First Principles of Instruction (2002) (*drawn by the author*)

In phase 1: discovery, participants entered and discovered the user’s world by experiencing different ED techniques. Since participants participated voluntarily, they were willing to experience the ED process. As Kouprie and Visser (2009) mentioned, curiosity and motivation were essential for the first phase. For *principle 2: activation*, Merrill (2002) stated that “Learning is promoted when existing knowledge is activated as a foundation for new knowledge” (p. 45). In this study, participants were expected to recall their ED experiences and/or their relevant experiences from previous courses that could be used as a foundation for the new knowledge in the design process.

In phase 2: immersion, participants wandered around the user’s world while experiencing ED techniques. This phase was the most important one since designers increased their knowledge by taking the user’s point of view (*principle 2: activation*).

In Phase 3: connection- participants connected with the user by recalling his/her own experiences to create an understanding of what the user felt and understood. For *principle 3: demonstration*, Merrill (2002) stated that “Learning is promoted when new knowledge is demonstrated to the learner” (p. 45). In this study, researcher indicated a video recording about user’s kitchen utilization and asked participants to attend lecture about empathy in design, to interview with the user and to make an empathy map about user’s needs to improve learning. These learning activities were new knowledge for participants.

In Phase 4: detachment- participants stepped back into the role of designer and redesigned the user’s kitchen with their increased understanding for generating better universal design solutions. In addition, participants were asked to reflect on what they had learned from the experiment and their empathy abilities to suggest universal design solutions. Since, for *principle 4: application*, Merrill (2002) stated that “Learning is promoted when new knowledge is applied by the learner” (p. 45). Lastly, in group interview, researcher interviewed with participants and encouraged them to share their ED experiences. And they were asked to use the knowledge they have acquired in daily life. Since, for *principle 5: integration*, Merrill (2002) stated that “Learning is promoted when new knowledge is integrated into the learner’s world” (p. 45).

The reason for using Merrill’s First Principles of Instruction was that Merrill (2002) elaborated the five prescriptive design principles that form a foundation for designing problem-centered instruction. The principles are interrelated to one another and focus on different ways of learning (Merrill, 2002). Also, they have been used as part of an instructional strategy to increase learning in higher education and evaluate and redesign their courses according to these principles (Collis & Margaryan, 2005; Gardner, 2011). Merrill’s principles of instruction aim to improve the quality of the learning experience and care about their learning outcomes as other similar instructional design models (Addie Model, Bloom’s taxonomy by Bloom et al., 1956; Bloom, 1984, Understanding by Design/ Backward design Framework by Wiggins & McTighe, 2005).

To illustrate, ADDIE instructional design model was developed in 1975 and has been used by many studies such as Wang and Hsu (2009), Özdilek and Robeck (2009). It consists of a five-stage process as Analyze, Design, Develop, Implementation and Evaluate that aims to design and develop instructions. An important part of ADDIE instructional design model is continual or formative feedback (<https://online.seu.edu>). Bloom's taxonomy (Bloom et al., 1956; Bloom, 1984) classifies the different skills and objectives that the educators set for their students. To organize the various levels of cognitive learning, the classification system based on the three domains are cognitive, affective, and psychomotor was developed (Bloom et al., 1956). Later, these categories were revised and modified by Krathwohl (2002). The revised structure of Bloom's taxonomy has been integrated into the courses to analyze and develop students' learning outcomes and cognitive processes (Altay & Demirkan, 2014). Understanding by Design (UbD)/ Backward design framework was created by Wiggins and McTighe (2005). It consists of three stages, namely (1) identify the desired results, (2) determine the acceptable evidence and (3) plan learning experiences and instruction. UbD framework focused on analyzing classroom instruction, students' learning outcomes, curriculum design and performance assessments (Wiggins & McTighe, 2005).

The main difference between Merrill's First Principles of Instruction and the other models is that it is problem-centered (task-centered) and expects students to solve real world problems. The ADDIE instructional design model is more related with the role of feedback in noticing problems in instruction. Bloom's taxonomy is more associated with psychology aiming to organize different levels of cognitive learning and UbD is interested in the curriculum, performance of students and classroom instruction. Also, Merrill's First Principles of Instruction are compatible for online education and support collaboration among students to work together. These principles are valuable criteria in the design and assessment of the courses (Collis & Margaryan, 2005) that are effective in learning. Instructional designers have applied these principles in meaningful ways (Gardner, 2011). Besides, in this study, these principles are expanded by combining learning strategies such as empathic design, collaboration, and co-design. Additionally, it has been expanded with the following elements:

- Collaboration among students in experience on empathic design techniques and design process.
- Co-design with user.
- Knowledge sharing and learning from user's.
- Being involved in diverse user's ability and experienced it with tasks.
- Online education.

4.4 Data Collection Methods

The methodology of the study involved mixed method research. This study involved mainly qualitative data but was also supported by quantitative data. For qualitative research, the data collection methods were observations, interviews, online meetings' video records and researcher's logbook and for quantitative research were the IRI and kitchen survey (see Table 2). These methods were explained in detail in the following sections.

Table 2 Detailed Data Collection Methods

The type of research	Data Collection Methods	Statement
Qualitative	1. Direct Behavioral Observations	Researcher observed participants' behavior during the experiment.
Qualitative	2. Researcher's Logbook	Researcher gradually noted all necessary information about the experiment.
Qualitative	3. Visual Video Recordings	Researcher recorded visual meetings.
Qualitative	4. Verbal Response Measurement • Group Interview Protocols • Design Conversation Protocols	Researcher asked questions about the experiment and asked participant to discuss design decisions verbally.

(cont'd)

Table 2 (cont'd)

Quantitative	5. Written Response Measurement • Interpersonal Reactivity Index (IRI) • The Kitchen Survey	Researcher asked participants to fill in the IRI and the kitchen survey.
Quantitative	6. Researcher's Assessments on end products	• Design solutions • Checklist Assessment

4.5 Data Analysis Methods

The qualitative data of this study was examined by thematic analysis (Hypothesis 2 and 3). The video recordings included (1) group interviews, and (2) participants' conversations in design process that were studied thematically (see Table 3).

The quantitative data analysis methods of this study were descriptive analysis consisting of the duration of ED techniques, empathy level, kitchen priority rate and checklist analysis of design assessment sheet. The end products of the participants were analyzed by the design assessment sheet.

Table 3 Detailed Data Analysis Methods

The type of research	Data Analysis Methods	Statement
Qualitative	Thematic Analysis	Data obtained from the group interview and participants' design conversation protocols from design processes.
Quantitative	Statistical Analysis	Data obtained from IRI and the kitchen survey.

4.6 Participants

This study was carried out in the fall semester of the 2020-2021 academic year. The participants of the study were the second-year undergraduate students of the

Department of Interior Architecture and Environmental Design at I.D. Bilkent University, Ankara, Turkey. The participants ($n=12$) were voluntary. The age range of the participants were from 20 to 26 years ($M_{age}=23$) and included nine females and three males (see Table 4). Participants were divided into four groups (except for the control group namely, group D) to experience different ED techniques and redesign a kitchen as seen in Table 5.

Table 4 Demographic Characteristics of Groups

	Groups			
	Group A	Group B	Group C	Group D
Characteristic				
Age (<i>M</i>)	21	20	21	21
Sex				
Men	2	1	0	0
Women	1	2	3	3

Table 5 Showing the Label of Participants in Each Group

	Groups			
	Group A	Group B	Group C	Group D
Participants	Participant 1, 2, 3	Participant 1, 2, 3	Participant 1, 2, 3	Participant 1, 2, 3
Participants' label	P1A, P2A, P3A	P1B, P2B, P3B	P1C, P2C, P3C	P1D, P2D, P3D

Each participant had equal background information about UD, HF/E principles, since they all studied the course called ‘Human Factors (or Ergonomics)’ that aims to integrate the principles of universal design by theoretical and practical applications (Altay & Demirkan, 2014). The experiment was announced to all second-year interior architecture students, but twelve students participated voluntarily.

Participants were informed about the research project, its aims, and the experimental

procedure and they were notified that the results of the study would only be used for educative and research purposes.

4.7 Experimental Setting

The online environment was the experimental setting and all participants participated in Zoom meetings, because of Covid-19 pandemic. Group A visited the user's real kitchen online. Group B attended online lecture about empathic design and Group C performed the role-playing activities from user's point of view in their own kitchen on online meetings. The real kitchen environment was in the user's own home. It was in an apartment flat that was built in 2006, at Çankaya/Ankara. The apartment flat was 135 square meters located on the second floor of a reinforced concrete residential building. The kitchen was located on the north side, had a floor area of 16 square meters, L-shaped layout and its ceiling height was 2.60 meters. In addition, the balcony has a floor area of 3.5 square meters (see Figure 21).



Figure 21. User's kitchen from four points of view

The selection criterion of the user was one having a temporary physical impairment (broken arm). The user of this study was a right-handed woman at the age of 60 with the height of 1.55 cm. She broke her arm in kitchen use. Even though she is living with her husband who is the same age, she has a hard time using the kitchen. The user does not think her kitchen is universal and has appropriate size and spaces. Besides, she has a very difficult time using the kitchen with a broken arm.

There were several reasons in selecting a kitchen environment for this study, as (1) kitchen is considered a challenging and problematic area to simulate the activities and to solve the design problems. Besides, (2) it is one of the active environments in residential buildings, it involves home-based basic activities of daily living (BADL) and considered as obligatory activities, such as eating. Also, (3) the instrumental activities of daily living (IADL) that reflect active living activities such as cooking, preparing meals and other kitchen activities (Ahrentzen & Tural, 2015) are held in kitchen. Moreover, (4) people especially women spend much of their daily time in the kitchen. According to the result of Kocaoğlu's (2016) research, women ($n=120$) have spent 4.60 days (live-in single-story houses) and 3.97 days (live in multi-story houses) per week in cooking activity. Also, women have the potential of facing many accessibility problems and home accidents in their kitchen utilization.

There are some design characteristics that need to be considered while designing a kitchen. According to the results of the descriptive analysis of Kocaoğlu's (2016) research, the frontal length of the main working area negatively affects the physical activity levels of women (36 out of 100 responses). The participating women also explained that the main working area is crucial for many kitchen activities to work efficiently with an ease of use, besides, the height of reach to wall cabinets and layout of the kitchen are crucial too (Kocaoğlu, 2016).

In kitchen design, spatial and storage requirements (Demirkan & Kutlusoy, 1998; Grandjean, 1973), all the appliances with applicable sizes need to be considered (Demirkan & Kutlusoy, 1998). Kitchen layouts (one-sided/single galley, two-

sided/corridor, L-shaped, U-shaped and aisle) need to be designed based on the work triangle. Joyce and Swift (1988) defined the work triangle as “This is the logical inter-relationship of the cook’s three main aids: the cooker, the refrigerator, and the sink” (p. 14). The arrangement of workstations from ‘left to right in order: sink-main surface-oven- somewhere to put things down’ must be provided for efficient work without needless movements (Grandjean, 1973). The recommended distance between refrigerator- sink-cooker is maximum 7 meters in small kitchens, 8 meters in large kitchens. The minimum combined length is 3.6 meters. The height of reach is another design characteristic that influences physical activities of people, as Grandjean (1973, p. 148) stated that “the most convenient height of reach-which lies between 65 to 150 cm from the floor-extends only the lowest shelf of the upper cupboard and to the front half of the shelf of the lower cupboard.” In this study, participants were asked to consider all the above-mentioned design characteristics of kitchen utilization and develop UD solutions.

This kitchen user has a broken arm as well as her kitchen has problematic design features related to the UD principles and guidelines. The problematic areas of this kitchen were:

- There were various base and wall cabinets with a reach problem. The design of the wall cabinets maximized hazard and the adverse consequences of accidental actions. The user fell from a chair when she was trying to reach the wall cabinets and, she has difficulties in using base cabinets since she takes too much effort to use them (*the relevant UD principles are; principle 5- tolerance for errors, principle 6- low physical effort and principle 7- size and space for approach and use*).
- Ease of moving/maneuvering in the kitchen was not possible for people with wheelchair and the kitchen did not have an adequate clear floor area if more than one person uses the kitchen (*the relevant UD principles are principle 1- equitable use, principle 3- simple and intuitive use*).

- The sequence of use and work centers were not applicable since they were placed from left to right as, cooker- counter- sink (*the relevant UD principles are principle 2- flexibility in user, principle 3 simple and intuitive use*).
- There was no adequate counter space on at least one side of the refrigerator (*the relevant UD principle is principle 7- size and space for approach and use*).
- There was an inadequate circulation space around the dining table, people cannot sit and watch television (*the relevant UD principle is principle 7- size and space for approach and use*)

4.8 Instruments

The instruments of the study were (1) Interpersonal Reactivity Index (IRI) (Davis, 1980, 1983) (see Appendix B), (2) Design brief, (3) Lecture on Empathic Design, (4) The Kitchen Survey (adapted from Afacan & Demirkan, 2010) (see Appendix C), (5) Design Assessment Sheet (see Appendix D), (6) Semi-structured interviews, and (7) Researcher's logbook.

4.8.1 Interpersonal Reactivity Index (IRI)

In this study, the IRI (Davis, 1980, 1983) was used as an assessment tool to measure participants' individual differences in empathy. Participants were clearly informed that the index was for research purposes. The essential part of this assessment was measuring the effectiveness of the ED process on participants' empathy. To answer research question 1 (RQ1: How does experiencing empathic design process affect interior architecture students' improvement in the multiple dimensions of empathy?), participants were asked to fill the index twice before and after the experiment. They were asked to indicate how well each item describes them by choosing the appropriate letter on the scale: A, B, C, D, or E. The items were answered on a 5-

point Likert scale ranging from “A=Does not describe me well” to “E=Describes me very well”.

Measuring empathy levels of individuals is conceivable by various instruments such as questionnaires, (e.g., The Toronto Empathy Questionnaire; Spreng et al., 2009; Questionnaire of Cognitive and Affective Empathy; Reiners et al., 2011), indexes, (e.g., IRI; Davis, 1980, 1983) or scales (e.g., Basic Empathy Scale; Jolliffe & Farrington, 2006; Hogan Empathy Scale; Hogan, 1969; The Empathic Tendency Scale; Dökmen, 1988). The common feature of these instruments is measuring both the cognitive and affective empathy levels of individuals. Out of these instruments, the IRI (Davis, 1980, 1983) was chosen since it covers multiple dimensions of empathy. So, the IRI makes it possible to analyze different empathy dimensions in depth.

IRI (Davis 1980, 1983) has twenty-eight items that are prepared for measuring the four different empathy-related dimensions based on both affective and cognitive components. The items are about a person's thoughts and feelings in a variety of situations. The index includes the four subscales and each subscale consist of seven items (perspective taking (PT) (cognitive empathy)- *items (3,8,11,15,21,25,28)*, fantasy (FS) (cognitive empathy)- *items (1,5,7,12,16,23,26)*, empathic concern (EC) (affective empathy)- *items (2,4,9,14, 18, 20,22)*, and personal distress (PD) (affective empathy)-*items (6,10,13,17,19,24,27)* (Davis, 1980, 1983). “The perspective taking (PT) scale assesses the tendency to spontaneously adopt the psychological point of others; the Fantasy (FS) scale taps respondents' tendencies to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays. The other two subscales measure typical emotional reactions of the respondents: The empathic concern (EC) scale assesses “other-oriented” feelings of sympathy and concern for unfortunate others, and the Personal Distress (PD) scale measures “self-oriented” feelings of personal anxiety and unease in tense interpersonal settings” (Davis, 1983, pp. 112-114). The EC and PT are the other-oriented subscales compared to the PD that the self-oriented one. If the research is not measuring total empathy and/or the researcher is only interested in one or two

subscales (Chopik, et al., 2017), each subscale needs to be analyzed separately (Konrath, 2013).

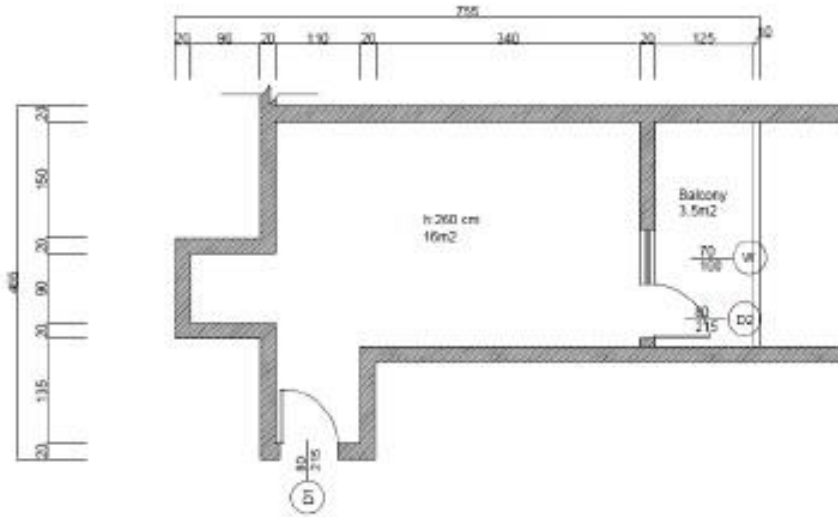
4.8.2 Design Brief

The design brief was delivered to participants to find an answer to the second research question (RQ2: To what extent does empathic design process reflect the interior architecture students' design process and end products in terms of applying human factors/ergonomics and universal design principles?). The design brief consisted of a design problem, a floor plan drawing of the real kitchen environment, brief information about the user and related design requirements and technical information about the kitchen area (see Figure 22). The brief information about the user was as follows: "The user is a woman at the age of 60 with the height of 1.55 cm and a right-handed person. She has a broken arm experience because of a home accident. Even if she is living with her husband who is at the same age, she has a hard time in using the kitchen." The design challenge was to redesign a kitchen with a dining area for a couple in their 60's and for all people. The final design solutions should include UD solutions considering both the user and all people. The cabinets, storages, appliances, illumination, work surfaces, circulation, and materials should be considered in the light of HF/E and UD principles. The same design brief was delivered to all groups before the design process began. After delivering the design brief, a discussion was generated in each group. Brief information about the user and the design challenges were introduced.

Design Problem: You are given the real kitchen floor plan with a balcony in an apartment flat that was built in 2006 at Çankaya/Ankara. The apartment flat is 135 square meters on the second floor of a reinforced concrete residential building. The kitchen has a floor area 16 square meters, and its ceiling height is 2.60 meters. Besides, the balcony is 3.5 square meters.

You are required to design a universal kitchen in an apartment for a couple in their 60's.

There should be dining area within a kitchen, and you can integrate balcony area into kitchen floor. Please consider cabinets and storage, counters or work surfaces, circulation, appliances sink and faucets, illumination, and materials in the light of human factors and universal design principles.



Requirements: You are asked to draw your design by freehand or digitally in 1/50 scale.

- Initial ideas, design statement.
- Research, concept information.
- Plan and section (sketches)
- Sketch perspective(s)

Figure 22. Design Brief

4.8.3 Lecture on Empathic Design

The lecture called ‘Empathy and Empathic Design’ was one of the teaching interventions of this study (Hypothesis 2) (see Figure 23). The researcher gave the lecture only to Group B on an online session in virtual meeting via Zoom. The duration of the lecture was 30 minutes. The purpose of the lecture was to provide

knowledge about empathy, empathic design and teaching how to create an empathy map.

Empathy and Empathic Design

3. Empathic Design

- provides in-depth understanding of people's problems about product/environment utilization
[38][39][40][41]
- increase students' awareness in social and physical conditions of people with diverse abilities
[39]

positive outcomes on students' design projects

[38] Altay (2017)
[39] Altay and Demirkan (2014)
[40] Gomez-Lanier (2018)
[41] Torrens (2000)

Figure 23. Sample slide from the lecture about empathic design

The lecture began with the definition of empathy and its related components, and the theoretical knowledge about ED. Previous studies about building empathy in design education were indicated. Also, the special communication tools as storytelling techniques, personas, empathy map (Bairaktarova et al., 2016; Tschimmel, 2012; Ferreira et al., 2015), scenarios, storyboards, literature, original quotes, photos and/or videos of users in their home environment were presented (Kouprie & Visser, 2009; van Rijn et al., 2011). Research strategies and techniques used in ED were designated and some frameworks about ED were exemplified. The user's video recording (recorded on day 1) was indicated. Moreover, how to make empathy was told by showing examples from literature. Also, the researcher and Group B created a sample empathy map so that Group B could understand better how to make an empathy map. At the end of the lecture, the persona of the user (see Figure 24) was sent to Group B, and they were asked to make an empathy map for the user.

- Age: 60
- Retired Teacher
- Married
- 1.55 height
- Have a son (married)
- Lives with her husband
- Loves cooking, curious about plate, pan, glass etc.
- Cooks alone (generally)
- Watches TV when cooking and eating
- Has a broken arm



Figure 24. The persona of the user for Group B

4.8.4 Kitchen Survey

The Kitchen Survey, adapted from Afacan and Demirkan's (2010) study, was used to answer third research question (RQ3: How does experiencing empathic design process reflect on students' perceptions of their learning experience?). The survey instrument developed by Afacan and Demirkan (2010, pp. 338-341), originally comprised of eight kitchen design features as "(A) circulation, (B) cabinets and storage areas, (C) counters/work surfaces, (D) appliances, (E) sink and faucets, (F) controls (sockets, switches, and appliance controls), (G) illumination and (H) materials" and 87 items considering the needs of diverse users. "The instrument includes kitchen design features that contribute to or can be components of a promising universal kitchen solution" (Afacan & Demirkan, 2010, p.322). The items are based on the information obtained from international UD and human factors design resources (Afacan & Demirkan, 2010). In the survey instrument, it is asked to rank the importance level for each kitchen design item for efficient work in the kitchen. In this study, the 40 detailed items about controls and appliances were

removed since participants were not asked to solve the details about them. Thus, 7 kitchen design features and 47 items were used as Kitchen Survey as seen in Table 6.

Table 6 Kitchen Design Features and the Related Items in the Kitchen Survey

Kitchen Design Features	Number of items	Item numbers
Circulation	5	1,2,3,4,5
Cabinets and storage areas	10	6,7,8,9,10,11,12,13,14,15
Counters/work surfaces	10	16,17,18,19,20,21,22,23,24,25
Appliances	10	26,27,28,29,30,31,32,33,34,35
Sinks and faucets	3	36,37,38
Illumination	4	39,40,41,42
Materials	5	43,44,45,46,47

Participants and the user rated the importance level (on Likert scale) of each item for working successfully in a kitchen environment for a broken arm person. To understand to what extent the participants understand the user's kitchen priorities, they were asked to fill in the survey from the user's (who has a broken arm) point of view at the end of the design task. The user was asked to fill in the survey at the beginning of the experiment. The answers from participants and the user were compared. The purpose of the comparison was to match the answers and analyze their similarities. Thus, similar answers indicated the level of empathic understanding of the participants on the user's priorities in kitchen environment.

4.8.5 Design Assessment Sheet

The design assessment sheet was created to be used to answer research question 2 and assess the end products of the participants. The criteria for the assessment of end products were derived from literature. Certain criteria were also believed to be

important and therefore added to the design assessment sheet. The sheet consisted of a checklist for evaluation under two sections (2) the principles of universal design (The Center for Universal design, 1997) and (3) the Kitchen Survey items (adapted from Afacan & Demirkan, 2010). The Center for Universal design (1997) stated the importance of ‘universal design principles’; and Afacan and Demirkan (2010) stressed the importance of ‘the kitchen needs’ of diverse users. The results were then compared to see whether there is any significant difference or not among participants’ end products. The researcher used a design assessment sheet to evaluate each groups’ end product submissions.

4.8.6 Semi-Structured Interviews

In this study, there were two recorded semi-structured interviews. First, Group A (in co-design) interviewed the user that were involved in their open-ended questions for receiving detailed information about the user and her kitchen utilization. Second, the researcher conducted a group interview with the participants to understand their in-depth reflections about the ED process. The focus of the group interview was on the learning outcome and process of the experiment. The researcher asked open-ended questions about participants’ task experiences (see Table 7). Participants were expected to share their individual empathic design experiences interactively by assessing themselves objectively.

Table 7 The Questions in the Group Interview

Q1. What are your opinions about this experiment?
Q2. What are your opinions about integrating empathy into the lesson content?
Q3. How has participating in such an experiment changed your understanding of design for your future projects?
Q4. What do you think about IRI?
Q5. What do you think about the Kitchen Survey?
Q6. Could you please talk about your experience while designing collaboratively?
Q7. How was your drawing experience via using Zoom?

4.8.7 Researcher's Logbook

The researcher kept a logbook to note the observational data obtained throughout the entire experiment. She noted her observation about each group's ED process and group interview. The context of the logbook involved: (1) noting participants' behavior while they were dealing with a task, (2) noting quantitative data about each task such as duration of activities and brainstorming sessions etc., (see Figure 25).

First, the researcher quickly noted her first observations consisting of participants' behaviors (funny moments, difficulties etc.) and detailed about each activity while participants were conducting the tasks. After the experiment was carried out, she re-read her notes and watched video recordings to arrange and enrich her notes. Specifically, she re-noted word-by-word the participants' protocols from group interviews, design process and interview with the user and co-design sessions.

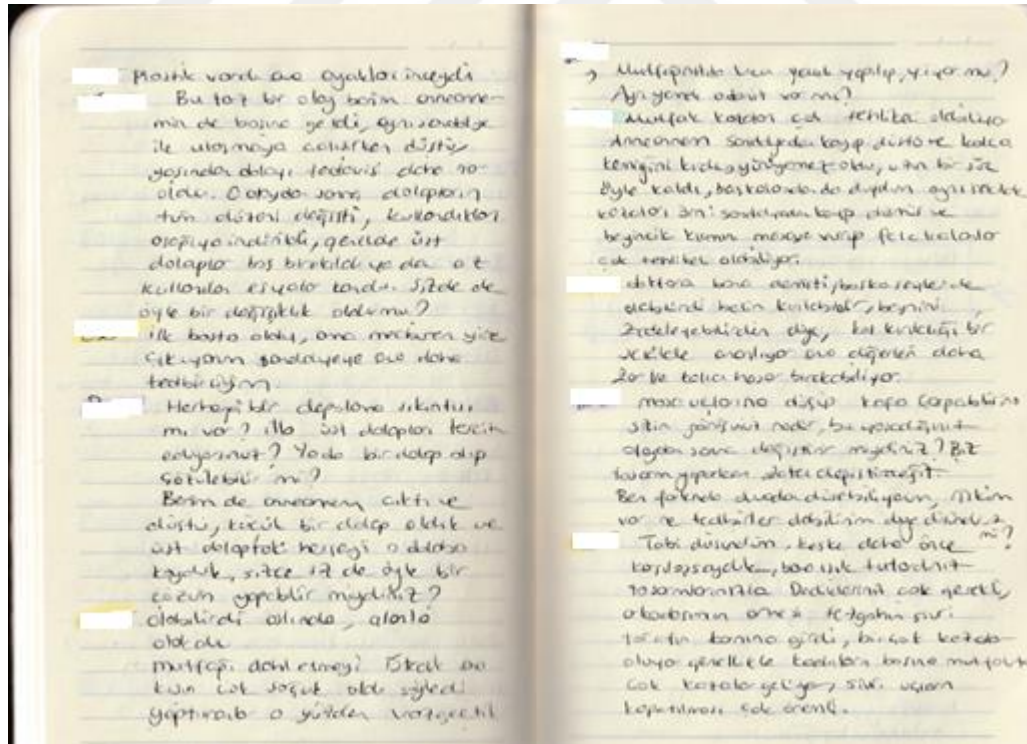


Figure 25. Researcher's Logbook

4.8.8 Thematic Analysis

Thematic Analysis (TA) was identified as “a process for encoding qualitative information. The encoding requires an explicit ‘code’. This may be a list of themes; a complex model with themes, indicators, and qualifications that are casually related; or something in between these two forms” (Boyatzis, 1998, p. 4). Similarly, TA was described as “a method for identifying, analyzing, and reporting patterns (themes) within data” (Braun & Clarke, 2006, p. 79).

According to Boyatzis (1998), the use of TA has three different stages, (1) deciding on sampling and design issues; (2) developing themes and a code; and (3) validating and using the code. In the second stage, there are two different levels in identifying the theme namely, manifest level and latent level (Boyatzis, 1998). Guest et al. (2012, p. 9) also explained the procedure of TA as; “thematic analyses move beyond counting explicit words or phrases and focus on identifying and describing both implicit and explicit within the data, that is, themes. Codes are then typically developed to represent the identified themes and applied or linked to raw data as summary markers for later analysis”. In addition, Boyatzis, (1998) stated that “a good thematic code should have five elements, (1) a label (a name), (2) a definition of what the theme concerns (the characteristics the theme), (3) a description of how to know when the theme occurs, (4) a description of any qualification to the identification of the theme, (5) examples, both positive and negative, to eliminate possible confusion when looking for the theme” (p.31).

Braun and Clarke (2006), who are researchers and teachers in qualitative psychology, discussed TA process and described their approach to thematic analysis. The researchers proposed a six-phase process approach to TA (see Table 8), respectively “familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, producing the report” (Braun and Clarke, 2006, p. 87). However, they reviewed their TA approach as *reflexive TA* and revised the six recursive phases as “(1) familiarizations; (2) coding; (3) generating initial themes; (4) reviewing and developing themes; (5) refining, defining, and

naming themes; and (6) writing up”. The main difference between the two approaches is that the revised one is based on the ‘reflexive’ approach and defined as involving later theme development, with themes developed from codes, and conceptualized (Braun & Clarke, 2019).

Table 8 Phases of Thematic Analysis (Braun & Clarke, 2006, p. 87)

Phases	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic ‘map’ of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

In this study, the coding process was performed manually based on the Boyatzis’ (1998) study and characterized as data driven. Codes were structured inductively, and the transcripts were re-carefully read line by line (Boyatzis, 1998). The apparent initial codes were determined based on the manifest content analysis such as finding the degree to which participant used the word (an analysis of the number of times that the participant used the word) to express their reflections and design solutions.

4.9 Procedure of the Study

The study was approved by the Ethics Committee of I.D. Bilkent University (No: 2020_11_23_01) (see Appendix A). The methodology of the study involved mixed research methods. To explore and analyze the effects of building empathy on interior architecture education, participants were divided into four groups (Group A, B, C, and D) and asked to conduct seven tasks in independent Zoom meetings in one week, and they were informed that the online meetings would be recorded. The tasks were as; (1) fill out the Interpersonal Reactivity Index (2) experience empathic design techniques, (3) redesign the user's kitchen, (4) codesign with the user, (5) fill out the kitchen survey (6) reflect empathic design process in group interview and (7) fill out the Interpersonal Reactivity Index again (see Figure 26). However, as seen in Table 9 and 10, each task was not required to be completed by all groups.

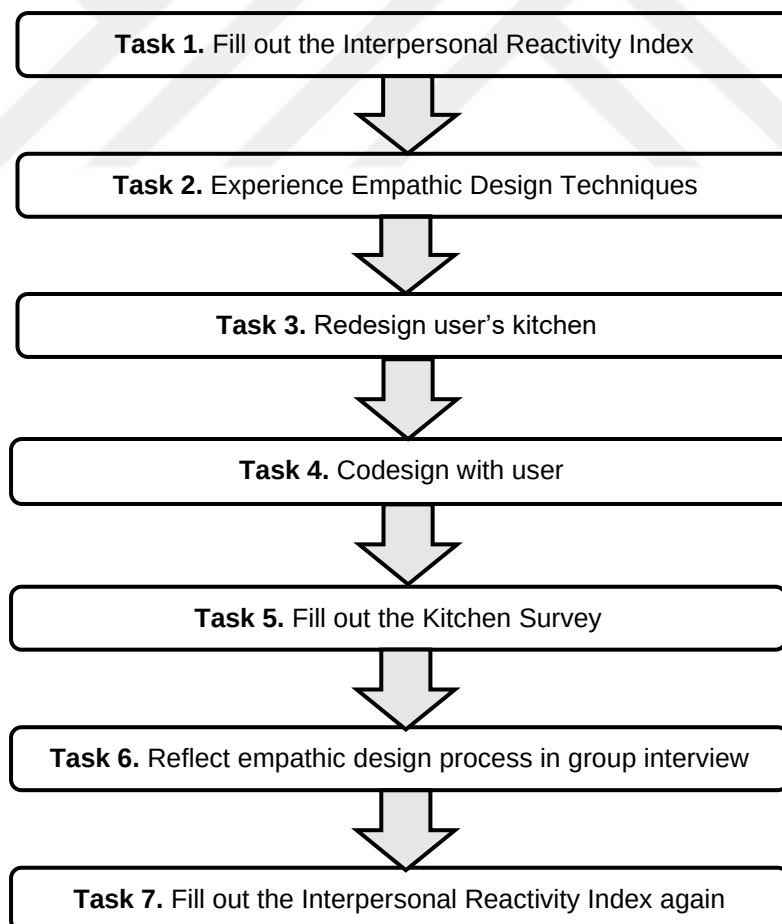


Figure 26. Procedure chart of the study

Table 9 Tasks Conducted by Each Group

	Groups			
	Group A	Group B	Group C	Group D (Control Group)
Task 1. Fill out IRI (20 min.)	✓	✓	✓	-
Task 2. Experience ED Techniques	✓	✓	✓	-
	Direct contact between designers and users	Indirect contact between designers and users	Role-playing	-
Task 3. Redesign user's kitchen (150 min.)	✓	✓	✓	✓
Task 4. Codesign with user (20 min.)	✓	-	-	-
Task 5. Fill out Kitchen Survey (20 min.)	✓	✓	✓	✓
Task 6. Reflect ED process in group interview (40 min.)	✓	✓	✓	✓
Task 7. Fill out IRI again (20 min.)	✓	✓	✓	-

Table 10 The Calendar of the Experiment

DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
GROUP A	GROUP B	GROUP C	GROUP A, B	GROUP C, D	GROUP A	GROUP A, B, C, D
Zoom Meeting 1	Zoom Meeting 2	Zoom Meeting 3	Zoom Meetings 4 and 5	Zoom Meeting 6 and 7	Zoom Meeting 8	Zoom Meeting 9
Task 1 and Task 2	Task 1 and Task 2	Task 1 and Task 2	Task 3	Task 3	Task 4	Task 5, Task 6 and Task 7

Task 1: Fill out the Interpersonal Reactivity Index

The aim of the first task was to measure the improvement in the multiple dimensions of empathy level of participants to answer the first research question 1. In this respect, IRI (Davis, 1980, 1983) was sent to participants from Group A, B and C by e-mail at the beginning of an experiment and brief information about the IRI was given. Participants answered 28 questions and sent their responses to the researcher via e-mail in 20 minutes. However, Group D (control group) was not involved in Task 2, they filled the IRI just before starting their design in Task 3, since they did not practice any ED technique.

Task 2: Experience Empathic Design Techniques

This task asked participants to conduct three distinct ED techniques. Group A was asked to create direct contact with the user by interviewing and observing. Group B was asked to attend the lecture, watch user's video recording, and make an empathy map. Group C was asked to simulate the user's physical limitation and try to perform role-playing activities in their real kitchen environment. They were asked to tie their one arm that they always use with a shawl and make pasta (for one person) and eat it while doing the following activities (see Table 11).

Table 11 Role-playing Activities for Group C

-
1. Open the kitchen door without any assistance (orientation)
 2. Find the cooking pot and fill it with water (use of cabinets, sink and faucet)
 3. Put the cooking pot on the oven and turn on (use of oven)
 4. Find the spoon and mix the water with adding salt (use of drawer)
 5. Find the pasta and put it in cook pot (use of cabinets)
 6. Straining the pasta using the strainer (use of sink)
 7. Open the refrigerator and take butter or oil and add into pasta (use of refrigerator)
 8. Find the plate and put the pasta into the plate (use of cabinet)
 9. Walk to dining table and sit on the chair and eat your pasta (dining area, orientation)
 10. After eating, put your fork and plate into the dishwasher (use of dishwasher)
 11. Leave the kitchen (orientation)
-

The activities were determined for Group C as to use the cabinets, counters, appliances (refrigerator, sink, cooker, dishwasher), experience circulation in the kitchen among workstations and using the dining area. Group C were allowed to attend each meeting to watch their group friends' role-playing activities. A helper (family member or friend) guided and followed participants to protect them from any accident and took video of them. Each participant had 20 minutes to complete the activities. Researcher recorded each role-playing act and noted the participants' behavior in her logbook.

Task 3: Redesign user's kitchen

The aim of this task was to reflect the ED experiences of participants on their design process. Each group (Group A, B, C and D) were asked to perform this task at independent Zoom meetings. The same design brief and the real kitchen's AutoCAD plan drawing were e-mailed to each group and a brief discussion on the problem was generated. The design process began with a brainstorming session. Then, the participants practiced developing UD solutions to the design problem. Only Group D were asked to fill out IRI and send their responses to the researcher.

The design processes were recorded, and the decision-making process of participants was observed by the researcher without interfering with their decisions. Participants were allowed to design either by freehand or using digital drawing software. If participants drew in a digital medium, they were asked to convert their drawings to PDF file and send them to the researcher. If they drew by freehand, they were asked to take a photograph of their drawings and send it to the researcher.

Task 4. Codesign with user

On the sixth day of the experiment, Group A members were asked to introduce their end product (plan, section and sketch perspective drawing) and explained their universal design solutions to the user and co-design with her (duration: 20 min.). The user was asked to comment on participants' design solutions and give feedback.

Task 5. Fill out the Kitchen Survey

After completing tasks 3 and 4, participants rated prioritization of the kitchen characteristics in the kitchen survey (adapted from Afacan & Demirkan, 2010) from user's (a broken arm person) point of view. The user filled in the survey at the beginning of the experiment. The aim of this task for participants was to understand user's needs by empathizing.

Task 6: Reflect empathic design process in group interview

To investigate in-depth reflections about ED experience, semi-structured interview was conducted as group interview. The focus of the interview was on the learning outcome and process of the experiment. Participants particularly discussed the experience they had received over the experiment about the learning methods applied, procedure, UD, collaborative design, and distance learning. The interview was recorded. Since the participants did not know which ED technique their other friends had experienced, it was explained which group had experienced which technique by going over the photos and videos. Participants were expected to share their experiences interactively by assessing themselves objectively. Furthermore, participants were asked to evaluate their learning activities in the ED process. The researcher asked open-ended questions about participants' task experiences. And participants watched their role-playing activities and interview and then discussed and shared their learning experiences regarding the impacts of ED techniques and strategies. The researcher indicated participants' role-playing activities, so they had a chance to assess themselves, also they were shown the interview and lecturing videos.

Task 7: Fill out the Interpersonal Reactivity Index again

In the last task, Group A, B and C were asked to fill the IRI again at the end of the group interview. The reason for asking participants to fill out this index again was to determine whether there was any difference in the empathy levels of participants or not. When all tasks were completed, the deliverables were expected as seen in Table

10. The common deliverables for each group were design process transcript, end product, kitchen survey answers and group interview transcript (see Table 12).

Table 12 Deliverables from Each Group

Groups				
	Group A	Group B	Group C	Group D
Deliverables	IRI, user interview and codesign transcripts, design process transcript, end product, kitchen survey, group interview transcript	IRI, empathy map, design process transcript, end product, kitchen survey, group interview transcript	IRI, role-playing videos, design process transcript, end product, kitchen survey, group interview transcript	Design process transcript, end product, kitchen survey, group interview transcript

4.10 Pilot Study

The pilot study was done in 7 days in November-December 2020 to test the effectiveness of the application process. The volunteer participants were comprised of 2020-2021 academic year eight Ph.D. students, 7 female and 1 male of the Department of Interior Architecture and Environmental Design, I.D. Bilkent University, Ankara, Turkey.

Participants were informed of their right to withdraw at any time. The age range was 27-31 ($M=28.75$). The participants were divided into four groups (Pilot Group A, B, C and D) and asked to work in pairs. Participants were coded as in Table 13. Pilot Group D was the control group who were not asked to experience any ED techniques and they were only required to redesign a kitchen and attend group interview.

Table 13 Showing the Label of Participants from Pilot Study

Group name	Participants	Participants' label
Pilot Group A	Pilot Participant 1, 2	PP1A, PP2A
Pilot Group B	Pilot Participant 1, 2	PP1B, PP2B
Pilot Group C	Pilot Participant 1, 2	PP1C, PP2C
Pilot Group D (Control group)	Pilot Participant 1, 2	PP1D, PP2D

The seven tasks were conducted in nine recorded Zoom meetings. At the beginning of the meetings, participants filled out the IRI (Davis,1980;1983) and e-mailed their responses to the researcher.

On the first day (Nov. 27, 2020), Pilot Group A filled out the IRI and e-mailed their responses to the researcher (*task 1*). They built direct contact with a real user who has a broken arm through interviewing (duration=10 min.) and observing user's daily life activities in kitchen (duration= 7 min.) (*task 2*) (see Figure 27).

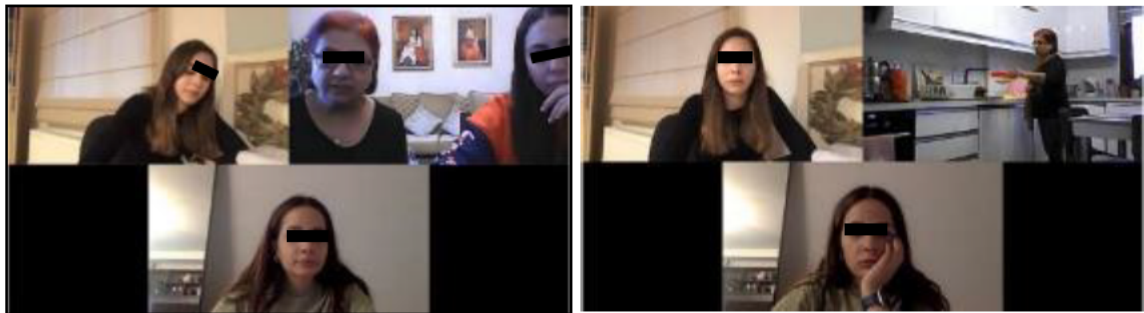


Figure 27. Pilot Group A interviewed and observed user

On the second day (Nov. 28, 2020) Pilot Group B filled out the IRI and e-mailed their responses to the researcher (*task 1*). They did not build direct contact with a user; they attended a lecture about ED, learned how to make an EM and watched the user's video recording (*task 2*). At the end of the meeting, Pilot Group B were asked to create an EM for the user (see Figure 28).



Figure 28. Pilot Group B attended a lecture

On the third day (Nov. 29, 2020), Pilot Group C filled out the IRI and e-mailed their responses to the researcher (**task 1**). They simulated a broken arm condition by wrapping their one arm and leaving it unusable in their own kitchen environments. They were asked to make pasta for one person and eat it. Participants watched each other's role-playing activities (**task 2**) (see Figure 29).



Figure 29. Pilot Group C conducted role-playing activities

On the fourth and fifth days (Nov. 30- Dec. 01, 2020), four independent Zoom meetings were held (see Figure 30). All groups ($n=12$) redesigned the user's kitchen universally (**task 3**). Groups drew either freehand or using digital drawing programs. In each group, one participant shared his/her screen and drew, the other group member explained his/her ideas. Each group had 2.5 hours.



Figure 30. All pilot groups in design process and researcher observed them

On the sixth day (Dec. 2, 2020), Pilot Group A met with the user again and presented their end product (plan, section, and sketch perspective drawing) to co-design with her (duration=25 min.) (**task 4**). The researcher observed the codesign process and took notes in her logbook.

On the last day (Dec. 3, 2020), all participants filled out the Kitchen Survey (adapted from Afacan & Demirkan, 2010) from the point of view of a person with a broken arm (**task 5**) and e-mailed responses to the researcher. Additionally, they attend the semi-structured group interview (duration=35 min.) to share their learning experiences and reflections about an experiment (**task 6**) (see Figure 31). However, four participants could not attend, they sent their responses as audio recordings. At the end of the group interview, participants filled out the IRI again (**task 7**) and e-mailed their responses to the researcher.



Figure 31. All Pilot groups in group interview

According to the analysis of the IRI, there was an improvement in PT and EC dimension in Group C (see Table 14). The results indicated the effectiveness of role-playing technique on improvement of EC and PT dimensions of participants' empathy. Participants' comments indicated that they found the IRI interesting and enjoyable. In the Kitchen Survey analysis, Group A gave the closest answer to the user's answer. The results revealed the importance of building direct contact with the user on understanding the user's needs. One participant in Pilot Group B shared her opinion about the kitchen survey as; "we were asked to empathize while filling out the kitchen survey, it was quite important to use our empathy ability, I considered that our empathy ability have enhanced. It was forcing to think through the eyes of the user with different abilities." (PP2B).

Table 14 IRI Subscale Scores Before and After the Experiment, Pilot Study

	Groups											
	Pilot Group A				Pilot Group B				Pilot Group C			
	PP1A		PP2A		PP1B		PP2B		PP1C		PP2C	
Empathy Subscales	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
PT	12	12	18	20	28	28	9	10	24	26	26	28
EC	20	20	25	21	28	28	11	15	22	23	27	28
PD	16	12	18	19	20	13	18	19	13	8	13	14
FS	18	16	18	18	28	28	14	15	14	14	25	28
Total	66	60	79	78	104	97	52	59	73	71	91	98

According to the analysis of the learning activities, the results of the pilot study coincided with Merrill's first principles of instruction (Merrill, 2002). Participants' feedback about the pilot study were as follows:

It was a valuable, different, and significant experience for me. I realized the value of being able to move with two arms. I noticed that the length and width of the working area is insufficient. Having to use the kitchen with one arm means more effort so the distance between refrigerator-sink and cooktop must be short (*PP2C*).

I remembered the wheelchair person's turnaround radius from Human Factor's course (*PP1A*).

I liked to see the examples of empathy map and watching video about user's kitchen utilization. These improved my empathic ability. If I did not watch the video, I would not feel that involved. I was impressed that I saw someone in a real situation, so I wanted to do my best in the design and make her kitchen more comfortable usage (*PP2B*).

While we were designing, especially when designing the counters, the difficulties faced by the user came to our mind and we designed accordingly (*PP2A*).

In co-design, “we empathized while designing the wall-cabinet’s doors, we put ourselves in your place (a broken arm person) and we designed the cabinets doors as opening to the side so that you can open them easily (*PP2B*).

End products of pilot groups (see Appendix E) were assessed by the researcher with checklist analysis of Design Assessment Sheet. According to the assessment, participants who experienced the ED techniques (Pilot Groups A, B and C) have integrated their experiences and knowledge into their designs. Also, Group A provided more UD solutions with the correct application of HF/E principles.

In the light of the pilot study’s feedbacks, some revisions were made in the actual implementation process:

1. The durations of the interview and observation were extended. Participants were allowed to ask the user more questions.
2. The lecture duration was reduced since participants found the lecture time too much.
3. More combinations of multimedia (e.g., text and graphic and audio/video and graphics) in lecture were demonstrated to promote more effective learning.
4. A sample of empathy map was created with the researcher.
5. The helper oriented the camera in the role-playing activities.
6. Questions in the kitchen survey were reduced.

4.11 The Main Study

The study was conducted in 7 days in January 2020. The study was revised according to the six feedbacks from the pilot study. Twelve participants participated voluntarily.

In the first day, **Group A** conducted Task 1 and Task 2 in Zoom Meeting 1. At the beginning of the meeting, Group A filled out the IRI in 20 minutes and e-mailed their responses to the researcher (*task 1*). Then, they built direct contact with the user by interviewing (duration: 20 min.) and observing (duration: 17 min.) the user (*task 2*) (see Figures 32 and 33). They asked nineteen questions consisting of both open-ended and close-ended which they prepared beforehand for the user. The closed-ended questions were about the personal information of the user. In addition, they asked open-ended questions related to the difficulties or problems that user encountered in kitchen utilization. After the interview, Group A observed the user's kitchen utilization (duration: 20 min.). The user carried out her daily kitchen activities such as preparing meal, reaching the wall cabinets by stepping up onto the chair, washing something in the sink etc. and Group A continued asking questions and taking notes. At the same time, the researcher took notes about the participants' behavior in her logbook. The interview and observation took 37 minutes in total.

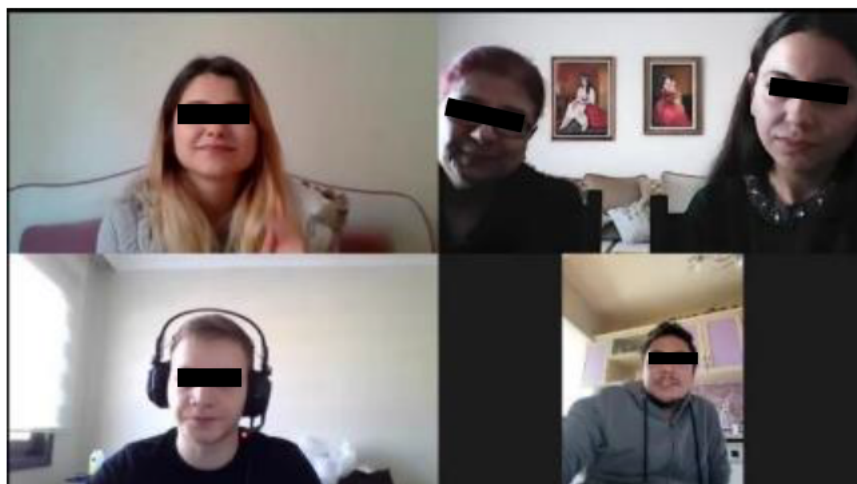


Figure 32. Group A interviewed with the user while researcher was observing participants

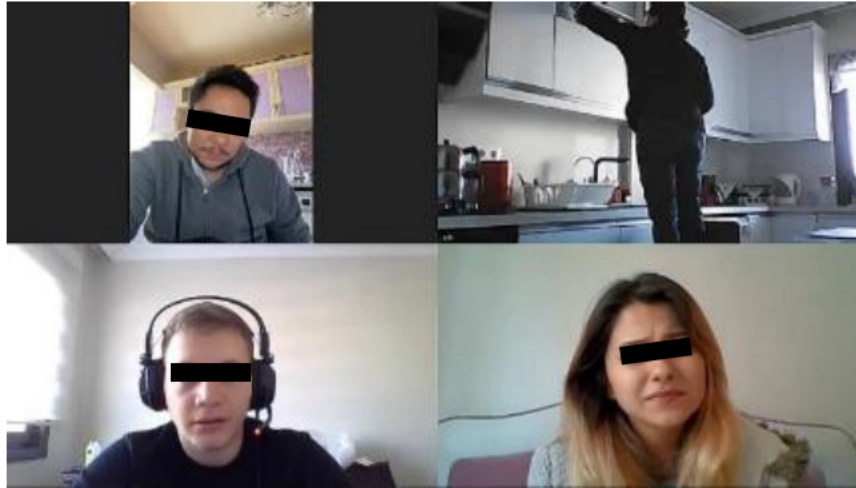


Figure 33. Group A observed the user's kitchen utilization

In the second day, Group B conducted Task 1 and Task 2 in Zoom Meeting 2. In Task 1, Group B filled out the IRI in 20 minutes and e-mailed their responses to the researcher (*task 1*). In Task 2, **Group B** attended the lecture (duration: 30 min.) (see Figure 34) and watched user's video recording. At the end of the lecture, student learned how to make an EM. For Group B to better understand how to make an EM, researcher and Group B made a sample EM for bathroom design for a walker user who became paralyzed ten years ago. At the end of the lecture, the persona of the user was sent to Group B, and they were asked to research online and create an EM for the user. At the end of the meeting, they sent their EM to the researcher (see Figure 35).



Figure 34. Group B attended to the Lecture about Empathic Design

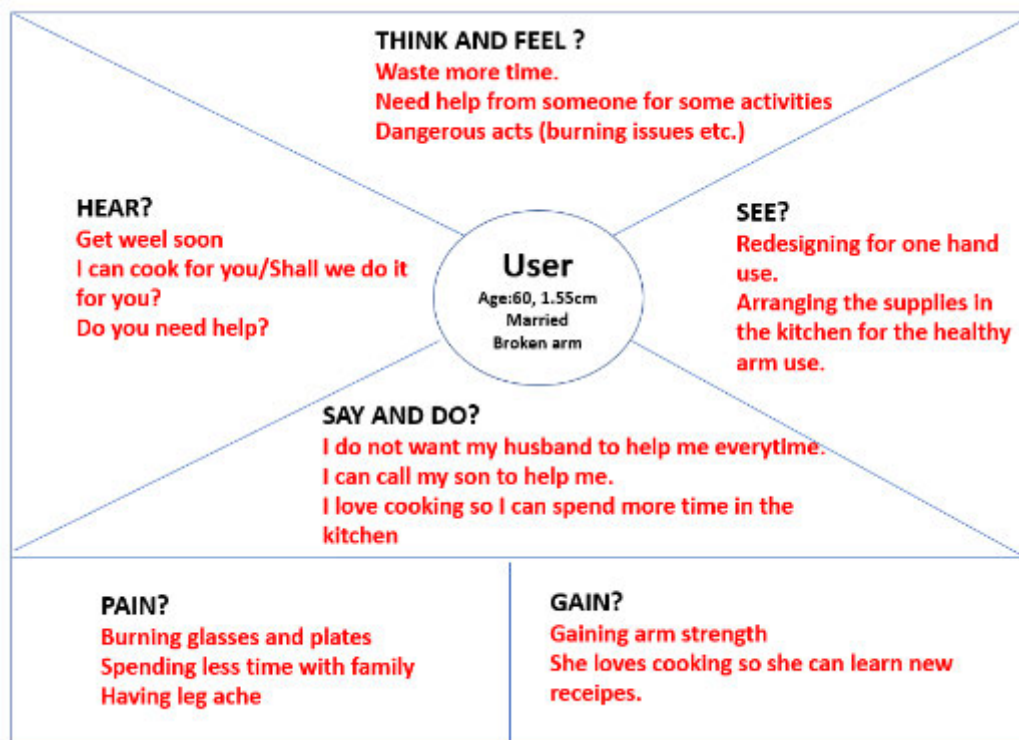


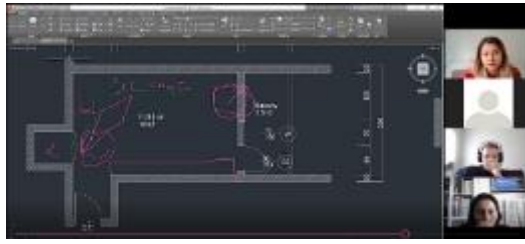
Figure 35. Empathy map created by Group B

In the third day, **Group C** conducted Task 1 and Task 2 in Zoom Meeting 3. At the beginning of the meeting, Group C filled out the IRI in 20 minutes and e-mailed their responses to the researcher (**task 1**). Each participant in Group C completed the specified role-playing activities in her own kitchen (see Figure 36). In addition, some participants tried additional and challenging activities (e.g., cutting a bag of pasta by using scissors, chopping vegetables by using knife, opening a jar of tomato paste) using one arm. While a participant was performing the activities, other group members watched, made comments, and compared activities with their own. A helper guided and followed participants and took video of them. Each participant conducted the role-playing activities in 20 minutes. Researcher recorded each role-playing activity and noted the participants' behavior and detailed information about the activities in her logbook.



Figure 36. Group C conducted role-playing activities

In the fourth and fifth day, Groups A, B, C and D redesigned user's kitchen (*task 3*) in four independent Zoom meetings (4, 5, 6 and 7) (see Figure 37). In the fourth day, Group A and B attended independent Zoom meetings. In the fifth day, Group C and D attended independent Zoom meetings. In each meeting, the same design brief and the AutoCAD plan drawing of the user's kitchen were e-mailed and a brief discussion on the design problem was generated. Before starting the design, Group D filled out IRI and sent their responses to the researcher. Groups started the design process with a brainstorming session, then they tried to find universal design solutions to the design problem. Each four-design process was recorded. The researcher observed participants' design decision making processes without interfering with their design decisions. Participants preferred to design by using digital drawing software. At the end of the meetings, they converted their drawings to PDF file and sent them to the researcher. Only Group C and D drew sketch perspective and sent their photographs to the researcher.



Group A



Group B



Group C



Group D

Figure 37. All groups in design sessions while researcher was observing them

In the sixth day, Group A codesigned with user (*task 4*) (see Figure 38). They introduced their end product and explained their universal design solutions to the user (duration: 20 min.). The user commented on participants' design solutions and gave feedback.

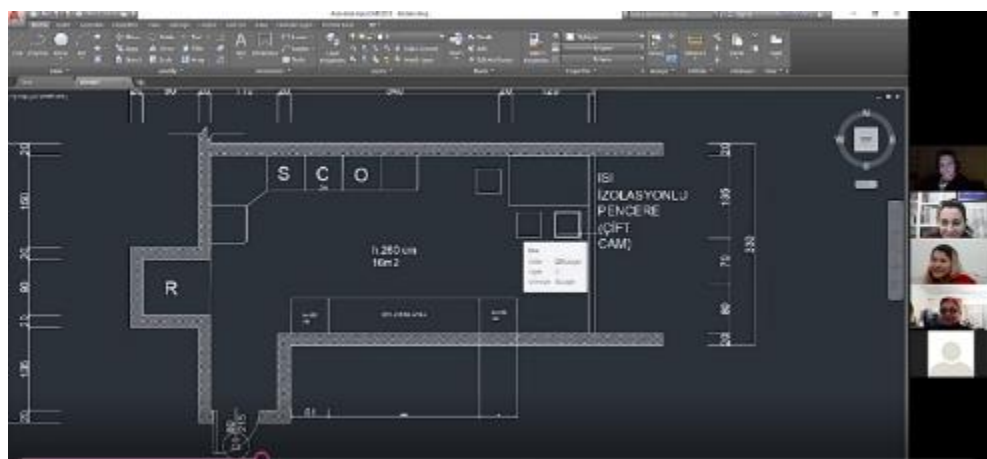


Figure 38. Group A in the co-design

In the seventh and last day, Zoom meeting 9 was held for all participants. Firstly, they filled out the kitchen survey from the user's (a broken arm person) point of view. Then, they e-mailed their responses to the researcher. Secondly, researcher conducted group interview with participants (see Figure 39). She asked questions about their empathic design experiences. Each participant shared their experiences interactively. The group interview was recorded. At the end of the meeting, Groups A, B and C filled in the IRI again and sent their responses to the researcher.



Figure 39. All groups and researcher were in group interview

In the next chapter, detailed information of the results on quantitative and qualitative analysis was presented. The results on the quantitative analysis included the results on IRI, the kitchen survey and their associations. The results on the qualitative analysis involved thematic analysis of design process and end products.

CHAPTER 5

RESULTS

In this chapter, the results of this study were divided into two headings as quantitative and qualitative analysis. The results on the quantitative analysis involved the results of IRI, the kitchen survey analysis and their associations. The qualitative analyses included the results of thematic analyses of participants' transcripts from group interviews and design process.

5.1 Results on the Quantitative Analysis

All quantitative data were analyzed by using the Statistical Package for the Social Sciences (SPSS, version 19) software (Argyrous, 2011). Descriptive statistics, including means, medians and standard deviations were used to calculate participants' responses to the IRI and the kitchen survey. Association analyses were done to investigate the relationship between the importance rank given to the universal kitchen design features and the number of features used in the UD process and the relationship between the number of kitchen design features used in the UD process and the frequency of sub-themes 5 (UD solutions).

5.1.1 On the Analysis of the IRI

This study focused on the analysis of the multiple dimensions of empathy while experiencing different ED techniques through a UD process (H1). Therefore, the aim was to compare the IRI scores from pre-test and posttest. Participants' (Groups A, B,

and C) responses from in pre-tests and post-tests were scored and calculated into four different dimensions of empathy (see Table 15). To compare the pretest and posttest scores of each empathy dimension in each group, descriptive statistics and the univariate analysis of variance were conducted (see Table 16, 17 and 18 and Figure 33).

Reliability analysis for the IRI instrument was explored in terms of Cronbach's alpha coefficients to determine the internal consistency of the subscales. The range of Cronbach's alpha scores for the pretest scales were from 0.79 to 0.83 ($PT_{pre}=0.830$, $EC_{pre}=0.829$, $PD_{pre}=0.822$, $FS_{pre}=0.791$). Also, the range of Cronbach's alpha scores for the posttest scales were 0.80 to 0.85 ($PT_{post}=0.803$, $EC_{post}=0.841$, $PD_{post}=0.850$, $FS_{post}=0.807$), which all subscales indicated strong reliability and internal consistency.

Table 15 Descriptive Statistics of the IRI Subscale Scores Before and After the Experiment

	Groups																	
	Group A								Group B				Group C					
	S1A		S2A		S3A		S1B		S2B		S3B		S1C		S2C		S3C	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Empathy Subscales																		
PT	21	25	17	15	19	15	20	26	23	18	26	25	15	17	14	21	19	20
EC	21	21	15	14	19	19	18	14	17	15	21	20	19	20	18	24	15	15
PD	19	11	11	11	9	10	17	12	11	11	10	12	17	16	11	10	16	22
FS	25	25	11	12	12	18	22	16	26	27	16	17	12	18	20	21	20	19
Total	86	82	54	52	59	62	77	68	77	71	73	74	63	71	63	76	70	76

In Group A, there was an increase only in the scores of FS subscale ($M_{pre}= 16.00$, $SD= 7.81$, $M_{post}=18.33$, $SD=6.51$) and a decrease in PD scales ($M_{pre}= 13.00$, $SD= 5.29$, $M_{post}= 10.67$, $SD= 0.58$) (see Table 16), which are significant in terms of cognitive and affective empathy. Group A said that the IRI raised their awareness about their personality and empathic understanding.

It was a good survey in terms of self-assessment, but I realized how I am incapable of being emphatic (*P2A*).

The Interpersonal Reactivity Index created a self-awareness for me (*P1A*).

Table 16 Descriptive Statistics Results of IRI for Each Subscale, Group A

<i>Scales</i>	Group A									
	Pretest					Posttest				
	<i>M</i>	<i>SD</i>	<i>M_d</i>	Min.	Max.	<i>M</i>	<i>SD</i>	<i>M_d</i>	Min.	Max.
PT	19.00	2.00	19.00	17	21	18.33	5.78	15.00	15	25
EC	18.33	3.06	19.00	15	21	18.00	3.60	19.00	14	21
PD	13.00	5.29	11.00	9	19	10.67	0.58	11.00	10	11
FS	16.00	7.81	12.00	11	25	18.33	6.51	18.00	12	25

In Group B, the pretest mean value of PT remained the same with the posttest ($M_{pre}= 23.00$, $SD= 3.00$, $M_{post}=23.00$, $SD= 4.36$) and the PD mean value decreased ($M_{pre}= 12.67$, $SD=3.79$, $M_{post}=11.67$, $SD=0.58$) (see Table 17).

Table 17 Descriptive Statistics Results of IRI for Each Subscale, Group B

<i>Scales</i>	Group B									
	Pretest					Posttest				
	<i>M</i>	<i>SD</i>	<i>M_d</i>	Min.	Max.	<i>M</i>	<i>SD</i>	<i>M_d</i>	Min.	Max.
PT	23.00	3.00	23.00	20	26	23.00	4.36	25.00	18	26
EC	18.67	2.08	18.00	17	21	16.33	3.21	15.00	14	20
PD	12.67	3.79	11.00	10	17	11.67	0.58	12.00	11	12
FS	21.33	5.04	22.00	16	26	20.00	6.08	17.00	16	27

In Group C, there was an increase in all scales of IRI (PT, $M_{pre}= 16.00$, $SD= 2.65$, $M_{post}= 19.33$, $SD= 2.08$), (EC, $M_{pre}=17.33$, $SD= 2.08$, $M_{post}= 19.67$, $SD=4.51$), (PD, $M_{pre}= 14.67$, $SD= 3.22$, $M_{post}= 16.00$, $SD= 6.00$), and (FS, $M_{pre}=17.33$, $SD= 4.62$, $M_{post}= 19.33$, $SD=1.53$) (see Table 18). Group C also mentioned that the IRI raised their self-awareness about people have diverse abilities as shown in the excerpt below:

The IRI made me feel this; sometimes I really do not feel so sorry for people, I realized that I did not care them a lot, but sometimes according to my mood, I felt like I was in despair, I realized that I was an unstable person (*P1C*).

Table 18 Descriptive Statistics Results of IRI for Each Subscale, Group C

<i>Scales</i>	Group C									
	Pretest					Posttest				
	<i>M</i>	<i>SD</i>	<i>M_d</i>	Min.	Max.	<i>M</i>	<i>SD</i>	<i>M_d</i>	Min.	Max.
PT	16.00	2.65	15.00	14	19	19.33	2.08	20.00	17	21
EC	17.33	2.08	18.00	15	19	19.67	4.51	20.00	15	24
PD	14.67	3.22	16.00	11	17	16.00	6.00	16.00	10	22
FS	17.33	4.62	20.00	12	20	19.33	1.53	19.00	18	21

To summarize, in fantasy dimension (related with cognitive component of empathy), the scores of Group B have decreased while Group A and C have increased. In perspective taking dimension (related with cognitive component of empathy), the scores of Group B remained constant, Group A had a slight reduction in scores and Group C's scores have increased. In the scores of empathic concern dimension (related with affective component of empathy), Group C has an increase while Group A and B have decrease. In personal distress dimension (related to affective component of empathy), there is an increase in the scores of Group C, and a decrease in both Group A and B's scores.

5.1.2 On the Analysis of the Kitchen Survey

The participants (except control group, Group D) ranked the importance level (Likert scale 1-5) of each kitchen design feature item ($n=47$) from user's point of view and the user filled the survey at the beginning of the experiment. The answers of the user and participants were compared to each other and analyzed.

Reliability analysis for the kitchen survey was explored in terms of Cronbach's alpha coefficients, to define the internal consistency of each feature. Cronbach's alpha value for total features was 0.897, which indicated a very strong reliability scale.

Cronbach' alpha scores for each kitchen design feature were between 0.888 (min.) and 0.900 (max.), which demonstrated that all subscales had a high reliability and internal consistency.

For all groups and the user, the mean and median values of each kitchen survey item was calculated. As seen in Table 19, there was not much variation in the means of the groups and the user, since all means were almost equal. In fact, when we compared the highest with the lowest values, which were the means for Group C ($M=4.50$) and Group A ($M=3.97$), we saw a very small difference in average level for total features. There were small differences from group to group, but similarity within the user. It means that after experiencing empathic design process, participants made empathy with the user with a broken arm and ranked the kitchen design priorities from user's perspective. And their design awareness of user's needs was increased.

Descriptive statistics results indicated that Groups A and B had mean values ($M_A=3.97$; $M_B=3.99$) that were close to the user ($M_U=4.11$). Furthermore, since the measurement was ordinal the median values were significant and the median values indicated that Group A, B, and the user had equal values ($M_d=4.00$).

Table 19 Descriptive Statistics for the Important Level for Total Kitchen Design Features

	Groups			
	Group A	Group B	Group C	User
<i>M</i>	3.97	3.99	4.50	4.11
<i>SD</i>	0.96	0.99	0.66	0.81
<i>M_d</i>	4.00	4.00	5.00	4.00

In addition, descriptive statistics analyses were done to find the mean, median and standard deviation values of each kitchen design feature for each group (including

the control group and the user) (see Appendix G). Results indicated that for *circulation*, Group C gave more importance ($M=4.73$, $SD=0.59$) than the user ($M=4.00$, $SD=0.71$) and Group B had the closest mean value of 3.87 ($SD=1.12$) to the user's mean value. For *cabinets and storage*, user ranked more importance ($M=5.00$, $SD=0.00$) than the other groups and Group C had the closest mean value of 4.34 ($SD=0.77$) to the user's mean value. For *counters and work surfaces*, Group C gave more importance ($M=4.60$, $SD=0.62$) than the user ($M=3.70$, $SD=0.82$) and Group D had the closest mean value of 4.17 ($SD=1.23$) to the user's mean value. For *appliances*, Group D gave more importance ($M=4.77$, $SD=0.57$) than the user ($M=4.10$, $SD=0.88$) and Group A had the closest mean value of 4.20 ($SD=0.76$) to the user's value. For *sink and faucets*, the mean values given by Group C and D were the same ($M=4.67$) and more than the user's ($M=4.00$, $SD=0.00$) and Group B had the closest mean value ($M=4.00$, $SD=0.87$) to the user's mean value. For *illumination*, Group D's mean value 4.75 ($SD=0.45$) was higher than the user's ($M=3.50$, $SD=0.58$) and Group A had the closest mean value 3.33 ($SD=1.30$) to the user's value. For *materials* Group C gave more importance ($M=4.40$, $SD=0.74$) than the user ($M=3.80$, $SD=0.84$) and Group B had the closest mean value of 3.87 ($SD=1.25$) to the user's mean value (see Figure 40).

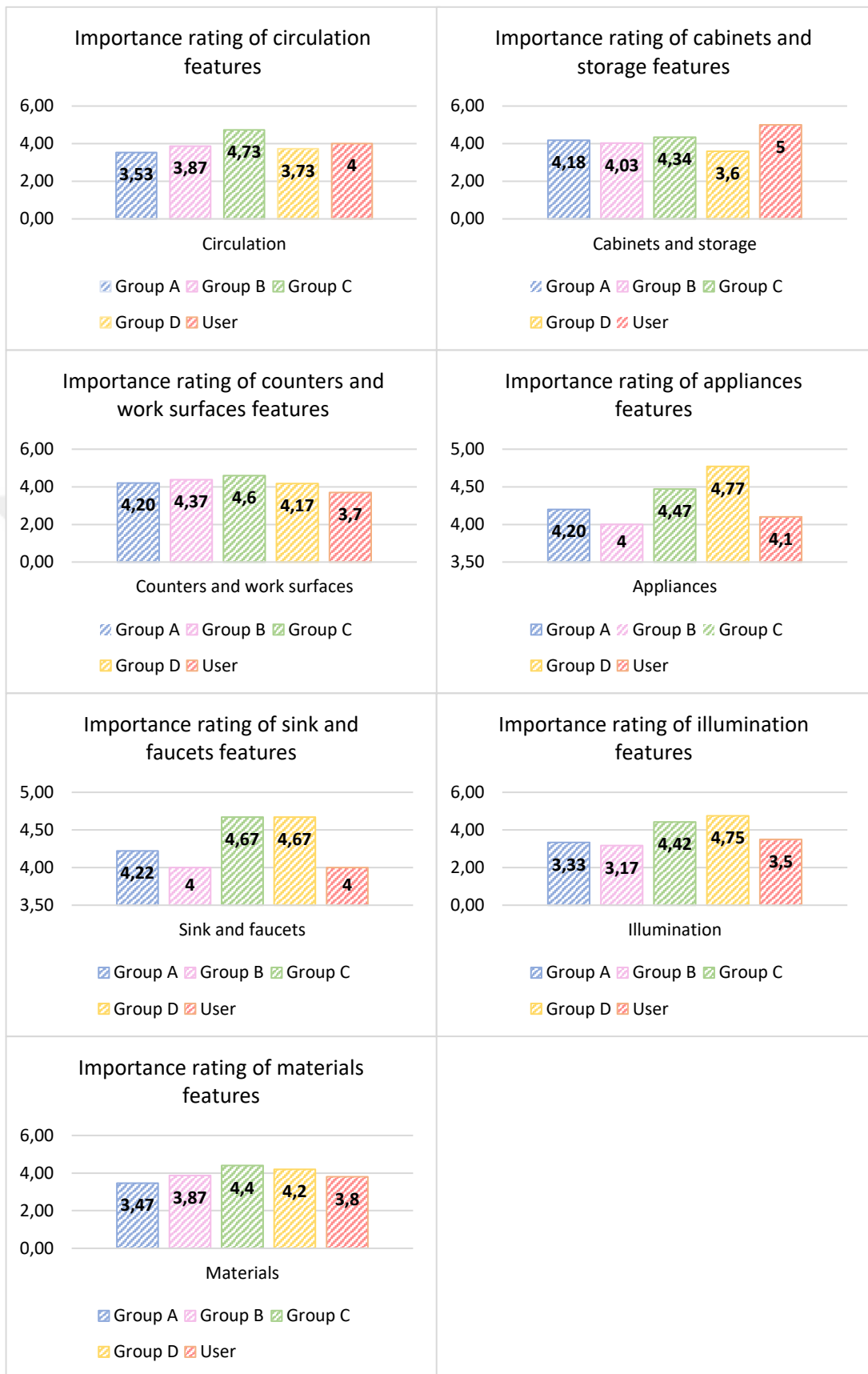


Figure 40. Comparisons of the importance rating of design features of each Group and the User

To summarize, Group C gave the highest value in 4 out of 7 kitchen design features in comparison to the other groups and the user. Also, Group B had the closest mean value to the user in 3 out of 7 kitchen design features compared to the other groups. Moreover, the most important design feature was different for each group and the user. ‘Sink and faucets’, ‘counters and work surfaces’, ‘circulation’, ‘appliances’, ‘cabinets and storage’ were found as the most important kitchen design feature for efficient work in the kitchen for a broken arm person. However, three groups (Group A, B, and the user) gave the least value for the *illumination*. So, they considered illumination as the least important one for a person with a broken arm. And other groups (Group C and D) found *cabinets and storage* as the least important one (see Table 20).



Table 20 Kitchen Design Features Rating of Importance (from most to least) According to Each Group and the User

Groups										
Group A			Group B		Group C		Group D		User	
Most to less	Kitchen design feature	M	Kitchen design feature	M	Kitchen design feature	M	Kitchen design feature	M	Kitchen design feature	M
1	Sink and faucets	4.22	Counters and work surfaces	4.37	Circulation	4.73	Appliances	4.77	Cabinets and storage	5.00
2	Appliances	4.20	Cabinets and storage	4.03	Sink and faucets	4.67	Illumination	4.75	Appliances	4.10
3	Counters and work surfaces	4.20	Sink and faucets	4.00	Counters and work surfaces	4.60	Sink and faucets	4.67	Sink and faucets	4.00
4	Cabinets and storage	4.18	Appliances	4.00	Appliances	4.47	Materials	4.20	Circulation	4.00
5	Circulation	3.53	Circulation	3.87	Illumination	4.42	Counters and work surfaces	4.17	Materials	3.80
6	Materials	3.47	Materials	3.87	Materials	4.40	Circulation	3.73	Counters and work surfaces	3.70
7	Illumination	3.33	Illumination	3.17	Cabinets and storage	4.34	Cabinets and storage	3.60	Illumination	3.50

5.1.3 On the Association Analyses

Somers' d measure of association on SPSS was used to analyze the associations among the importance rank given to the kitchen design items in kitchen survey (independent variable) and the number of suggestions of kitchen design items in the kitchen survey (dependent variable). The results indicated a very strong positive association between these two variables in Group A (Somers' $d=0.90$, $p=0.009$) at alpha level 0.05 but no association was found in Groups B, C and D (see Appendix H).

Additionally, the relations among the number of suggestions of kitchen design items in the kitchen survey and the frequency of sub-themes 5 (UD solutions) revealed from the design conversation protocols were examined using the Gamma measure of association. The significant moderate association between these two variables were found in Group C (Gamma= 0.579, $p=0.021$) and Group D (Gamma= 0.667, $p=0.010$) at alpha level 0.05 (see Appendix H).

5.2 Results on the Qualitative Analysis

In this section, the results on the qualitative analysis involves analysis of participants' behaviors in using the ED techniques, thematic analysis of participants' reflections about the experiment and thematic analysis of design process and end products are presented in detail.

5.2.1 On the Analysis on Participants' Behaviors

Group A seemed very enthusiastic in asking questions and laughed during the interview. They looked like they were having fun. In the observation, they had compassion for the user, and they were worried if the user would fall when the user was trying to reach the wall cabinets by stepping up onto the chair. It was a very distinct experience for them as they had not built any direct contact with the user before. In the co-design task, they were excited to present their end product to the user. **Group B** listened to the lecture carefully and they were very interested and

concentrated on the lecture. They liked the video shown in the lecture and found it to be instructive, and they were willing to make an empathy map. **Group C** had difficulty in performing the activities, they were careful and anxious while doing the activities. **Group D** (control group) did not experience any ED techniques, they only redesigned a user's kitchen and attended group interview. In design sessions, Group A had fun, Group B were calm, Group C were restless and excited, and Group D had hard time finding a solution, they were indecisive. In the group interview, all participants had fun, they were willing to answer questions. They asked each other about their empathic design experiences.

To summarize, all groups had fun, they were pleased to participate in such an experiential study. Group A seemed very enthusiastic to build direct contact with the user, Group B were interested in empathy lecture and making an empathy map, Group C was distressed since they had never experienced such a role-playing activity before, Group D was distressed and indecisive in design process since they did not experience any ED techniques. Therefore, they did not have detailed information about the user (see Table 21).

Table 21 Analysis of Participants' Behavior

Groups				
	Group A	Group B	Group C	Group D
Behavior	Enthusiastic, compassionate, pleasant, funny	Interested, concentrated, pleasant, funny	Distressed, frightening, enforced, pleasant, funny	Distressed, indecisive, funny

5.2.2 Results on the Thematic Analyses

Thematic analyses based on Braun and Clarke's (2006) six phase approach and Boyatzis' (1998) study are used to analyze the data gathered from group interviews protocols and design conversation protocols of each group in design process.

5.2.2.1 On the Thematic Analysis of Group Interview

To answer the research question 3 (RQ3: How does experiencing empathic design process reflect on students' perceptions of their learning experience?), participants' reflection comments gathered from the group interviews were analyzed by thematic analysis.

Phase 1: Familiarizing yourself with your data

In the first phase, the verbal data from group interview transcripts of participants were transcribed verbatim into written form after watching the Zoom record. Then, the transcripts were read multiple times to establish initial impressions to find that something important or notable. Since Braun and Clarke (2006) stated that the important part of first phase was to be familiar with all aspects of the data. Hence, the transcription data was essential after reading and re-reading the entire data set noting down the initial ideas. Some notes were taken about the emergent preliminary themes. The initial ideas were noted down to familiarize the data as: *The participants' responses were various about the ED process and involved positive reflections. Some repeated words for describing the process attracted the attention as 'useful', 'different', 'informative', 'difficult', and 'fun' etc., Furthermore, some participants expressed their awareness was increased after the ED process.*

Phase 2: Generating initial codes

In this phase, the apparent initial codes were defined by analyzing the number of times that the participants used the word to express their perceptions of their learning experience. Key activities like affects, thoughts and emotions were considered as potential codes and noted as seen in Table 22.

Table 22 The Apparent Initial Codes with the Number of Times Mentioned

Difficult (13 times)
Nice/good/fine/beautiful (11 times)
Fun/joyful/enjoyable (8 times)
Useful (6 times)
Different/unusual (6 times)

Table 22 (cont'd)

I realized that... (6 times)
Instructive or educational (4 times)
Pleasant (3 times)
I am pleased... (1 time)
I liked... (1 time)
I am glad... (1 time)
I forced... (1 time)
I had to... (1 time)
Helpful (1 time)
Informative (1 time)
Exciting (1 time)

As Braun and Clarke (2006) mentioned there are number of ways of coding extracts. In this study, after determining the apparent codes, the visual presentation was designed to indicate and identify the initial potential codes. Since the visual way of analyzing benefit to see the similarities, differences, and relationships between codes.

First, all transcript of responses were printed and photocopied, the apparent codes in answers relevant to the research question were highlighted by using different colored pens. Then the answers were cut and pasted to the white board (answers pasted on the green post-it and participants' labels were written in the lower right corner of the green post-it). Lastly, to create grouping to see how they relate to each other, the yellow 'post-it' notes were used as descriptive labels group of initial codes and colorful notes are used to name the potential themes. Then, the codes were analyzed in terms of how similar or different codes may combine or differ to search and form the themes (Braun & Clarke, 2006). Codes were labeled and description about the content of the theme and any qualification or exclusion to the identification of the theme (indicators are determined) and examples were presented to eliminate possible confusion when looking for the theme (Boyatzis, 1998).

Phase 3. Searching for themes

In phase 3, the several codes were analyzed and tried to focus on the broader level of themes to analyze the codes and consider how similar codes may combine to form a theme. For example, some codes that related to the perceptions of challenging aspects of the process were ascertained. Some participants described such learning experience as 'difficult', 'different/unusual', and explained the parts they had

difficulty within the experiment. These codes were collated into an initial theme called ‘*challenging aspects of process*’. At the end of this phase, all codes were placed into one theme (see Table 23).

Table 23 The Initial Potential Code Development Based on Boyatzis’ (1998) Study

Potential Theme 1 Label--- Instructive aspects of process Definition--- The participant describes the process as educative/instructive/useful/informative or helpful. Indicators---- When the participant says, “It was a useful study”, or “It was very educational” etc. Differentiation --- All participants indicated this theme.
Potential Theme 2 Label--- Pleasant aspects of process Definition--- The positive comments regarding a pleasant aspect. Indicators--- The participant describes the process as pleasant/nice/good/fine/beautiful or starts his/her sentences as “I liked...” and “I am glad/pleased...” i.e. “I think it was a particularly good experience.” Differentiation---- P1A, P2A, P3A, P1B, P3B, P1C, P2C, P3C, P1D, P2D, S3D indicated this theme. S2B did not show this theme.
Potential Theme 3 Label--- Joyful aspects of process Definition--- The positive comments regarding a joyful aspect. Indicators--- The participant describes the process as fun/ /exciting/joyful. Differentiation---- P1A, P2A, P3A, P1B, P3B, P1C, P2C, P3C, P1D, P2D, P3D indicated this theme. P2B did not show this theme.
Potential Theme 4 Label--- Challenging aspects of process Definition--- The challenging comments regarding an aspect. Indicators---- When the participant describes the process ‘difficult’, ‘different/unusual’ or starts his/her sentence as ‘I forced...’, “I had to...” Differentiation---- P1A, P2A, P1C, P2C, P3C, P1D, P2D, P3D showed this theme; participants in Group B did not show this theme.
Potential Theme 5 Label--- Raising awareness in design process. Definition--- Refer to awareness that goes beyond. Indicators--- Responses regarding raising awareness or when the participant starts his/her response as “I realized that....” Differentiation---- P1A, P2A, P1B, P2B, P1C, P2C, P3C, P1D, P2D showed this theme; P3A, P3B, P3D did not show this theme.

Phase 4. Reviewing themes

In this phase, the themes are analyzed, modified, and developed by producing ‘thematic map’ to understand “the relationship between codes, between themes, and between different levels of themes” (Braun & Clarke, 2006, p. 89). The initial thematic map was generated (see Figure 41).

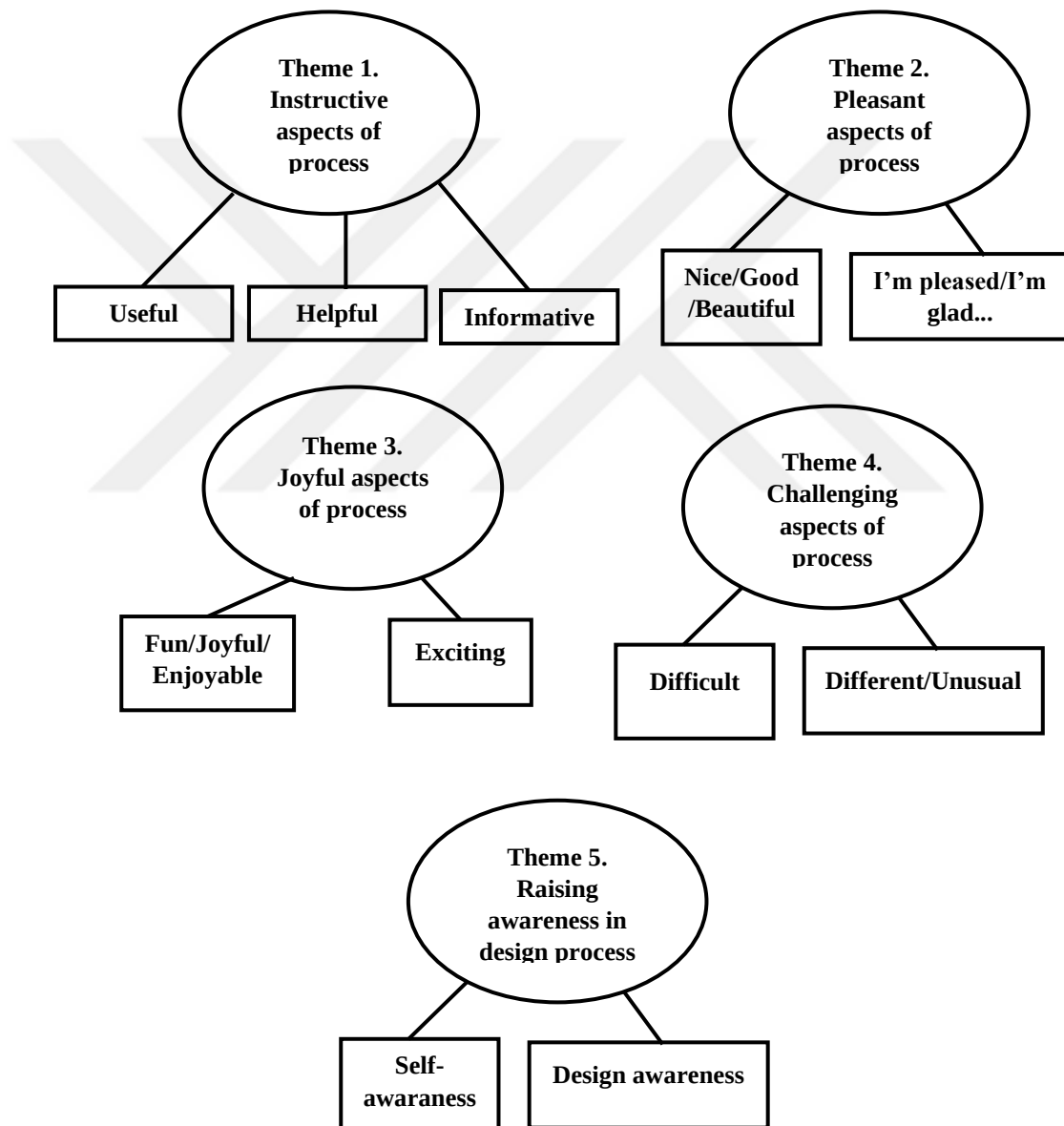


Figure 41. Initial thematic map from group interviews

It was realized that *potential theme 2 pleasant aspects* and *potential theme 3 joyful aspects* are quite close in terms of content, thus, they combined each other as '*pleasant and joyful aspects of process*' (see Figure 42).

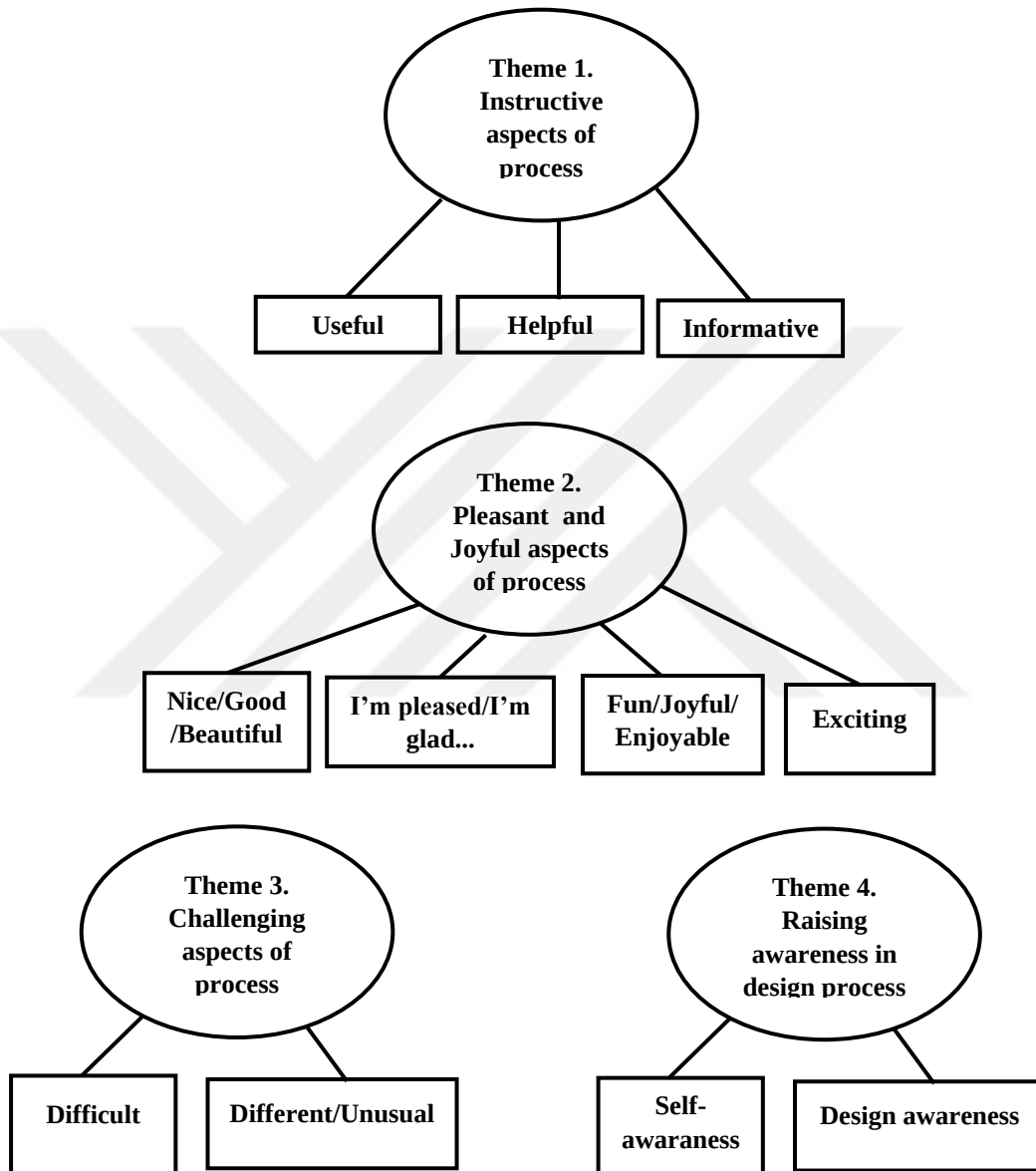


Figure 42. Developed thematic map from group interviews

After structuring developed thematic map, it was also recognized that some codes were previously placed in *pleased and joyful aspects of the process* and *challenging aspects of the process* have affective relations with each other since they all refer to

affective aspects. Hence, the new theme was created as *affective aspects of the empathic design process* and the themes mentioned above are involved in this theme as sub-theme. Besides, to clarify what was meant process the empathic design process added and categorized themes as learning process and learning outcome (see Figure 43). The themes were also looked at with respect to the entire data set and considering the validity.

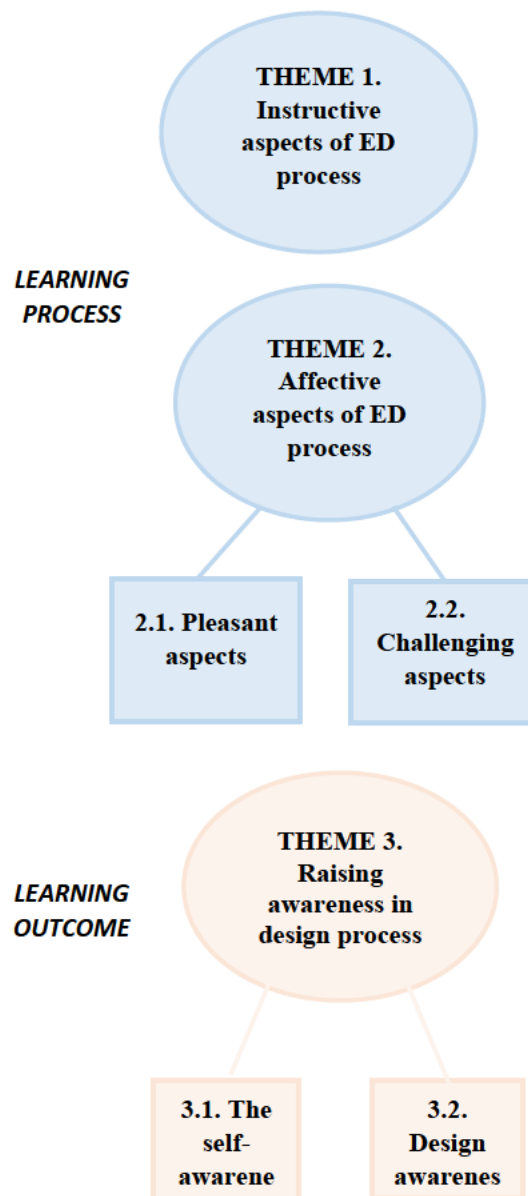


Figure 43. Final thematic map from group interviews

Phase 5. Defining and naming themes

In this phase, Braun and Clarke (2006) suggested that the researcher should discover the essence of each theme by ‘define and refine’ and organize them. In this analysis, participants’ perceptions of their individual learning process about ED process included instructive and affective aspects and participants made comments as their learning outcome how such practices raised their awareness, the self and design.

Theme 1 included participants’ instructive aspects of empathic design process since all participants found the process educational and some comments related with the suggestion of ED in design education. Theme 2 contained participants’ affective aspects and were divided into two sub-themes since participants expressed pleasant, joyful, and challenging feelings about the process in most of their responses. Theme 3 comprised participants’ increased awareness and was divided into two sub-themes since participants both explained their increased awareness on the self-awareness and the design awareness.

Phase 6. Producing the report

In phase 6, it was required to produce a scholarly report by providing appropriate analysis of the themes within the data by selecting vivid, compelling extracts examples, and describing and making an argument data in terms of the relations to the research question and the literature.

Theme 1: Instructive aspects of the empathic design process

‘Good’, ‘nice’, ‘instructive’, ‘fun’, ‘different’, ‘difficult’, and ‘useful’ were the words participants used commonly when they were commenting on their learning process. All groups indicated theme 1 in their comments. Regarding the learning process, **Groups A** mentioned that *the instructive aspects of the empathic design process (theme 1)*. ‘Informative’, ‘useful’, and ‘instructive’ were the words Group A used to describe their learning process. One participant in Group A commented that although they were only second-year students, it was a vital and instructive experience for them to interview, observe, and co-design with the user. Also, P2A

recommended that ED could be taught in the practical courses. He also expressed even it would be more beneficial if it could be integrated into the entire interior architecture education and training life. The following quote illustrated this idea,

We learned how to implement the principles of UD theoretically in the HF course, but we did not have the chance to apply it, and my biggest problem is forgetting how to apply UD principles in my designs. I forgot the dimensions after the exam was over, many things remained in my mind theoretically, but I really must open the course notes and look at them practically. It may be taught as a lesson (on a practical basis) so as not to refer to the course notes and look again (P2A).

Groups B and C also found that *learning by experiencing/doing* approach in ED process was more educative than traditional learning approaches. In addition, they drew attention to the emphasis of ED approach in the design critics.

In general, we are designing our projects by thinking of the UD principles. For instance, when we get critics, we have a chance to apply them, then we can get critics again. If empathic design understanding is emphasized in the criticism received it may be useful to think about it and take it critical later. I do not know if it should be a separate lesson, but I think it should be one of the topics that needs to be discussed in the design studio courses (P1B).

Theme 2: Affective aspects of empathic design process

Group A also mentioned *affective aspects of the empathic design process (theme 2)*.

In this theme, they usually used the word ‘fun’, ‘nice’, and ‘pleasant’ regarding a *pleasant aspect of their learning process (sub-theme 2.1)*. They also stated the *challenging aspect of the empathic design process* and found the experiment as ‘unusual’ and difficult’ (*sub-theme 2.2*). Especially, designing for both the user and for everyone at the same time forced them. Group A commented about their learning process as follows:

It was an *unusual* experience. Working for a client, observing their needs, etc. everything changes accordingly, we usually set standards in our design work, we get average values, take measurements, but this time things have completely changed, it

was both *fun* and *informative* to observe this. We used to take standard measurements in our previous projects, but now it was *different* to adjust it to the customer, it was *pleasant* experience (P1A).

Since when you do something standard, you get a UD, but it was a bit more *difficult* to do it for the person and keep it universal at the same time, we *had to* think more. It was very *instructive*. It was pleasant, but not every user is as nice as ours. It was a *useful* study (P2A).

Group A also evaluated collaborative working in an online environment. Two participants in Group A mentioned the difficulty of collaborative drawing via Zoom, and the other participant emphasized that drawing and sharing design ideas via Zoom was fun.

While we were drawing, we had *difficult* times, it was *unusual* (theme 2). I wish we could have equal conditions while drawing, because among the group only one person drew, and the others were just interfering (like making comments) in the process (P1A).

On the contrary to my friend, it was real *fun* to command and to test accordingly. We had a lot of *fun* while drawing. We helped each other. For instance, if I got stuck on something, maybe I would think about it for an hour, but when there were three people in the group, one thinks about something while another thinks about something else, group work is a *nice* thing (P2A).

Group B did not indicate sub-theme 2.2 since they did not make any comment about challenging aspects of the empathic design process. They found the lecture instructive, useful, and helpful as they have learned how to make an empathy map. They commented that making an empathy map was useful and enjoyable.

Empathy map was especially *useful* while starting the design. Since we had something that we could turn to look at when we needed to check our design (P1B).

Group C said they had difficulty in performing the role-playing activities by isolating one arm. Using the kitchen with only one arm was a difficult and a different experience for them. To illustrate, P2C and P3C elaborated on their learning process as follows:

.... I think this experience was particularly *good*, as my other group friend said it was not understood without experiencing it by yourself, I think it was a particularly *good* experience (P3C).

Group D stated that they had difficulty in redesigning a universal kitchen while considering both the user and all people. As one participant (P3D) commented: ‘It was hard to think of everything. For example, it was necessary to design an adequate clear floor area for the wheelchair user for maneuvering easily, but at the same time, the cabinets should be placed since there was a shortage of storage.’ P3D also stated that in the design process, it was difficult to prioritize the design decisions for users with different abilities. P1D emphasized the UD process was a challenging task with the lack of information about the user’s abilities. The following quote illustrated that idea:

I had a *difficult* time; it was *difficult* to say if I was in his place just by thinking. Since there are too many variable parameters, and there was not much information about the user. We did not have the opportunity to talk with the user, I tried to empathize by thinking directly, however it was so *difficult* to solve design problems. *I had to* think a lot, wondering if it would be hard for him/her, just thinking about it was a little harder than experiencing, but still this aspect also improved, the more I think, the more I challenge myself (P1D).

In **Group D**, participants had different opinions about working online. P2D found drawing together via Zoom was complicated in expressing their design ideas just by intervening verbally and annotating on the design. Also, they argued it was not fair for just one student to have a right to draw. On the contrary, participant who had a right to draw commented that she did not have difficulties while drawing and she was pleased and even enjoyed it. In addition, P1D mentioned that it was easier for a

person to draw through a computer program and others were involved with their ideas via Zoom, since it would be more difficult to draw by hand.

Theme 3: Raising awareness

Regarding the learning outcomes, **Group A** indicated sub-theme 3.1, they thought that IRI raised their self-awareness about their personality and empathic understanding. To illustrate, P2A found the IRI as valuable index in terms of self-assessment, since he realized that how he was incapable of being empathetic. Likewise, P1A expressed the IRI increased her self-awareness and added after she filled the IRI she realized how she was sensitive person. In addition, they realized how difficult it was to design when taking into consideration both the user who has a broken arm and all people.

Group B also elaborated on their learning outcome as being positive and noted an increase in their awareness of self and design (*theme 3*). For instance, P2B confessed that she could not know building empathy in design before this experiment and found the empathy map was the most efficient tool in understanding the user's needs about interior environments.

When we empathize with the other person, I don't think that we can fully understand him/her, but I think the empathy map is the closest tool for us to understand someone, I never knew about empathy map before. (P2B)

Regarding the learning outcomes, **Group C** stated that their design awareness was increased (*theme 3*). For example, one participant explained by giving an example from her previous interior design project as shown in the excerpt below:

Now *I realized that* my understanding of UD was a little bit shallow. I have just *discovered that* it was not enough just providing the clear floor area availability in the public restroom by just considering a radius of 150 cm for people who use wheelchair (P1C).

Group C found the kitchen survey was useful and stated that the kitchen survey raised their design awareness (*sub-theme 3.2*). P2C stated that when she was filling the survey from the user's (who has a broken arm experience) point of view, she figured out she should rate each kitchen design feature's importance level as 4 or 5 (out of 5). Since she simulated a broken arm condition, she empathized with the user. Therefore, she found that each kitchen design feature was important for universal kitchen design. After the experiment, she also criticized herself for not being very empathetic and sensitive as a designer for all people (*sub-theme 3.1*).

To summarize, all participants' reflections about the experiment were analyzed thematically and it was found that experiencing the ED techniques in design process were positively reflected on the participants' perceptions of their learning experience (H3). As a result of the thematic analysis of group interviews, three emergent themes and four sub-themes were determined as follows: in the learning process (1) *instructive aspects*, (2) *affective aspects* included two sub-themes as (2.1) *pleasant aspects* and (2.2) *challenging aspects*, and in the learning outcomes as (3) *raising awareness* involved two sub-themes as (3.1) *self-awareness* and (3.2) *design awareness* (see Table 24).

Table 24 Three major themes and sub-themes from group interviews

Reflections	Major emergent themes and sub-themes	
Learning Process	1	Instructive aspects of empathic design process
	2	Affective aspects of empathic design process
	2.1	Pleasant aspects of empathic design process
	2.2	Challenging aspects of empathic design process
Learning Outcome	3	Raising awareness in design process
	3.1	The self-awareness
	3.2	Design awareness

5.2.2.2 On the Thematic Analysis of the Design Process

To answer the research question 2, (RQ 2: To what extent does empathic design experience reflect the interior architecture students' design process in terms of applying HF/E and universal design principles?) and to explore the traces of

empathic design process on participants' design thinking actions, the design conversations among participants were thematically analyzed.

Phase 1. Familiarizing yourself with your data

The video recordings of each group's design processes were watched, and the design conversations (verbal data) were transcribed verbatim into written form. Then the transcripts were read many times to be familiar with all aspects of the data. Some notes were taken about the initial ideas about the data.

The first impression from the data was as: *the participants' design conversations were about discussion and generation usable UD solutions. The common and repeated words were drawing attention and noted. Besides, it was determined that there was a both similar and different relationship between the way in which participants in each group approach a design problem.*

Phase 2. Generating initial codes

The transcripts were read line by line to diminish the raw information (Boyatzis, 1998) then re-read and the initial codes were indicated by using highlighters. Some repeated words were determined when participants expressed their UD solutions, and they were analyzed that how many times they were mentioned (see Table 25).

Table 25 The Apparent Initial Codes Related with the Design Process

Reach problem
Work triangle
Circulation
Floor area availability
Wheelchair user or the wheelchair's turnaround radius'
Lighting
Work sequence
Storage (cabinets and areas)
Smooth edges of the table/counter
Knee space under the sink
Pull-out dishwasher/drawer
Placement at eye/elbow level

Table 25 (cont'd)

‘Human Factors’ course In the simulation exercise, I had a trouble... In the interview, the user mentioned about...
--

The initial codes were analyzed for identifying how they related and differed from each other and identified based on Boyatzis’ (1998) study (see Table 26).

Table 26 The potential codes were written with reference to Boyatzis’ study (1998)

Potential Theme 4 ➤ Label--- Individual Empathic Design Experiences ➤ Definition--- The comments regarding an ED experience. ➤ Indicators---- When participant remembered their ED experiences. ➤ Differentiation---- Groups A, B and C indicated this theme.
Potential Theme 5 ➤ Label--- Experiences from Prior Courses ➤ Definition--- Remembering their prior knowledge. ➤ Indicators---- When participant shared knowledge learned in ‘Human Factors’, ‘Interior Design Studio’, ‘Construction and Materials’ or other courses. ➤ Differentiation---- All groups indicated this theme.
Potential Theme 6 ➤ Label--- Universal Design Solutions ➤ Definition--- The expressions regarding design solutions ➤ Indicators---- When participant used terminology from interior design and human factors/ergonomic such as ‘work triangle, reach problem, circulation etc. ➤ Differentiation---- All groups indicated this theme.

Phase 3. Searching for themes

The initial codes were collated by considering how similar codes may combine to form a theme. For instance, there were several initial codes that related to the UD solutions, they could be sub-theme of the major *universal design solution*’ theme. Some apparent codes frequently mentioned by participants such as ‘work triangle’, ‘circulation’, ‘floor area availability’, ‘wheelchair user’s turnaround radius’ labeled as similar codes and collated into a potential sub theme as *passages and circulation spaces*. Furthermore, participants frequently mentioned the cabinets, it was

determined that the content of the problem about storage was different. Some participants focused on the inadequacy of cabinets, and some about the reach problem of the cabinets. So, the two separate sub-themes were generated as ‘reach problem of cabinets’ and ‘inadequacy of storage cabinets and areas.’

Phase 4. Reviewing themes

In phase 4, the thematic map was generated to analyze the relationship between codes and themes. It was recognized that some apparent codes in UD solution theme were similar and could be combined to form sub-themes. To illustrate, the three codes *knee space under the sink*, *pull-out dishwasher/drawer*, *placement at eye/elbow level* were not really work as a sub-theme however these three could be combined into a new sub-theme called *accessibility of appliances*. Furthermore, when reviewing the sub-theme *safety*, it was recognized that there were at least one or two sub-themes within this sub-theme. Since participants emphasized ‘the smooth edges’, ‘the location of appliances’ and ‘the durability of materials’ in terms of safety issue. At the end of this phase, the themes were looked at with respect to the entire data set and generated the final thematic map (see Figure 44).

Phase 5. Defining and naming themes

In this phase each theme and sub-theme were defined and refined to identify the ‘essence’ of what each theme was about (Braun & Clarke, 2006). Firstly, it was recognized that participants remembered their ED experiences and prior courses as the way approach a problem. Thus, all the relevant codes were incorporated into one major theme (*Theme 4*) and named as *past experiences* and contained two sub-themes, *individual empathic design experiences* and *experiences from prior courses*. Secondly, participants’ design conversations were mostly about finding a UD solution. Thus, Theme 5 included *universal design solutions* with ten sub-themes.

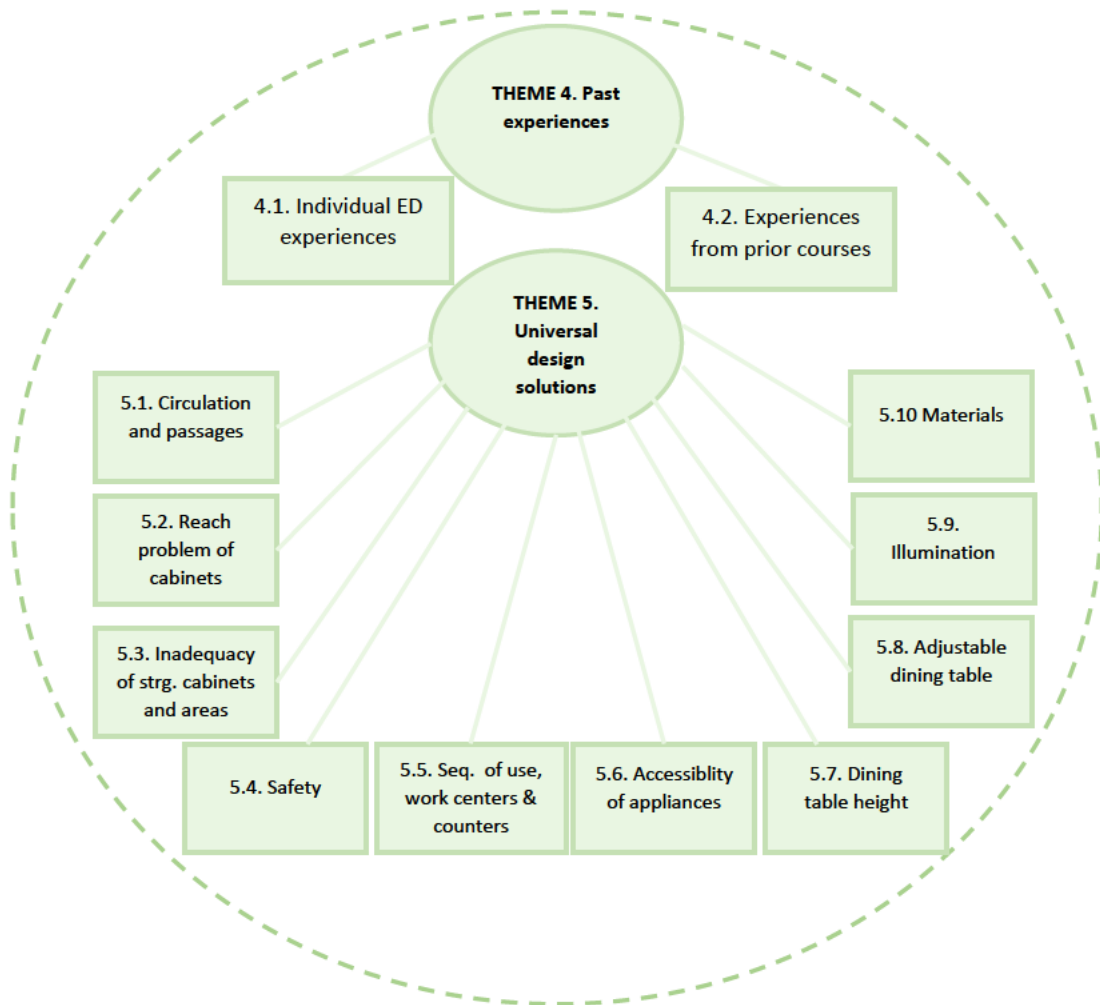


Figure 44. Final thematic map from design process

Phase 6. Producing the report

The report included vivid, compelling extracts examples, description and argument data in terms of the relations to the research question and the literature.

Theme 4: Past Experiences

Group A indicated theme 4 since they remembered their past experiences included their individual empathic design experiences (*sub-theme 4.1*) when they tried to think of design problems that the user could encounter. They also recalled the knowledge about the user that was accumulated in the interview and observation. Moreover, they recalled the demographic and physical characteristics of the user such as age, job status, short stature, arm length from the interview and they tried to determine the possible design problems. The following quotes from the conversation indicated participants' user-centered approach in the design process:

P1A: The main problem for the user was not able to reach to the shelves of the wall cabinets (*observation*)

P2A: If we design a long table, she can have trouble in reaching to the end of the table...If we design a low chair, she can be in trouble while sitting. She mentioned that she has a broken arm because of falling, we should round the sharp edges (*interview*)

P3A: There is a floor area availability problem (*observation*)...There is a wall-cabinet under the refrigerator that she cannot reach (*observation*)

P2A: I think the biggest problem for the user is the lack of storage area, since she mentioned that she has a lot of things so that she must step up onto the chair/ take a risk and reach the wall-cabinets even if this is dangerous for her (*interview*).

Group A recalled some knowledge gained from the prior taken courses (*sub-theme 4.2*). To illustrate, P2A tried to remember the activity centers of the work triangle

from the ‘Human Factors’ course and he also tried to recall his prior knowledge from the ‘Construction and Materials’ course about thermal installation when he considered breaking down the wall of the balcony and integrating the balcony area into the kitchen.

Group B merely remembered some information about the user from persona and their empathy map (sub-theme 4.1). They did not remember or mention anything about the lecture. Also, the information about the user did not come to their minds directly. To illustrate, first, they designed a high wall cabinet that the user already had a problem in reach. As they recognized the user’s short stature and old age, then they changed the height of the cabinets. Two participants indicated sub-theme 4.2, they mentioned their prior courses’ knowledge. One of them recalled the ‘Interior Design Studio’ course and remembered the instructor’s explanation as “Murat teacher said that 120 cm width for passage is adequate for public spaces and desirable 80 cm for one person, so let’s make it 100 cm for our kitchen design”. Another participant indicated this theme twice, she remembered the knowledge she gained in the ‘Human Factors’ course.

As we learned in the ‘Human Factors’ course, while we are locating the dining area, the circulation and working zone should be separated...If I remember correctly from the ‘Human Factors’ course, the sequence of work should be as sink-counter-cooker-counter (*P1B*).

Group C recalled their individual role-playing activities and the problems that they had handled (*sub-theme 4.1*) and tried to find a UD solution accordingly. One comment was as follow:

Let’s locate the oven and dishwasher at the eye level since in the role-playing exercise, I had a trouble and could not bend (*P2C*)

P1C empathized with the user as she made a connection between the problems she and the user had faced. She emphasized the reach and safety problems and said that the user has a short stature like her, so the user could not reach the high shelves of the wall cabinets. She could have fallen from the chair in her role-playing activity, she could not reach to the shelves of the wall cabinet by using only one arm and she was very afraid of falling. It was analyzed that experiencing empathic design techniques helped participants to better understand people with diverse abilities' problems.

Group C's problem-solving approaches were *activity-based*, they did activity analyses through scenario building techniques. They remembered and shared their role-playing activities and envisioned the possible activities (*sub-theme 4.1*). At the beginning of the design process, they tried to imagine the activities to provide the sequence of the work as:

In scenario 1: 'She has come home after shopping, the things she bought need to be put on the counter, then she would open the refrigerator and place them in it... In scenario 2 (cooking): 'she opens the refrigerator and takes something out of it, then goes to the sink, washes them then she would cut them on the counter and cook them on the cooker.'... In scenario 3 (preparing a dining table), the meal was on the cooker and should be served to the table.

All group members in Group C indicated the sub-theme 4.2, they mentioned the knowledge acquired in the prior courses that they had taken. For example, P3C remembered various kitchen types from the examples the instructor showed in the 'Human Factors' course. P2C remembered and said that "...as we learned in the 'Human Factors' course, there should be an appropriate counter space on at least one side of the refrigerator." P1C indicated this sub-theme twice since she remembered the safety issues from two different courses. She recalled the instructors' warning in the 'Interior Design Studio' about the sharp edges of the table that she designed in her restaurant project. Participants explained their experiences as follows:

The cooker should not be in front of the window, however when I asked Burçak teacher, and she said that cooker could be placed slightly closer to the window but there should be an adequate counter space on both right and left side of the cooker (P2C).

In my restaurant project in the design studio course, I did not pay attention to the smooth edges on the tables, so the instructors warned me (P1C).

Group D also indicated the *sub-theme 4.2* three times. They remembered the visual examples that the instructor showed in the ‘Human Factors’ course about the placement of the sink, however one participant could not remember the right sequence of the workstations.

In ‘Human Factors’ course I remembered the examples that instructor showed us, corner locations of sink are preferred for universal kitchen design. In Burçak teacher’s examples sink was almost near the corner (P2D).

Theme 5: Universal Design Solutions

Group A tried to create appropriate and feasible UD solutions (*theme 5*). The design solutions they found were related to the circulation and passages, reach problem of cabinets, the inadequacy of storage cabinets and areas, safety (specifically about smooth on the counter and table, the location of appliances) sequence of use, work centers and counters, accessibility of appliances (especially oven), adjustable dining table for clear floor space, illumination regarding the task and natural light and material. Some participants’ design thinking excerpts were as follows:

If she falls when she steps up onto the chair, she may hit the sharp edges of the table or counter. Therefore, smooth edges should be provided on the counter and table (P3A).

In my opinion, for reach problem, the less and/or low wall-cabinets, the better. (P3A).

We should consider daylight if we locate the dining table at the balcony area. (P2A).

According to the thematic analysis results, **Group B**'s design solutions (*theme 5*) were coded as the explicit sub-themes as circulation and passages, reach problem of cabinets, the inadequacy of storage cabinets and areas, safety, sequence of use, work centers and counters, accessibility of appliances included providing knee-space under the sink, pull-out dishwasher, and dining table's height and material. In this group, no design solutions were identified about the placement of appliances at the eye level or elbow level and the illumination adequacy of the kitchen area. Some of their design ideas as follows:

We can locate an island counter in the middle what if she broke her foot/leg and uses a wheelchair. So, we should think of a wheelchair user's turning radius (*P1B*).

What about the cooker's location? In option 1, we suggested that the cooker to be located near the dining table. It could be dangerous (*P3B*).

As a result of the thematic analysis for **Group C**, the emergent themes were the circulation and passages, reach problems in cabinets, inadequacy of storage cabinets and areas, safety, sequence of use, work centers and counters, accessibility to appliances including the placement of oven at the sitting elbow height for a wheelchair user, adjustable dining table and material. No design solutions were discovered for providing a knee-space under the sink, pull-out dishwasher, dining table height and the illumination level of the kitchen area.

P2C: The important case for a wheelchair user is she wants to do something, there needs to be 150 cm for turnaround space, but if she sits only at the dining area, it could be 100 cm adequate as a passage.

P1C: What is the width of the wheelchair? Is it 85 cm? If so, in our design, wheelchair user cannot pass to the balcony area.

According to the thematic analysis for **Group D**, the sub-themes about UD solutions were circulation and passages, reach problem of cabinets, the inadequacy of storage cabinets and areas, safety (smooth edges and durability of materials), sequence of use, work centers and counters, knee-space under the sink, placement of oven and

dishwasher at the eye level and sitting vertical grip reach, pull-out dishwasher, dining table height, the task lighting on the work surface and material. No design solutions were mentioned about the safety issues, the location of appliances and the ambient and daylight levels.

What does the sitting vertical grip reach for 5%ile women? We should locate the oven based on that dimension (P2D).

I considered an adjustable dining table, but there may be difficulty adjusting the table height because of old age (P3D).

To summarize, the approaches of the groups in generating universal design solutions were distinct. **Group A**, thought in detail in finding design solutions. However, they sometimes refrained from understanding *design for all* approaches since they had *user centered* approach. Although they underlined the problems of wheelchair users and children, they generally commented on the problematic areas of the kitchen related to accessibility and reach problems of the user. **Group B** did not indicate any specific design approach, but they tried to consider people with diverse abilities in their universal design solutions, however they sometimes remembered their empathy map. **Group C** considered in-depth the obstacles and problems of kitchen use, and they often changed their design ideas. They had *activity-based* design thinking. They tried to find solutions by thinking empathetically, since they recalled their role-playing activities and made a connection between the problems they faced, and the user might encounter. **Group D** had difficulty suggesting universal design solutions, they changed their design ideas a lot. Besides, they did not indicate any user-centered approach, as they mainly considered design problems that people who use wheelchair and walker can encounter.

As a result of the thematic analysis, **Group A** demonstrated a *user-centered approach* since they did direct contact with the user. **Group A** preferred to draw with AutoCAD and chose P3A to share his screen to draw during the design process (*duration: 122 min.*). They asked for help from the researcher in using AutoCAD as

they were newer to use. They started the design with brainstorming session (*duration: 30 min.*), they annotated and explained their initial design ideas.

Group B saw pictures of the existing kitchen and the user before starting the design. In the design process (*duration: 136 min.*), they preferred to draw all required drawings through SketchUp. They selected P2B to draw and share her screen. Participants started the design with a brainstorming session (*duration 23 min.*), they annotated and sketched their initial design ideas on the design brief in PDF format.

Group C preferred to draw with AutoCAD and selected P1C to share her screen to draw. In design process (*duration: 113 min.*) they started with a brainstorming session (*duration 33 min.*), they thought of accommodating their design for access and use generally for right-or-left-handed person, elderly, and wheelchair user. They thought in-depth and changed their minds a lot and they even asked the researcher for help in their design decisions, nevertheless the researcher did not help the participants.

Group D (control group) asked for extra time to make individual sketches (*duration: 15 min.*) before starting the design. In the design process (*duration: 167 min.*), they preferred to use AutoCAD, and P2D volunteered to share her screen and draw. They started the design with a brainstorming session (*duration 45 min.*), they expressed their design ideas one by one and spent more time than the other groups (Groups A, B and C), so they exceeded the delivery time (150 min.) and needed to have more time to complete their drawings, since they were indecisive to produce appropriate and feasible universal design solutions. In the design process, they did not get involved in the user-centered approach, they generally focused on elderly and people with mobility impairments. For example, they thought of putting the appliances at the eye level as to ease people with diverse abilities' access, locating the buttons of the oven to the front so that they are easily accessible, providing a knee-space under the sink for approaching it for a wheelchair user and effective counterspace for both comfortable working and putting electrical appliances.

They had difficulty in finding an appropriate design solution, one participant said she could not empathize while thinking of a design solution and stated, ‘abled people’ and ‘disabled people’ when she commented on designing a separate space for people with diverse abilities. From this comment, it was understood that her awareness about people with diverse abilities was not sufficient since this categorization of people revealed discrimination and stigmatization. **Group D** was good at group work, they assigned tasks to each member as P1D was completing the plan and section drawings, while P2D was drawing the 3D sketch perspectives by hand and P3D was deciding on the appropriate materials and taking notes.

As seen in Table 27, the six sub-themes out of ten sub-themes were labeled in common by all groups. The first common and most repeated (31 times) sub-theme was the *sub-theme 5.1 circulation and passages*. The first things that came to the mind of participants were ease of maneuvering and adequate passage width for wheelchair users. Participants mostly emphasized the wheelchair users’ characteristics, problems, and challenges in the kitchen environment; however, they did not mention the problems of people with sensorial impairment (people with visual or aural impairments). The second common and often repetitive (18 times) sub-theme was the *sub-theme 5.2 the reach problem of cabinets*. Participants generally remembered the physical characteristics of the user (i.e., short stature and old age). The third common and often repeated (15 times) sub-theme was the *sub-theme 5.5. the sequence of use and work centers*. They stated that the existing kitchen’s sequence of use and work centers were incorrect. The fourth common and frequently repeated sub-theme was *sub-theme 5.6. accessibility of appliances* (12 times). Participants were concerned about the wheelchair user’s and elderly’s accessibility of appliances and provided UD solutions. The fifth and sixth common and frequently repeated sub-themes were the *sub-theme 5.3- inadequacy of storage cabinets and areas* and the *sub-theme 5.4 safety* and were both mentioned eleven times. Participants also mentioned the *sub-theme 5.3* while providing adequate circulation and passages space and ease of reach to cabinets for physically impaired people (some groups decided not to place wall cabinets). In addition, participants commonly focused on the *sub-theme 5.4* which is extremely important for kitchen utilization for both elderly and people with diverse abilities. They remembered the

accident of the user while she intended to reach the wall cabinet and, their relatives or grandparents had faced the same problems in the kitchen environment.

The least repeated sub-themes were the *sub-theme 5.8. adjustable dining table* (3 times) and the *sub-theme 5.9. illumination* (4 times).

Table 27 Sub-theme Frequencies of Sub-themes of Theme 5 in Each Group

Theme 5 (sub-themes)	Groups				Total
	Group A	Group B	Group C	Group D	
5.1. Circulation and passages	10	8	9	5	31
5.2. Reach problem of cabinets	6	4	2	6	18
5.3. Inadequacy of storage cabinets and areas	2	2	3	4	11
5.4. Safety	4	1	4	2	11
5.5. Sequence of use, work centers and counters	2	1	6	6	15
5.6. Accessibility of appliances	3	3	1	5	12
5.7. Dining table height	2	2	0	2	6
5.8. Adjustable dining table	1	0	1	1	3
5.9. Illumination	3	0	0	1	4
5.10. Materials	0	1	4	2	7

To test hypothesis 2, participants' design process and conversations were analyzed thematically. Participants recalled and used their empathic design experiences and strived to develop universal design solutions (H2). As a result of the analysis of design conversations, two major and two sub-themes were yielded as (4) *past experiences* included two sub-themes (4.1) *individual empathic design experiences* and (4.2) *experiences from prior courses* and (5) *universal design solutions* (see Table 28).

Table 28 Emerging Themes Revealed from Design Conversations

Reflection	Major emergent themes and sub-themes	
Design Process	4	Past experiences 4.1 Individual empathic design experiences 4.2 Experiences from prior courses
	5	Universal design solutions 5.1 Circulation and passages (Floor area availability, frequency of use: the work triangle, clearance problem) 5.2. Reach problem of cabinets 5.3. Inadequacy of storage cabinets and areas 5.4. Safety (smooth edges, the location of appliances, durability of materials) 5.5. Sequence of use, work centers and counters 5.6. Accessibility of appliances (clearance problem) (Knee-space under the sink, placement at eye level/elbow level, pull-out dishwasher/drawer) 5.7. Dining table height (posture problem) 5.8. Adjustable dining table 5.9. Illumination (task, ambient, natural lighting) 5.10. Materials

5.2.2.3 On the Analysis of Themes and Their Relations

The first theme was the *instructive aspects of the empathic design process* related to the system of education of the empathic design process. All groups found this experiment as educative/instructive/useful/informative; these explicit words also played a role as the indicators of this theme. ‘Useful’ was used by six participants (out of twelve) to describe the learning process. Four participants used both words ‘educational’ and ‘instructive’, and two participants commented about the learning process as ‘helpful’ and ‘informative’.

The second theme that emerged was the *affective aspects of the empathic design process* resulting from the empathic design experience and was divided into two sub-themes as *pleasant and challenging aspects*. ‘Nice, good, fine and beautiful’ were the words that participants used frequently to describe the process and were mentioned eleven times.

Eleven participants (out of twelve) commented that they found the experiment enjoyable/fun/ joyful/exciting. 'Difficult' was a word that all participants used to describe the process and mentioned thirteen times. Participants also found the experiment as 'different/unusual' (mentioned 6 times), since they had never experienced such an experiment before. Besides, some participants started their responses with 'I forced...', 'I had to...' to express the difficulties that they have faced.

The third theme was *raising awareness* and had two sub-themes as 'self-awareness' and 'design awareness' based on the participants' reflections. The results indicated that participants believed the ED experience increased their awareness regarding self and design. Besides, participants shared how their self-awareness was raised after taking the IRI and the Kitchen survey.

The fourth theme, which was directly associated with the fifth theme, was about the participants' approach to a design problem. It was based on the participants' recalls of their *past experiences* in generating UD solutions derived from their *individual empathic design experiences* and accumulated knowledge in their *prior courses*. The groups (Group A, B and C) who experienced ED techniques remembered their individual ED experiences and used them in creating UD solutions. It was observed that participants had benefited from their ED experiences. Furthermore, participants recalled the knowledge and *experiences in their prior courses* while solving the design problem. The courses that they mentioned were 'Human Factors', 'Interior Design Studio', and 'Construction and Materials'. Totally, this theme was indicated twelve times.

The fifth theme was the *universal design solutions* that were retrieved in the design process. Participants shared their design ideas to find better design solutions, although they did not have enough time for a broader analysis of the problem.

The final thematic map (see Figure 45) of the study was developed, and emergent themes were analyzed in terms of their relations. Each theme was clearly linked to the related research question and have a relationship with each other.

All the major themes and sub-themes were related to each other and specifically, all the themes were associated with the fifth theme *universal design solutions*. The emerging relations between themes generated three relations.



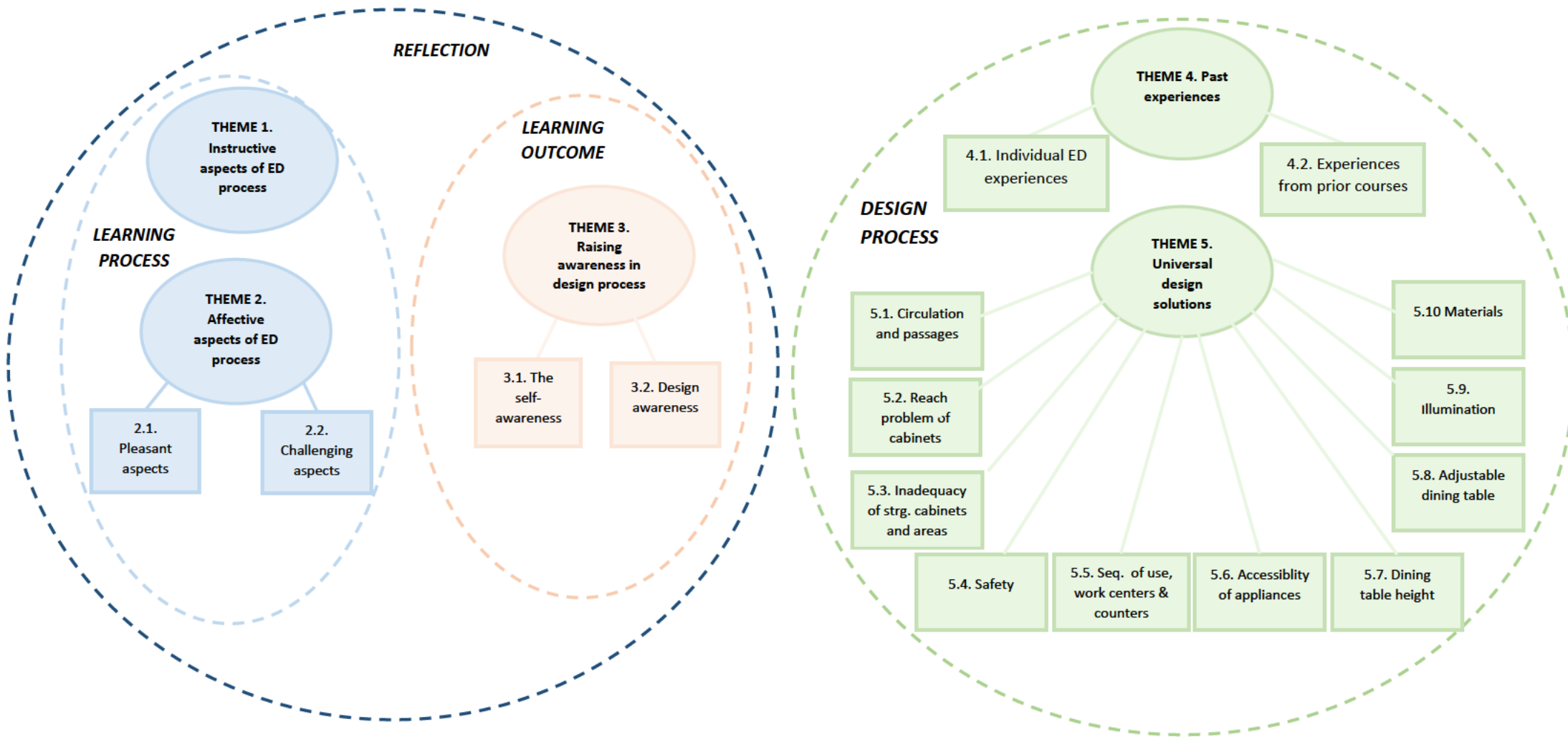


Figure 45. Final thematic map of the study

Initially, the *sub-theme 2.2 challenging aspects of the empathic design process* was directly related with *theme 3. raising awareness* and *theme 5. universal design solutions*. Participants encountered some difficulties while they were experiencing each empathic design technique and recognized user's problems. Thus, these difficulties they faced gave them a better understanding and awareness of the user's problems. Challenging aspects of the participants positively affected their self-awareness and design awareness and encouraged them to find more UD solutions (*Relation 1*) (see Figure 46).

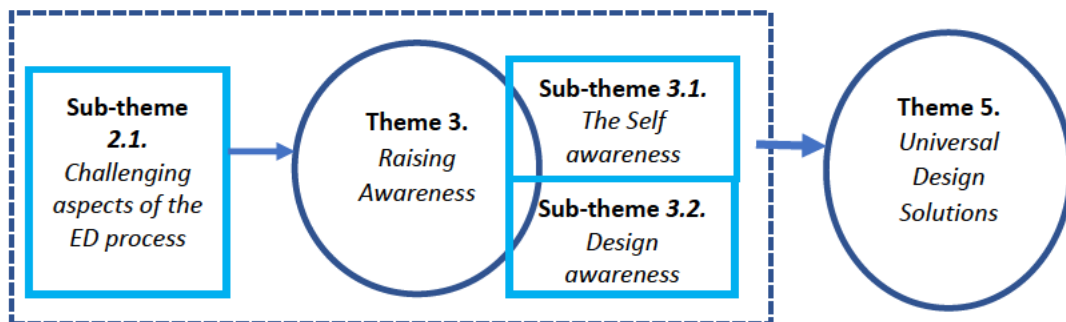


Figure 46. Relation 1

Secondly, the *sub-theme 4.1. individual empathic design experiences* were associated with the *sub-theme 3.2. design awareness* and all were related with *theme 5. universal design solutions*. Remembering empathic design techniques helped participants to enhance their design awareness and propose more universal solutions (*Relation 2*) (see Figure 47).

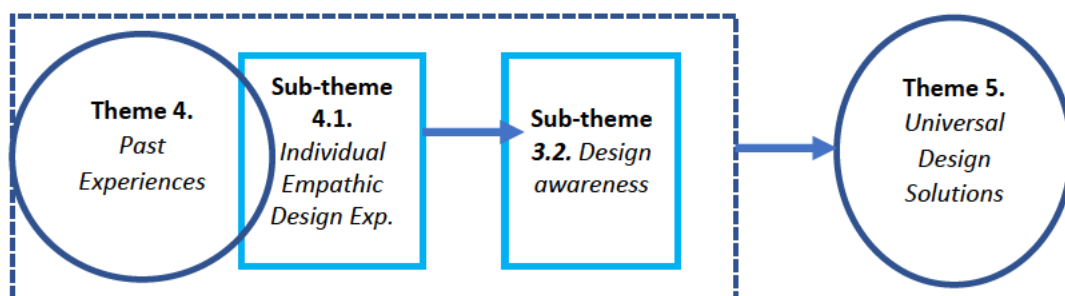


Figure 47. Relation 2

The *sub-theme 4.2. experiences from prior courses* were associated with the *sub-theme 3.2 design awareness* and the *fifth theme universal design solutions*. Since participants recalled their previous knowledge and experiences from prior courses, their design awareness was enhanced and allowed them to make more UD solutions. Recalling experiences from prior courses positively affected participants' design awareness and caused them to find UD solutions (*Relation 3*) (see Figure 48).

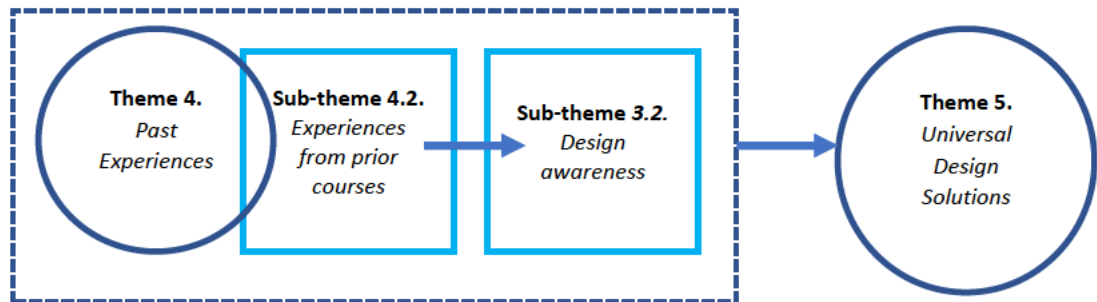


Figure 48. Relation 3

5.2.2.4 Relationship Between Theme 5 and the Kitchen Design Features in Analysis of End Products

In this section, the analysis of each group's end product was presented with building the relationships between sub-themes 5 of theme 5. universal design solutions and the kitchen survey results. To test hypothesis 2, the assessment of the end products was conducted with the aid of design assessment sheet by researcher. Participants should have to take into consideration both the user (person with a broken arm) and all people with diversified abilities. UD and HF principles should be incorporated into their design and the end product should propose UD solutions (theme 4). Table 29 presents the assessment of groups' end products according to UD solutions. Table 30 presents the distribution of the emergent sub-themes of theme 5- UD solutions for each group.

Table 29 Assessment of Groups' End Products According to UD Solutions

	GROUP A	GROUP B	GROUP C	GROUP D
The 7 principles of Universal Design (The Center for Universal Design, 1997, version 2.0)	6	5	5	6
The 47 kitchen needs of diverse user groups (adapted from Afacan & Demirkan, 2010)	33	28	35	35

Table 30 Distribution of the Emergent Sub-themes of Theme 5- UD Solutions for Each Group

Sub-themes of Theme 5. Universal Design Solutions																
	5.1. Circulation and Passages	5.2. Reach problem of cabinets	5.3. Inadequacy of storage cabinets and areas	5.4. Safety			5.5. Sequence of use, work centers and counters	5.6. Accessibility of appliances (clearance problem)			5.7. Dining table height (posture problem)	5.8. Adjustable dining table	5.9. Illumination			5.10 Materials
				Smooth edges	Location of appliances	Durability of materials		Knee-space under the sink	Placement at eye level/ sitting elbow height	Pull-out dishwasher/ drawer			Task	Ambient	Natural	
Group A	✓	✓	✓	✓	✓	–	✓	–	✓	–	✓	✓	✓	✓	✓	–
Group B	✓	✓	✓	–	✓	–	✓	✓	–	✓	✓	–	–	–	–	✓
Group C	✓	✓	✓	✓	✓	✓	✓	–	✓	–	–	✓	–	–	–	✓
Group D	✓	✓	✓	✓	–	✓	✓	✓	✓	✓	✓	✓	✓	–	–	✓

Group A submitted only the orthographic drawings (1 plan + 1 section). Although sketch perspective drawing was also requested; they could not draw and deliver it (see Figure 49). **Group A** indicated Relations 2 and 3, they recalled their empathic design experiences (interview and observation) and knowledge from the prior courses. As their design awareness increased, they tried to find more UD solutions. As a result of the end product assessment, their end product comprised 6 out of 7 UD principles and proposed 33 out of 47 kitchen design items. Group A indicated 9 out of 10 sub-themes about UD solutions (see Table 27) (*theme 5*).

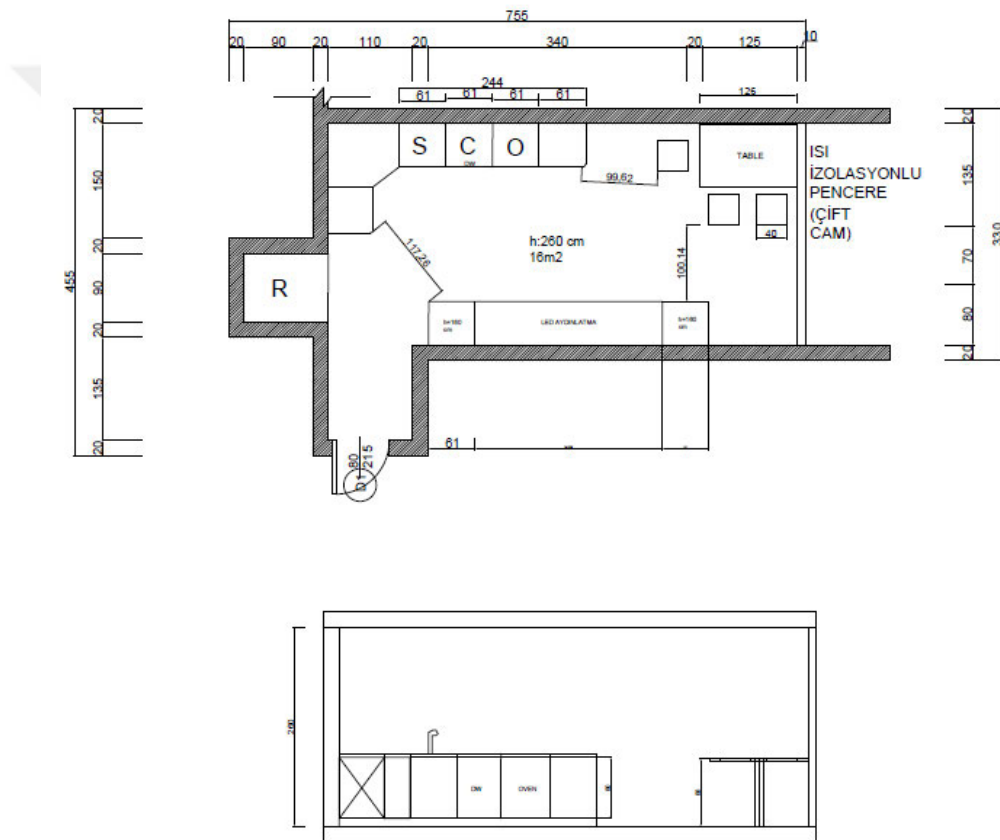


Figure 49. End product from Group A (*drawings are not to scale*)

Sub-theme 5.1 Circulation and passages

Group A indicated the *sub-theme 5.1*. ten times. As a result of the kitchen survey analysis, according to the median value, Group A ranked their importance level as $M_d=4.00$ (out of 5) for '*circulation*' features and suggested 4 (out of 5) circulation items in their end product. 'Clear floor area', 'work triangle', 'circulation' were the words used by the participants. They recalled the existing kitchen's circulation problem as having a narrow passage because of the table and chairs, and they suggested free spaces in their end product. First, they decided to enclose the balcony with glass to design a dining area. They remembered seven UD principles and they opened the kitchen door to the outside so that individuals with orthopedic impairments could pass easily (*UD Principle 1-equitable use*). They also recalled the sequence of work triangle from their prior course 'Human Factors' (*sub-theme 4.2*), their design awareness has enhanced and corrected the existing work triangle (refrigerator, sink and cooking surface) (*Relation 3*).

Sub-theme 5.2 and 5.3 Reach problem of cabinets and inadequacy of storage cabinets

Group A indicated the *sub-theme 5.2*. six times and the *sub-theme 5.3* twice. As a result of the kitchen survey analysis, according to the median value, they ranked their importance level as $M_d=4.00$ (out of 5) for '*cabinets and storage areas*' and suggested 7 (out of 10) items in their end product. They recalled the interview with the user and observation, and they remembered the user's reach problem because of her short stature and old age. Then, their design awareness has increased and considered about reach problem in more detail and suggested not to locate any wall cabinets (*Relation 2*). As one student commented: 'The fewer the wall-cabinets, the better for the user' (*UD Principle 6, low physical effort*). However, they noticed that one of the existing kitchen's problems was lack of storage area and units (*sub-theme 5.3*) and they suggested one wall unit ($h=160$ cm) with two cabinets, and they said that the unit can be used as a TV unit that can be seen by everyone when sitting at the dining table.

Sub-theme 5.4. Safety (smooth edges, the location of appliances, durability of materials)

Group A indicated the *sub-theme 5.4* four times. First, they proposed smooth edges on the counter and table so that there would be no accidents. Secondly, they eliminated the wall cabinets to prevent falling accidents, since they knew that the user fell and broke her arm while trying to access the wall cabinets (*Relation 2*). Thirdly, they considered that there may be a problem with storage for items that are not often used and the things like medicine that children should not access, and they proposed a storage cabinet out of reach of children. Lastly, participants also made some design suggestions as adequate counter space for placement of electrical appliances (e.g., toast machine, kettle). And, they added that they should not locate those appliances next to the sink or cooker because of safety issues (*UD Principle 5, tolerance for error*).

Sub-theme 5.5 Sequence of use, work centers and counters

Group A indicated the *sub-theme 5.5* twice. As a result of the kitchen survey analysis, the median value indicated that Group A ranked their importance level as 4 ($M_d=4.00$ (out of 5)) for 'counters and work surfaces' and proposed 8 (out of 10) items in their end product. They found that the existing kitchen's sequence of use was not applicable and decided to change it to the right sequence. They considered the user's arm length and suggested appropriate counter depth for the user.

Sub-theme 5.6. Accessibility of appliances (clearance problem)

Group A indicated the *sub-theme 5.6* three times. They ranked their importance level as 4 (out of 5) for *appliances* and suggested 8 (out of 10) items and gave their importance level as $M_d=4.00$ (out of 5) for *sink and faucets* and suggested 3 (out of 3) items.

Group A gave importance to provide a clear space in front of refrigerator, cooktop, oven, sink and dishwasher, and to ease of reach to all the essential elements of appliances from preferred positions. To illustrate, they remembered the UD principle

(*sub-theme 4.2*) and considered locating the oven at eye level (*UD Principle 7-size and space for approach and use*), but they did not reflect it on their end product.

Sub-theme 5.7. Dining table and chair height (posture problem)

Group A indicated the *sub-theme 5.7* twice, they designed a dining table and chair considering the user's short stature. They discussed the appropriate size of chair and table for the user and proposed alternative solutions.

Sub-theme 5.8. Adjustable dining table

Group A indicated the *sub-theme 5.8* only once, they concentrated a lot on the dining table design and suggested an adjustable dining table (*UD Principle 2- flexibility in use*).

Sub-theme 5.9. Illumination

Group A indicated the *sub-theme 5.9* three times. As a result of the kitchen survey analysis, they ranked their importance level as $M_d=3.00$ (out of 5) for '*illumination*' and suggested 3 (out of 4) items in their end product. They underlined adequate natural light should be considered when they located the dining table in the balcony area. They also suggested LED lighting for the upper part of the wall cabinets.

Sub-theme 5.10. Material

Group A did not suggest any materials even though they ranked their importance level as $M_d=3.00$ (out of 5) for *material* in the kitchen survey. However, they only thought if they removed the balcony area, there may be a problem with heating in winter, and they recommended heat-insulated glass. The missing UD principles were 'simple and intuitive use' and 'perceptible information'. They did not suggest free space at three sides of the dining table, adjustable shelves, lazy Susan's, and removable base cabinet doors, any safety suggestion about durability of materials,

different height for counters, adequate illumination levels above the cooktop, knee-space under the sink and pull-out dishwasher/drawer and hood (see Table 31).

Table 31. Relations Between Kitchen Design Features and Sub-themes, Group A

Kitchen Design Features			Related Sub-themes	
Name	Importance level (Median) (out of 5)	Design Feature Suggestions	Name	Times
C1. Circulation	4.00	4 (out of 5)	5.1. Circulation and passages	10
C2. Cabinets and Storage areas	4.00	7 (out of 10)	5.2 Reach problem of cabinets	6
			5.3 Inadequacy of storage cabinets	2
C3. Counters and work surfaces	4.00	8 (out of 10)	5.5. Sequence of use, work centers and counters	2
C4. Appliances	4.00	8 (out of 10)	5.6. Accessibility of appliances	2
C5. Sink and Faucets	4.00	3 (out of 3)	5.6. Accessibility of appliances	1
C6. Illumination	3.00	3 (out of 4)	5.9. Illumination	3
C7. Materials	3.00	0 (out of 5)	5.1. Materials	0

Group B submitted 1 plan + 1 section + 1 perspective drawing (digitally drawn) (see Figure 50). As a result of the end product assessment (see Appendix F) their product comprised of 5 out of 7 UD principles and they suggested 28 out of 47 kitchen design items. Lastly, Group B indicated 8 out of 10 sub-themes about UD solutions (*sub-theme 5*) (see Table 27) and indicated Relations 2 and 3.

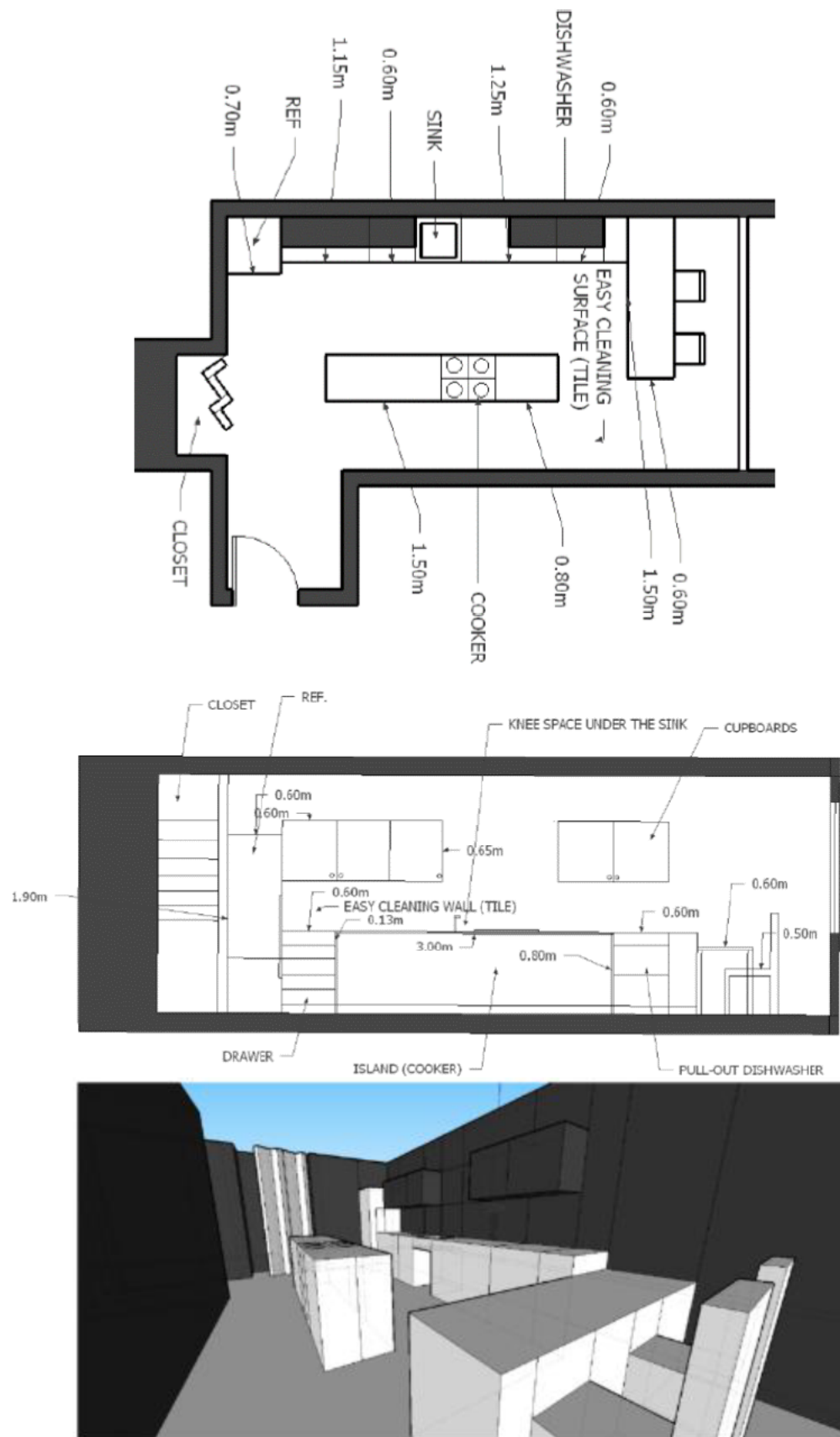


Figure 50. End product from Group B (*drawings are not to scale*)

Sub-theme 5.1 Circulation and passages

Group B indicated the *sub-theme 5.1* eight times. As a result of the kitchen survey analysis, according to the median value, Group B ranked their importance level as $M_d=4.00$ (out of 5) for *circulation* and proposed 4 (out of 5) items.

‘Circulation’, ‘work triangle’, ‘wheelchair user’s turning radius’ were the words mentioned by participants. They generally focused on the circulation and working zone. Unlike other groups (Group A, C and D), they decided to design an island kitchen even though they knew there was insufficient floor area. Then, they criticized themselves as if the user breaks her leg or foot and uses a wheelchair or walker, they should consider wheelchair user’s maneuvering and pass when placing island kitchen, especially wheelchair users’ turning radius (150cm) (*sub-theme 3.2*) (*UD Principle 1- Equitable use*). So, they decided to integrate the balcony area into the kitchen to suggest more adequate floor area. Moreover, they recalled the ‘Interior Design Studio’ course instructor’s explanation when they were deciding on the size of the passage, and they remembered it as “the circulation and the working zone should have separated each other” from their ‘Human Factors’ course (*sub-theme 4.2*).

Sub-theme 5.2 and 5.3. Reach problem of cabinets and Inadequacy of storage cabinets

Group B indicated the *sub-theme 5.2* four times and the *sub-theme 5.3* twice. As a result of the kitchen survey analysis, Group B ranked their importance level as $M_d=4.00$ (out of 5) for *cabinets and storage areas* and proposed 7 (out of 10) items. In brainstorming, they mentioned the user’s short stature and old age and one participant emphasized that elderly people have short stature and get shorter and shorter, and he thought that they should consider small women’s 5% dimension, but afterwards they forgot their decision and designed high wall cabinets ($h=195$ cm). After finalization their design, they realized their mistake and remembered the user’s height was 155 cm from their EM and their design awareness has increased and they decided to diminish the height of the wall cabinets (*Relation 2*) (*UD Principle 6-low physical effort*), but still not easy to reach to the high shelves for the user. Also, they

decided to locate a single storage cabinet over the refrigerator, but they again realized the reach problem.

Sub-theme 5.4. Safety (smooth edges, the location of appliances, durability of materials)

Group B indicated the *sub-theme 5.4* once. They underlined the safety issues when they were considering not locating the cooker next to the bar table (*UD Principle 5-tolerance for error*).

Sub-theme 5.5. Sequence of use, work centers and counters

Group B indicated the *sub-theme 5.5* once. As a result of the kitchen survey analysis, Group B ranked their importance level as $M_d=5.00$ (out of 5) for *counters and work surfaces* and proposed 7 (out of 10) items. One participant remembered the right sequence (as sink-counter-cooker-counter) of use from ‘Human Factors’ course (*sub-theme 4.2.*) and proposed sufficient counter length at the side of the refrigerator, cook top and sink (*Relation 3*).

Sub-theme 5.6. Accessibility of appliances (clearance problem)

Group B indicated this theme third times. As a result of the kitchen survey analysis, Group B ranked their importance level as $M_d=4.00$ (out of 5) for *appliances*, proposed 6 (out of 10) features and for *sink and faucets* as $M_d=4.00$ (out of 5) suggested 3 (out of 3) items.

They proposed free space in front of the refrigerator, cook-top and dishwasher and sink and ease of reach all the essential elements of those appliances from preferred positions. To achieve this, they tried to remember sitting elbow height and they suggested knee-space under the sink and pull-out dishwasher (*UD Principle 7- size and space for approach and use*).

Sub-theme 5.7. Dining table and chair height

Group B indicated the *sub-theme 5.7* twice. They suggested a bar table with a height of 60 cm and a chair with a 50 cm of seating height.

Sub-theme 5.8. Adjustable dining table

Group B did not indicate the *sub-theme 5.8* and proposed an adjustable dining table. Since they proposed island kitchen, they generally considered using counter surface as dining table.

Sub-theme 5.9. Illumination

Group B did not indicate the *sub-theme 5.9* and did not suggest any lighting equipment. Even though they ranked their importance level as $M_d=4.00$ (out of 5) for *illumination*.

Sub-theme 5.10. Materials

Although Group B ranked their importance level as $M_d=4.00$ (out of 5) for *materials*, they only suggested 1 (out of 5) item as an easy-care floor material.

The missing UD principles were ‘simple and intuitive use’ and ‘perceptible information’. They did not suggest any free space around the dining table since they designed a bar table. The missing design features were ‘ease of reach to the high portions of the wall cabinets’, ‘effective use of corner cabinets’ and ‘removable base cabinet doors’, ‘counters at various heights’, ‘pull-out work surfaces’ and ‘rounded edges on the counter’. In addition, they also did not propose the hood (see Table 32).

Table 32 Relations Between Kitchen Design Features and Sub-themes, Group B

Kitchen Design Features			Related Sub-themes	
Name	Importance level (Median) (out of 5)	Suggestions	Name	Times
C1. Circulation	4.00	4 (out of 5)	5.1. Circulation and passages	8
C2. Cabinets and Storage areas	4.00	7 (out of 10)	5.2 Reach problem of cabinets	4
			5.3 Inadequacy of storage cabinets	2
C3. Counters and work surfaces	5.00	7 (out of 10)	5.5. Sequence of use, work centers and counters	1
C4. Appliances	4.00	6 (out of 10)	5.6. Accessibility of appliances	1
C.5 Sink and Faucets	4.00	3 (out of 3)	5.6. Accessibility of appliances	2
C.6. Illumination	4.00	0 (out of 4)	5.9. Illumination	0
C7. Materials	4.00	1 (out of 5)	5.10. Materials	1

Group C submitted 1 plan + 1 section + 1 perspective drawing (freehand) (see Figure 51). As a result of the end product assessment, their product comprised of 5 out of 7 UD principles and proposed 35 out of 47 kitchen design items. Participants indicated 8 out of 10 sub-themes (see Table 27) in their end product and indicated Relations 1, 2 and 3.

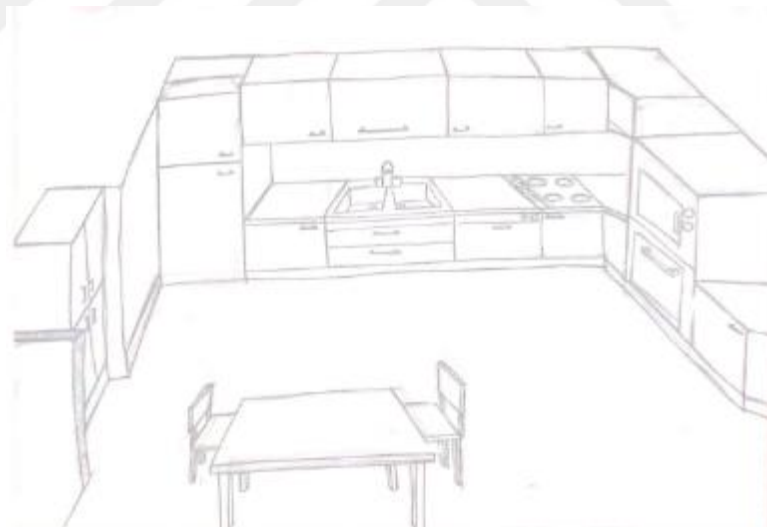
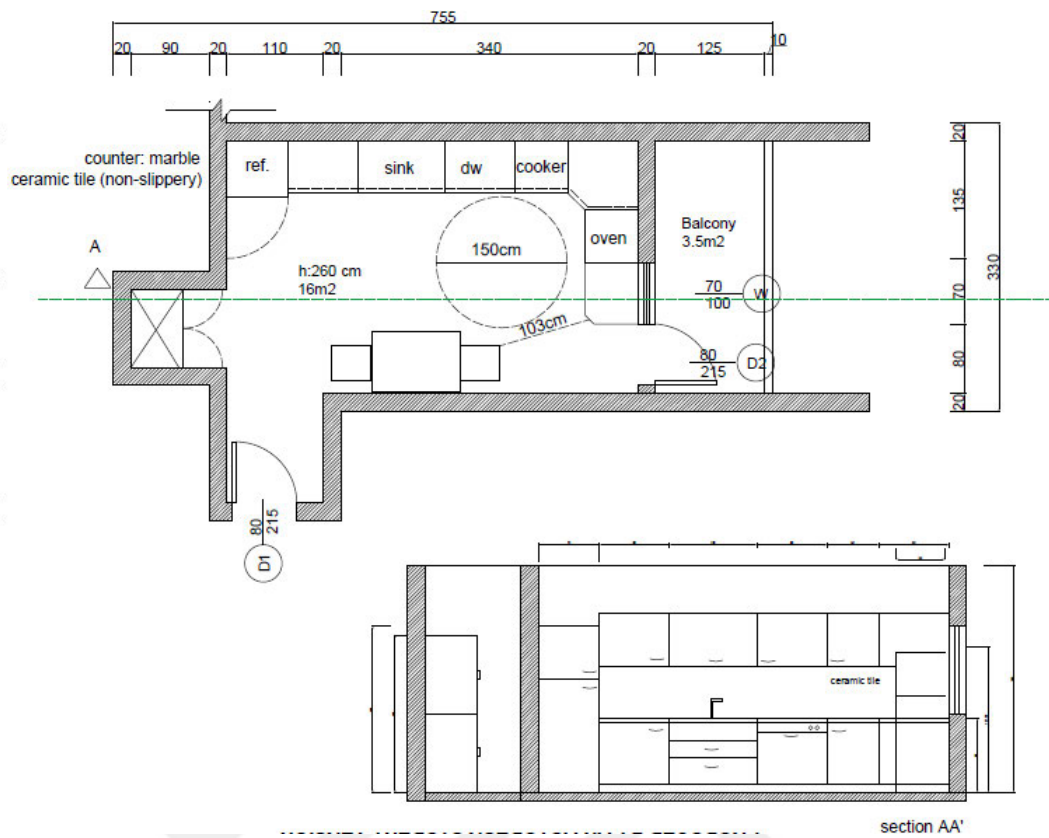


Figure 51. End product from Group C (*drawings are not to scale*)

Sub-theme 5.1. Circulation and passages

Group C indicated the *sub-theme 5.1* nine times. As a result of the kitchen survey analysis, Group C was the group that gave the most importance $M_d=5.00$ (out of 5) to ‘*circulation*’ compared to other groups and the user. They suggested 5 (out of 5) kitchen design items.

‘Circulation’, ‘work triangle’, ‘wheelchair user’s turning space’ were the words used by participants. They recalled the width of the wheelchair (85 cm) and the dimension wheelchair user’s turning space (150 cm), then they proposed an adequate floor space for wheelchair user’s ease of moving in the kitchen and free space for three sides of the dining table (*sub-theme 4.2*) (*UD Principle 1- equitable use*). They remembered the right proximity (max 7 m.) between the refrigerator and cook top for the work triangle and they proposed work triangle as refrigerator, sink and the cooker were all on the same line.

Sub-theme 5.2. and 5.3 Reach problem of cabinets and inadequacy of storage cabinets

Group C indicated the *sub-theme 5.2* twice and the *sub-theme 5.3* three times. Group C gave the importance level as $M_d=4.00$ (out of 5) for ‘*cabinets and storage*’ and proposed 7 (out of 10) items.

One participant in Group C recalled the problem (could not reach the highest point of the cabinet) she faced while conducting the role-playing activities. Her design awareness has increased, and she thought that the user would not be able to reach the high shelves since she was short like her and decided not to locate the wall-cabinets because of the reach problem (*Relation 1*). However, they noticed the lack of storage units and changed their idea and designed wall cabinets higher than 190 cm which were not reachable for the user. They also proposed cabinet door handles that could be used with low effort (*UD Principle 6-low physical effort*).

Sub-theme 5.4. Safety (smooth edges, the location of appliances, durability of materials)

Group C indicated the *sub-theme 5.2* four times. Firstly, they indicated this theme when considering the location of the cooktop and they decided not to locate the cooktop in front of the window. However, one participant remembered the instructor's speech as 'cooktop could be located little near the window, but there should be counter space both at the right and left side of the cook top' (*sub-theme 4.1.*) Secondly, they decided not to design shelves because of safety issues. Thirdly, they recalled their previous interior design project and instructor's warning (*sub-theme 4.1.*) and they proposed smooth edges for the counter and table. Lastly, they proposed marble which is fire-resistant surface material for counters (*UD Principle 5-tolerance for error*).

Sub-theme 5.5. Sequence of use, work centers and counters

Group C indicated this theme six times. As a result of the kitchen survey analysis, Group C ranked their importance level as $M_d=5.00$ (out of 5) for *counters and work surface* and suggested 8 (out of 10) items. They considered left and right-handed person (*UD Principle 2-flexibility in use*) when they were remembering the right sequence of use in the kitchen. One participant in Group C recalled her role-playing practice. Since she is right-handed person, she had trouble using the refrigerator with left arm.

Sub-theme 5.6. Accessibility of appliances (clearance problem)

Group C indicated this theme once. As a result of the kitchen survey analysis, Group C ranked their importance level as $M_d= 4.50$ (out of 5) for *appliances* and suggested 7 (out of 10) items and $M_d= 5.00$ (out of 5) for *sink and faucets* and proposed 3 (out of 3) features. They proposed locating the oven at eye level (*UD Principle 7- size and space for approach and use*).

Sub-theme 5.7. Dining table and chair height

Group C did not indicate this theme specifically.

Sub-theme 5.8. Adjustable dining table

Group C indicated this theme once. They proposed an adjustable dining table in order not to take up too much space.

Sub-theme 5.9. Illumination

Group C did not indicate this theme and did not propose any lighting equipment although they gave the highest importance level as $M_d=4.50$ (out of 5) for the *illumination* compared to other groups and the user.

Sub-theme 5.10. Materials

Group C indicated this sub-theme four times. Group C ranked their importance level $M_d=5.00$ (out of 5) for *materials* and suggested 4 (out of 5) items. They suggested marble as a heat-resistant countertop material, ceramic tile as slip-resistant, durable, and easy-care floor material.

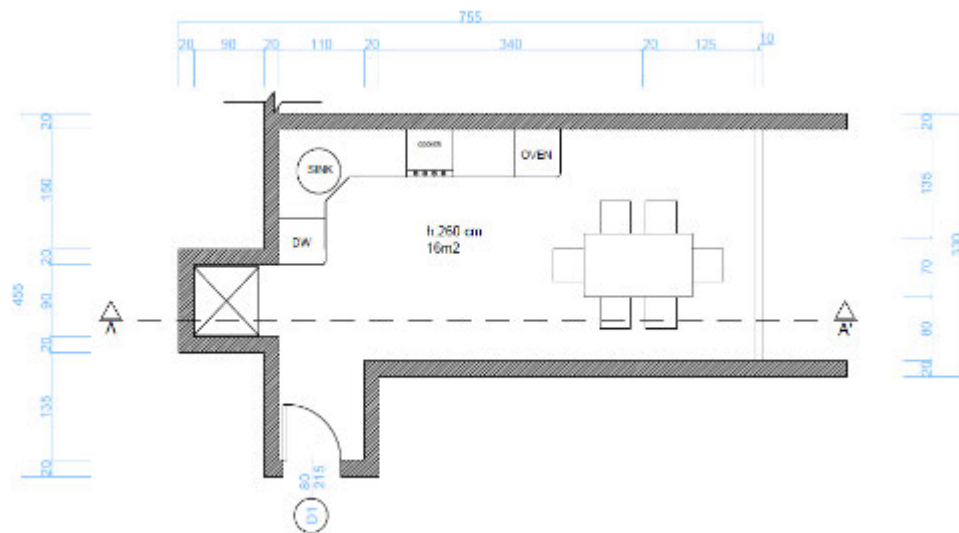
The missing UD principles were ‘simple and intuitive use’ and ‘perceptible information’. There was a reach problem with the high shelves of the wall cabinets and cabinets did not have any pull-down shelves. There were no counters at various heights and pull-out work surfaces. The controls of the cooktop were not reachable from the preferred position since they were located at the left part of the cooktop. There were no natural and artificial lighting solutions. And no color contrast between the floor and counter material. The missing design features were (1) ‘ease of reach to all essential elements of the cooktop from preferred positions’ they proposed to locate control buttons at the left side of the cooktop which has a clearance problem for the wheelchair user, (2) ‘close access to the hood’ and ‘ease of reach to all

essential elements of the hood from preferred positions’ - they did not suggest hood (see Table 33).

Table 33 Relations Between Kitchen Design Features and Sub-themes, Group C

Kitchen Design Features			Related Sub-themes	
Name	Importance level (Median) (out of 5)	Suggestions	Name	Times
C1. Circulation	5.00	5 (out of 5)	5.1. Circulation and passages	9
C2. Cabinets and Storage areas	4.00	7 (out of 10)	5.2 Reach problem of cabinets	2
			5.3 Inadequacy of storage cabinets	3
C3. Counters and work surfaces	5.00	8 (out of 10)	5.5. Sequence of use, work centers and counters	6
C4. Appliances	4.50	7 (out of 10)	5.6. Accessibility of appliances	1
C.5 Sink and Faucets	5.00	3 (out of 3)	5.6. Accessibility of appliances	0
C.6. Illumination	4.50	0 (out of 4)	5.9. Illumination	0
C7. Materials	5.00	4 (out of 5)	5.1. Materials	4

Group D Group D submitted 1 plan+ 1 section + 1 free hand sketch perspective+ material decisions (see Figure 52). As a result of the end product assessment (see Appendix F), their end product is comprised 6 out of 7 design principles and they proposed 35 out of 47 items. Group D indicated all sub-themes 5 (see Table 27)



Materials:
 -Counter: Marble
 -Cabinets: Plywood
 -Floor: Ceramic 60x30
 -Wall #1: Ceramic (between lower and upper cabinets)
 -Wall #2: Paint

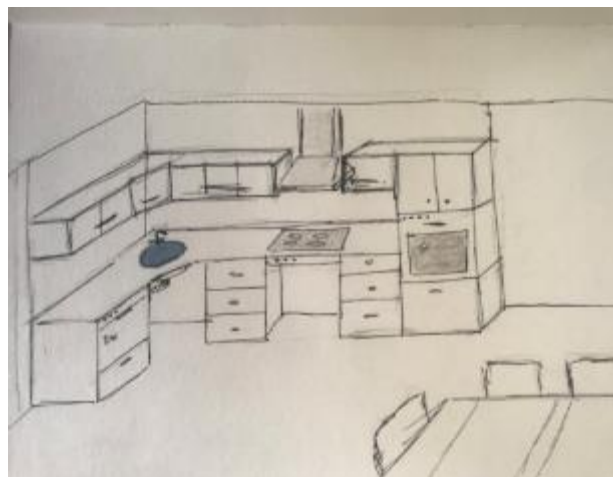
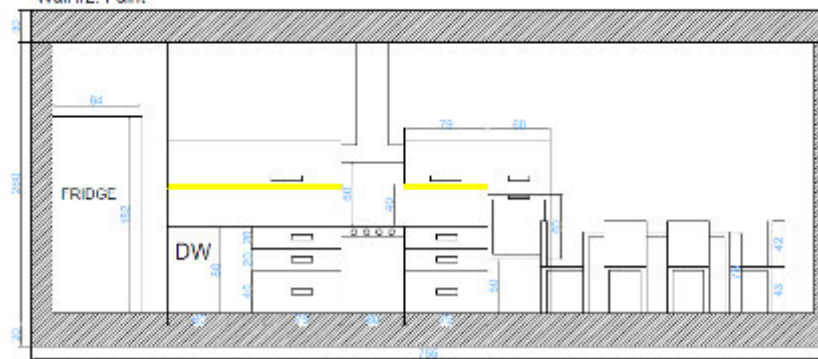


Figure 52. End product from Group D (*drawings are not to scale*)

Sub-theme 5.1. Circulation and passages

Group D indicated the sub-theme 5.1 five times. As a result of the kitchen survey analysis, Group C ranked their importance level as $M_d=4.00$ (out of 5) for *circulation* features and proposed 3 (out of 5) items in their end product.

‘Circulation’, ‘work triangle’, ‘passages’ were the words frequently used by participants. They suggested integrating the balcony area into the kitchen to provide adequate floor area. They considered wheelchair users’ ease of maneuvering in the kitchen and proposed a 150 cm radius area (*UD Principle 1-equitable use*).

Sub-theme 5.2. Reach problem of cabinets and 5.3 Inadequacy of storage cabinets

Group D indicated the -theme 5.2 six times and the sub-theme 5.3 four times. As a result of the kitchen survey analysis, Group C ranked their importance level as $M_d=3.50$ (out of 5) for *cabinets and storage* features and proposed 8 (out of 10) items.

They determined the lack of storage cabinets and suggested wall cabinets considering the user’s short stature. They remembered the dimension of ‘sitting vertical grip reach (103 cm) and located the dishwasher and oven according to this dimension (*UD Principle 7- size and space for approach and use*).

Sub-theme 5.4. Safety (smooth edges, the location of appliances, durability of materials)

Group D indicated this sub-theme twice. They suggested smooth edges for counters and heat- resistant countertop material (*UD Principle 5- tolerance for error*).

Sub-theme 5.5. Sequence of use, work centers and counters

Group D indicated the sub-theme 5.5 six times. As a result of the kitchen survey analysis, Group D ranked their importance level as $M_d=5.00$ (out of 5) for *counters and work surfaces* features and proposed 7 (out of 10) items in their end product.

They were concerned about the right- and left-handed people and remembered the sequence as refrigerator-counter-sink-counter-cook top-counter and emphasized that the sequence should be from left to right (*UD Principle 2-flexibility in use*). They also suggested that the sink should be next to the dishwasher and should not be far from the refrigerator.

Sub-theme 5.6. Accessibility of appliances (clearance problem)

Group D indicated this sub-theme five times. As a result of the kitchen survey analysis, Group D ranked their importance level as $M_d=5.00$ (out of 5) for *appliances* and proposed 10 (out of 10) design features and gave $M_d=5.00$ (out of 5) for *sink and faucets* and suggested 3 (out of 3) items.

They considered that the user at old age and she may use a wheelchair in the future and suggested a knee-space under the sink and cook top and pull-out dishwasher (*UD Principle 6-low physical effort*). They suggested a sink at the corner location. They also suggested that the oven and micro-oven should be located at eye level so that people with disabilities can access them easily.

Sub-theme 5.7. Dining table and chair height

Group D indicated this sub-theme twice. They suggested 75cm for the height of the table and 85 cm for the chair's sitting height.

Sub-theme 5.8. Adjustable dining table

Group D indicated this sub-theme once and proposed an adjustable dining table. However, one participant stated that people with disabilities and the user may have some difficulties bending over while opening and closing the dining table.

Sub-theme 5.9. Illumination

Group D indicated the *sub-theme 5.9* once. Although Group D ranked their importance level as $M_d=5.00$ (out of 5) for *illumination*, they proposed 1 (out of 4) item. They solely suggested an adequate illumination level over the working surfaces.

Sub-theme 5.10. Materials

They indicated this sub-theme twice and ranked their importance level as $M_d=5.00$ (out of 5) for *materials*, they proposed 3 (out of 5) items. They suggested marble as a heat-resistant countertop material, ceramic as a durable and slip-resistant floor material, plywood for cabinets, ceramic, and paint for the walls.

The missing UD principles were ‘simple and intuitive use’ and ‘perceptible information’. The missing design features were related to the interrupted clear floor is at the work triangle between the refrigerator, sink and cooker, no counters at various height, inadequate artificial light in the kitchen, no color contrast between floor and counter material, and an easy-care floor material. They did not suggest the effective use of corner cabinets and removable base cabinet doors (see Table 34).

Table 34 Relations Between Kitchen Design Features and Sub-themes, Group D

Design Features			Related Sub-themes	
Name	Importance level (Median) (out of 5)	Suggestions	Name	Times
C1. Circulation	4.00	3 (out of 5)	5.1. Circulation and passages	5
C2. Cabinets and Storage areas	3.50	8 (out of 10)	5.2 Reach problem of cabinets	6
			5.3 Inadequacy of storage cabinets	4
C3. Counters and work surfaces	5.00	7 (out of 10)	5.5. Sequence of use, work centers and counters	6
C4. Appliances	5.00	10 (out of 10)	5.6. Accessibility of appliances	3
C.5 Sink and Faucets	5.00	3 (out of 3)	5.6. Accessibility of appliances	2
C.6. Illumination	5.00	1 (out of 4)	5.9. Illumination	1
C7. Materials	5.00	3 (out of 5)	5.1. Materials	2

Learning activities of the study was analyzed by Merrill's First Principles of Instruction (Merrill, 2002) and found that these principles were appropriate and useful for instructing empathic design in design process (see Appendix J). Real-word tasks (interview, observation, co-design, role-playing, lecture, design, interview), real kitchen problem, problems of a broken arm person were the problems that participant solved. Students recalled their existing knowledge from empathic design experience, 'Human Factors', 'Construction and Materials', 'Interior Design Studio' courses. New knowledge as empathy map, the role-playing video recording, pictures from empathic design experiences etc. were demonstrated. Participants were reflected their new knowledge in redesigning a kitchen (design process, co-design, end product). And they also reflected their new knowledge a in group interview while they were discussing the empathic design process.

In the following chapter, the discussion and interpretation of the results gathered from the experiment in relation to the literature review were presented. The quantitative and qualitative results were discussed from both designer's and educator's point of view.



CHAPTER 6

DISCUSSION

This chapter included two sections; in the first section, quantitative results included IRI, Kitchen survey and association were discussed. In the second section, qualitative results of the study included thematic analyses' results were discussed in terms of the similar studies' results from the literature.

6.1 Discussion on the Quantitative Results

In this section, quantitative results including results of IRI, kitchen survey and their associations were discussed compared with previous similar studies.

6.1.1 On the IRI Results

It was hypothesized that experiencing empathic design techniques reveals improvements on multiple dimensions of students' empathy (Hypothesis 1). To test hypothesis 1, the development in participants' empathy was measured using the IRI (Davis, 1980, 1983) in a pre-and-posttest format. The four distinct empathy dimensions (FS, PT, EC, PD) were analyzed based on the changes in pretest and posttest scores.

Davis (1980) stated internal reliabilities (ranging from 0.71 to 0.77) and test-retest reliabilities (ranging from 0.62 to 0.80). Similarly, in this study the Cronbach's alpha scores range for pretest scales were 0.79 to 0.83 and for posttest scales from 0.80 to 0.85.

It was hypothesized that each empathy dimension would improve after experiencing the ED techniques in each group, but the results indicated that only Group C's (role-playing) scores were increased in all dimensions. Role-playing technique had an important factor in this result since Group C built better empathy with the user to understand her physical limitation compared to the other groups (Altay et al., 2016; Kocaoğlu & Demirkan, 2019). Therefore, H1 was not rejected.

The results indicated that there was an increase in the PD scores of Group C since they were anxious and uncomfortable while conducting role-playing activities and performing activities using only one arm was a challenging and unusual experience for them. Although the PD scale was expected to decrease in the other groups, Group A (direct contact between designers and users) and Group B (indirect contact between designers and users) based on David (1983) statement, as the PD subscale was negatively correlated with the EC and PT subscales, but interestingly Group C's PD post-scores were increased as Stratton et al.'s (2008) study. In that study, the researchers used only three empathy dimensions (PT, EC, and PD) of IRI to investigate the changes in medical students' empathy and found that medical students' ($n=64$) EC and PT scores decreased, while PD scores increased. However, another research (Kim, 2020) from medical education had distinct results. The researcher analyzed the impact of project-based learning approach on medical student's empathy over the semester and found that students who had lower empathy ($n=23$) in pretest scores had increased their empathy scores in all three subscales (FS, EC, and PD). Moreover, Hess et al.'s (2019) used IRI to test and retest empathic tendencies of engineering students ($n=29$), and an increase in PT scale and a decrease in PD scale were found.

The IRI was found to be an important index for the sake of two advantages (1) measuring multidimensions of students' empathy (Davis, 1980, 1983) and (2) increasing students' self-awareness. Participants found the IRI was educative and

enjoyable. More importantly, they said that the IRI increased their self-awareness and awareness of the people with diverse abilities' needs and problems. One participant realized that how he was incapable of being empathic, and the other participant realized how she was sensitive person. Another participant realized how she was an unstable person since she realized her behavior towards people with disabilities was changing.

6.1.2 On the Kitchen Survey Results

The kitchen survey results revealed similar scores within the user's and participants' answers and enhanced participants' design awareness on person with a broken arm's design priorities (*sub-theme 3.2*). Also, participants found the kitchen survey was useful.

Descriptive statistics results indicated that Groups A and B's mean values ($M_A=3.97$; $M_B=3.99$) were close to the user ($M_U=4.11$) and the median was equal for Groups A, B, and the user ($M_d=4.00$). Also, Group B had the closest mean value to the user's value in 3 out of 7 categories compared to the other groups. The result indicated that attending lecture about ED and creating an empathy map have an impact on understanding user's needs and priorities.

The results also demonstrated that Group C gave the highest value in 4 out of 7 categories than the other groups. This may be the reason that they simulated a broken arm person and empathized with user. P2C stated that when she was filling the survey from the user's point of view, she figured out she should rate each kitchen design features' importance level as 4 or 5 (out of 5). Since she simulated a broken arm condition, she empathized with the user. Therefore, she found every kitchen design feature was important for universal kitchen design. So, role-playing technique helped participants to empathize with the user to understand her kitchen priorities.

In Afacan and Demirkan (2010) study, the results found that a significant difference among the kitchen users ($n=135$) including adults, elderly, adults with impairments physically or visually with respect to six-factors of the survey. Unlike this study's results, illumination found as an important factor for the diverse kitchen users regarding "maximizing the function and enjoyment of kitchen for all since for all the participants regardless of the age and ability stressed the quality of light" (Afacan & Demirkan, 2020, p. 324). However, in this study, illumination category (three groups and the user) was found to be the least important kitchen design characteristics for a broken arm person. So, the priorities regarding illumination in kitchen could be different for people with diverse abilities such as temporary impairment (i.e., broken arm), or with permanent impairments or visual impairment or with the elderly (Demirkan & Olguntürk, 2014).

6.1.3 On the Association Analyses

The association analysis indicated that there was a strong relationship between the importance rank given and the number of used kitchen design features during the design process in Group A. This result lies parallel to Kouprie and Visser's (2009) and van Rijn et al.'s (2011) studies. Those studies emphasized that interviewing, observing, and co-designing methods give the designer a better understanding of the user's needs and difficulties in the use of product or environment. Also, the results of this study indicated that Group A direct contact group effectively identified how important each kitchen design feature was important by taking a perspective of user's point of view. Similarly with previous literature, this study revealed that direct contact technique was an effective for building empathy with the user (Heylighen et al., 2013; van Rijn et al., 2011) and producing design features in universal design process.

The results related to the association between sub-themes and kitchen design features indicated that Group C, whose end products were better than the other groups, had benefited from the emerged sub-themes to propose design features in their end

products. As they mentioned more sub-themes 5 than the other groups, their designs concerned more kitchen design features. As mentioned in Kouprie and Visser's (2009) study, as Group C was using the role-playing technique, the students' own experiences were evoked in a domain relevant to the user (ideation) in the design process. The results of this study were also supported with the other studies that stated role-playing technique is very efficient to feel and understand the user's physical limitations and their needs (Altay et al., 2016; Gomez-Lanier, 2018; Lam & Suen, 2015). Therefore, the participants in Group C proposed more universal design features while taking perspective of the user and acting out the user's life.

6.2 Discussion on the Qualitative Results

In this section, qualitative results of the study were discussed in detail. Firstly, participants from Group A, B and C's behavior in empathic design process were discussed. Then, discussion on the thematic analyses results from group interviews, design process and end products were presented.

6.2.1 On the Analysis of Participants' Behavior

Group A experienced the techniques for direct contact between designers and users. They enhanced their knowledge through listening and observing the user in her kitchen environment, also shared their design solutions (co-design) with the user similar to Altay's (2017) study. **Group B** experienced the technique for indirect contact between designers and user. They did not build a direct contact with the user, but they watched the user's video recording, attended the lecture about empathic design and created the empathy map. **Group C** experienced role-playing technique. They simulated the user and acted out in their own kitchen as if they had a broken arm.

The results of the observation indicated that participants were all excited for the empathic design experience and each group exposed some common and different behavior and attitudes with each other. The observed common attitudes in all groups were that they had a pleasant design experience and had fun as stated similarly in the previous studies (Altay et al., 2016; Altay, 2017). **Group A** members were enthusiastic and compassionate to make connection with the user as also stated in Altay's (2017) study. When they were observing the user's kitchen utilization as she was trying to reach the wall cabinets by stepping up onto the chair, they were worried if the user would fall. Contact with the user evoked positive emotions and empathy within students as also stated in van Rijn et al.'s (2011) study. **Group B** was concentrated and interested in the lecture, and they were willing to make an empathy map. **Group C** was the most enthusiastic group, but they were also distressed and frightened while doing role-playing activities as also reported in Altay and Demirkan's (2014) research. Interestingly, they enforced themselves, wanting to try additional and challenging activities.

6.2.2 On the Thematic Analyses Results

In this section, firstly, the reasons for choosing thematic analysis in this study were discussed briefly, then thematic analysis results from group interviews and design process were examined.

There are various reasons for selecting TA as qualitative data analysis method in this study. Firstly, the methodology of this study involved mixed method research where numerous data are emerged that need to be interpreted systematically such as textual data from group interviews and transcripts of conversations from the design process. The key characteristic of TA is the systematic process of coding the data and focusing on the explicit description and interpretation of the content through the creation of theme (Vaismoradi et al., 2013; Vaismoradi et al., 2016).

TA is recommended for analyzing detailed and complex data, also it is found flexible and useful (Braun & Clarke, 2006). Also, other advantages are stated such as relatively not complex and quick method to learn. Vaismoradi et al. (2013) stated that “The use of qualitative descriptive approaches such as descriptive phenomenology, content analysis, and thematic analysis is suitable for researchers who wish to employ a relatively low level of interpretation, in contrast to grounded theory or hermeneutic phenomenology, in which a higher level of interpretive complexity is required” (p. 399). TA is “a method for identifying, analyzing, and reporting patterns (themes) within data” (Braun & Clarke, 2006, p. 79), it is a more independent qualitative descriptive approach in contrast to content analysis. Since content analysis is more related with the analysis of large textual information and their frequency and their relationship (Vaismoradi et al., 2013).

TA is widely and commonly used as a qualitative data analysis method by scholars and researchers in psychology, sociology, literature, health, sport, and exercise and in many other disciplines (Malik et al., 2020) and in the context of learning and teaching research (Maguire & Delahunt, 2017; Xu & Zammit, 2020). However, there are few studies (Altay & Demirkan, 2014; Altay et al., 2016; Börekçi, 2017) using TA in interior architecture and industrial design education area. This research aims to fill this gap through using TA as a method to analyze qualitative data collected in experiential educational research. As a qualitative analysis method, TA is utilized in analyzing the reflections of experiencing empathic design process on students’ perceptions of their learning experience (hypothesis 3) and determining to what extent experiencing empathic design process reflected in students’ design process and in their end product (hypothesis 2).

6.2.2.1 On the Thematic Analysis of Group Interviews

Reflections of empathic design on participants’ perceptions of their learning process and design outcomes were explored. It was hypothesized that experiencing empathic design process positively reflect on students’ perception of their learning experience

(Hypothesis 3). The results revealed three emergent themes (1) instructive aspects of ED process, (2) affective aspects of ED process (pleasant and challenging aspects) and (3) raising awareness (the self and design awareness) in design process and these themes were supporting the Hypothesis 3. Therefore, this hypothesis was not rejected. This study's results were also supported in the earlier researches with similar results that had analyzed participants' learning processes and outcomes in an empathic design experience through thematic analysis (Altay, 2017; Altay & Demirkan, 2014; Altay et al., 2016; Hutton & Maguire, 2021).

For the first emergent theme known as the *instructive aspects of empathic design process*, participants criticized that *learning by doing/experiencing* approach was more useful than traditional learning methods since they emphasized that practical experiences were more permanent in their minds and memories as also reported in Altay (2017) and Altay et al.'s (2016) results. Also, they suggested that empathic approach in design could be highlighted in the curriculum as an elective course or in the 'Interior Design Studio' courses as also suggested by McDonagh and Thomas (2010). Moreover, McDonagh (2015, p. 422) stated "practice-based design research provides the opportunity to holistically explore the wide spectrum of user needs prior to and during the designing process." Also, empathy mapping as a new learning tool was found useful and helpful by participants (Bairaktarova et al., 2016; Ferreira et al., 2015).

The second-ranked theme exposed participants to affective aspects (*pleasant and challenging aspects of the empathic design process*) of the ED process. In the pleasant aspects of empathic design process (*sub-theme 2.1.*) some participants commented that they enjoyed this experiment and volunteered to participate in similar ED experiments in the future. Also, they stated that working as a group was enjoyable and useful to exchange design ideas for considering all people's needs in the design process. These feedbacks were so vital, and this theme can be worth highlighting (Altay et al., 2016; Altay, 2017).

The challenging aspects of empathic design process (*sub-theme 2.2*) were also found in this research. This aspect was also noticed in the previous studies and the reason was explained as follows, the participants stepped out of their comfort zone to conduct the ED techniques and they were forced (Campbell & McDonagh, 2009; Hutton & Maguire, 2021). Especially, designing for both the user with a broken arm and for all at the same time forced them significantly. Similar with the previous research (Altay & Demirkan, 2014), participants mostly mentioned the word ‘difficult’ (thirteen times) in their reflections.

The third theme *raising awareness in design process*, revealed self-awareness and design awareness as similar with the previous researches (Altay et al., 2016; Hutton & Maguire, 2021). Participants underlined that the IRI and kitchen survey raised their self-awareness and empathic understanding in the design process. Also, for the first time they had filled in a psychological index as IRI and the kitchen survey from a person who has a temporary impairment’s point of view. Hence, it is possible to say that these teaching approaches were innovative and impressive for them.

Participants’ design awareness was improved as in McDonagh and Thomas’s (2010) research and specifically in universal design approach as found in Altay’s (2017) study in empathic understanding. Besides, they realized how to build relationship between *empathy* and *design* and criticized their previous design projects’ universality. They understood the concept of universal design better, they learned that it does not solely involve people with disabilities, it embraces all people (McDonagh, 2015).

6.2.2.2 On the Thematic Analysis of Design Process and End Products

The study assessed to what extent does empathic design process reflects the interior architecture students’ design process and end product in terms of applying HF/E and UD principles (RQ1). It was hypothesized that integrating the empathic design approaches to design process produces more universally designed end products with

the correct application of HF/E principles (hypothesis 2). To test H2, the design processes were analyzed thematically regarding the effects of empathic design experiences and found two emergent themes (*theme 4. past experiences from sub-theme 4.1. individual empathic design experiences and sub-theme 4.2. from prior courses and theme 5. universal design solutions*). The results indicated that participants recalled and determined their empathic design experiences (*sub-theme 4.1*) to produce universal design solutions (*theme 5*) with the correct application of HF/E principles (Bairaktarova et al., 2016; Lam & Suen, 2015; Torrens, 2000). Therefore, H2 was not rejected.

The results revealed similar results with the previous studies in the reflections of building direct contact (McDonagh & Thomas, 2010; Strickfaden & Devlieger, 2011; van Rijn et al., 2011) and simulating user's abilities (Altay et al., 2016; Gomez-Lanier, 2018; Lam & Suen, 2015) on proposing universally design solutions. Group A and C remembered and determined more of their empathic design experiences (*sub-theme 4.1*) and demonstrated a more empathic approach to find feasible design solutions than another group (Group B). However, Group D (control group) had a hard time finding a design solution for *design for all approach* and wanted more additional time to complete their drawings. Hence, it is possible to say that empathic design process helped the students to find design solutions in a short time.

All groups mostly remembered the theoretical knowledge that they had gained from the prior courses (*sub-theme 4.2*), since their knowledge was fresh as they had recently taken these courses. However, in the pilot study, some participants (Ph.D. students) had trouble remembering the theoretical information. At this point, the results of this study (*theme 4-past experiences*) were significant since they suggested that when two teaching methods (theoretical and practical) were integrated, they were more memorable for the students as also stated in the previous literature (Altay, 2017; Altay et al., 2016). Thus, the participants both remembered their experiences from experiential learning and the theoretical knowledge that they gained from the prior courses during the design process.

The results indicated that there was a relationship between the results of the quantitative analysis of the kitchen survey and thematic analysis on universal design solutions. Sub-theme 5.9. Illumination was one of the least repeated (4 times) sub-themes found in the thematic analysis. Similarly, the illumination was found to be the least important ($M_A=3.83$, $M_B=3.17$, $M_U=3.50$, out of 5) kitchen design characteristic for a broken arm person. Although adequate illumination level was found to be a very important design characteristic for people with diverse abilities (Bernardi & Kowaltowski, 2010). Design students should consider the adequate illumination level in the design process and find more appropriate design solutions for all people. The other important result was the participants generally focused on wheelchair user's barriers, however they did not consider sensorial impaired people. Design students should focus more on sensorial impaired people's accessible problems.

The results of the analysis of the end products suggested that role-playing was more effective empathic design technique towards finding more universal solutions that were lying parallel with the previous studies (Altay et al., 2016; Gomez-Lanier, 2018; Lam & Suen, 2015) compared to the other techniques. Interestingly, although Group D was the control group, their end product was successful, this may be due to the academic success of students and maybe having more time to think to find more design solutions.

Empathic design strategies had revealed design awareness and outcomes in the previous studies that were conducted in different design fields; namely in architectural design projects (Gomez-Lanier, 2018; Strickfaden & Devlieger, 2011) and product design (Altay, 2017; Altay et al., 2016; Bairaktarova et al., 2016; Gagnon & Cote, 2014; McDonagh & Thomas, 2010; Torrens, 2000). Similar with the previous studies' results, this study emphasized the profound effects of empathic design approaches as practice-based experiences on students' design process and end products.

In the next chapter, the conclusion of the thesis with a summary of study was given. Then, implications of emphatical design techniques in interior architectural design education were explained based on this study's results. The conclusion chapter was followed by limitations of the study and suggestions for further studies.

Table 35. Comparison of the Results Obtained by Each Empathic Design Technique

		Groups			
		Group A (n=3)	Group B (n=3)	Group C (n=3)	Group D (control group) (n=3)
ED technique		Direct contact between designers and users	Indirect contact between designers and users	Role-playing	None
Changes of IRI subscales based on pre-and-post test results	Fantasy (FS)	↑	↓	↑	-
	Perspective Taking (PT)	↓	Almost constant	↑	-
	Empathic Concern (EC)	↓	↓	↑	-
	Personal Distress (PD)	↓	↓	↑	-
Importance level for total (47) kitchen design items (Md)		4.00 (out of 5)	4.00 (out of 5)	5.00 (out of 5)	-
Students' reflections on ED techniques		Enthusiastic, compassionate, pleasant, funny	Interested, concentrated, pleasant, funny	Distressed, frightening, enforced, pleasant, funny	-
Observations on student behavior during design process		Fun	Calm	Restless and excited	Forced, indecisive
Emergent themes revealed from group interviews (students' reflections about the experiment)	Theme 1. Instructive aspects of ED process	✓	✓	✓	✓
	Theme 2. Affective aspects of ED process	✓	-	✓	✓
	Theme 3. Raising awareness in design process	✓	✓	✓	✓
Emergent themes revealed from design process	Theme 4. Past experiences	✓	-	✓	-

Table 36 (cont'd)

		Groups			
		Group A (n=3)	Group B (n=3)	Group C (n=3)	Group D (control group) (n=3)
Emergent themes revealed in design process	Theme 5. UD solutions (times)				
	5.1. Circulation and passages	10	8	9	5
	5.2. Reach problem of cabinets	6	4	2	6
	5.3. Inadequacy of storage cabinets and areas	2	2	3	4
	5.4. Safety	4	1	4	2
	5.5. Sequence of use-work centers and counters	2	1	6	6
	5.6. Accessibility of appliances	3	3	1	5
	5.7. Dining table height	2	2	0	2
	5.8. Adjustable dining table	1	0	1	1
	5.9. Illumination	3	0	0	1
	5.10. Materials	0	1	4	2
The way approach to the design problem		User-centered	No specific approach	Activity-based	No specific approach
Theme relations seen in design process		Relations 2 and 3	Relations 2 and 3	Relations 1, 2 and 3	-

Table 36 (cont'd)

	Groups			
	Group A (n=3)	Group B (n=3)	Group C (n=3)	Group D (control group) (n=3)
End product deliveries	1 plan + 1 section	1 plan + 1 section + 1 sketch pers.	1 plan + 1 section + 1 sketch pers.	1 plan + 1 section + 1 sketch pers.
End product analysis (7 UD principles)	6	5	5	6
End product analysis (47 kitchen design items)	33	28	35	35
End product analysis (10 Sub-themes 5 of Theme 5-UD Solutions)	9	8	8	10

↑: increase; ↓: decrease; ✓: present; -: not present.

CHAPTER 7

CONCLUSION

The main objective of this research was building empathy in interior architecture education and discovering the effects and reflections of empathic design approach on interior design process and end products. Furthermore, delving into the pedagogical outcomes and assessments of empathic design process were the other objectives of this research. Empathic approach in the design process helped participants create more accessible and universally designed products and/or environments for *all people* whether having diverse abilities or not.

This study was conducted online sessions because of the Covid-19 pandemic situation in 2020-2021 Fall Semester. Twelve undergraduate interior architecture students formed four groups and worked together in the design process. The research was done with a control group and three experimental groups where different learning methods in empathic design were compared to clarify their impacts on empathic design process. Only nine participants experienced three different empathic design techniques, but all groups ($n=12$) participated in the design task. The results indicated that participants recalled and determined their empathic design experiences to produce universal design solutions with the correct application of HF/E principles (Bairaktarova et al., 2016; Lam & Suen, 2015; Torrens, 2000).

This study indicated that each empathic design technique was effective in a specific area (Altay & Demirkan, 2014) but role-playing technique was more effective in

raising empathy level and finding UD solutions than other empathic design techniques (direct contact between designers and users and indirect contact between designers and users). Nevertheless, some researchers claimed that it is not sufficient for designers to feel and understand user's daily life activities by simulating it in one day. Since people with permanent limitations have lived their impairments in their whole life (Cardoso & Clarkson, 2012). Role-playing technique only helps designers to think deeply about the difficulties faced by the users (Nicolle & Maguire, 2003; McDonagh & Thomas, 2010; McDonagh, 2015). This situation may be one of the limitations of the role-playing technique, but this technique provides students a chance to understand people's lives, especially people who have diverse abilities.

Firstly, the effectiveness of the empathic way of learning on participants' empathy was explored. The multiple dimensions of empathy (PD, FS, PT and EC) were measured by IRI before and after the experiment. And the scores in pre-test and post-test were compared. As a result of the analysis, there was an increase in PD, FS, PT and EC dimensions of empathy scores in Group C (role-playing). It is possible to say that experiencing role-playing technique was more efficient in enhancing empathy level in multiple dimensions compared to other techniques.

Secondly, this study examined to what extent the students become aware of the user's needs after experiencing the empathic design process. The participants were asked to fill in the kitchen survey through the user's (who has a broken arm) point of view and the answers were compared with the user. Descriptive statistics results indicated that Groups A (direct contact between designers and users) and Group B (indirect contact between designers and users) had close answers to the user. Moreover, Group B had the closest mean value to the user's value in 3 out of 7 categories compared to the other groups. The results demonstrated the impacts of lecture, empathy map and watching user's video recording on the understanding of user's design priorities. Besides, Group C ranked the highest value in 4 out of 7 categories in comparison to the other groups and the user. This may be a consequence of role-playing technique, since participants' *empathic horizon* (McDonagh & Thomas, 2010) raised and wanted to rate each kitchen design

feature's importance level as 4 or 5 (out of 5). Role-playing technique helped participants in empathizing with the user to understand her kitchen priorities.

The association analyses revealed that there is a strong relationship between the ranked importance level in the kitchen survey and the number of used universal design features during the design process in Group A. The results demonstrated that direct contact was a successful way of expressing empathy to produce effective design features in universal design process. Furthermore, the results related to the association between sub-themes and kitchen design features implied that Group C, whose end products were better than the other groups, had benefited from the emerged sub-themes to suggest universal design features in their end products. It was verified that participants proposed more universal design features while taking perspective of the user and acted out the user's life.

The results of the qualitative analysis (thematic analysis) demonstrated that empathic design process is certainly reflected on participants perceptions in their learning experience. The three emergent themes (*1. instructive aspects of the empathic design process, 2. affective aspects of the empathic design process and 3. raising awareness in design process*) supported these reflections. Other results of the thematic analysis in design process and the analysis of end products revealed that empathic approach improved participants' problem-solving skill as found in Gomez-Lanier's (2018) study, affected participants' design decision making process positively, and encouraged them to integrate UD and HF/E principles into their end products. Two emergent themes (*4. past experiences and 5. universal design solutions*) demonstrated that participants recalled their prior courses' learning and their empathic design practices to generate usable and feasible universal design solutions. End product assessments indicated that role-playing was more helpful as an empathic design technique towards finding universal solutions compared to the others. Although Group D was the control group, their end product was also successful. This could be a result of other factors, such as the group was composed of participants who have higher academic performance, drawing ability, good groupwork skills or

allocated more time in generating design ideas that resulted in effective design solutions.

Building empathy plays a significant role in developing successful design projects in architectural education. Since the control group (Group D) had difficulty in generating design solutions and they spent too much time, and they changed a lot of ideas while designing.

7.1 Implications of Emphatical Design Techniques in Interior Architectural Design Education

Analyzing and comparing three different empathic design techniques' influences on interior architecture students' online design process and end products were the new contribution to knowledge. The results of this study contribute to interior architectural design education in various educational methods, such as lecture-based learning, practice-based learning, and project-based learning. As participants suggested, empathic design should be integrated as assignments in theoretical courses, in design studios or in workshops, and it could be taught as an elective course (*theme 1*).

This study's results underlined the positive impact of empathic design process on proposing universal design solutions with the correct application of HF/E principles (*theme 5*) in design projects of students. Empathic design and techniques could be taught in both theoretical courses related with ergonomics, universal design, product design or design for people with diverse abilities (Altay & Demirkan, 2014; Altay, 2017) and practical courses while instructors give critics to students' design projects. Also, empathic design techniques can be given as research homework before students start their design projects. Empathic design workshops could be conducted to increase the awareness of students and develop their empathic design skills as attempted formerly (Altay et al., 2016; Gagnon & Cote, 2014).

Theoretical, and practical bases of empathic design can be combined and incorporated in the curriculum as an elective course called 'Empathic Design'. The

syllabus of this course can be structured according to this study's proposed framework and results. For instance, the theoretical knowledge can be taught in lectures then, students can be divided and asked to practice different empathic design techniques and are expected to work collaboratively to achieve their end products (*theoretical-practice and project-based learning*). For example, if students are designing a restaurant as a studio project, they could be asked to visit a restaurant and observe the relations among customers, employees, and the characteristics of the interior environment. Also, they can interview the customers and employees to obtain qualitative data. Additionally, students can do research online, watch videos or use communication tools (storytelling, empathy map, persona etc.,) to gain deeper insight into customers. Students can obtain empathy through role-playing. Then, students could be reminded of their previous knowledge obtained in prior courses and their empathic design experiences during the design process (*theme 4*).

Students' empathy level can be measured before and after taking the course. If students' empathy level is measured and informed about their scores at the beginning of the lecture, their self-awareness about empathic understanding can increase (*sub-theme 3.1*). And the effect of the courses can be tested by measuring students' empathy level again at the end of the course. Students could work in pairs or groups to experience different empathic design techniques. Surveys about design characteristics could be prepared or adapted from previous literature. Students could be asked to fill in these surveys from the user's point of view. Since this study's results indicated that participants design awareness had increased by filling the design surveys through person with a broken arm's eyes (*sub-theme 3.2*) since they have recognized the importance of design characteristics of the built environment more.

7.2 Limitations of the Study and Suggestions

There are several limitations for this study. The first limitation was the experiment conducted in virtual meetings. Future research can conduct similar experiments in face-to-face meetings. The second limitation was the limited number of participants and the user. Most students did not want to volunteer to participate in such an online

experiential study. Future researches might increase the number of participants, and the users. The third limitation was only second year interior architecture students volunteered. Future research can organize such an experiment with first-second, third- and fourth-year design students. The fourth limitation was the user has temporary physical limitation. The users with temporary and permanent limitation could be selected. Fifth limitation was time since the activities were conducted in online sessions. The time given to participants to complete the tasks (etc. role-playing, design process) was limited. This experiment was conducted in one week, but design educators can apply these tasks in a 14-week semester. Sixth limitation was participants filled out IRI and the Kitchen Survey in English version.

According to the results of this research, experiencing empathic design expanded participants' empathic understanding and design awareness, changed their perceptions of the kitchen environment positively and increased understanding of the challenges of people with diverse abilities encounter. In addition, designing with empathic understanding shortened the design decision-making process and helped to find more universal design solutions. This study demonstrated that empathic design could be used as an additional, alternative, and useful educational method in understanding diverse people's problems, expectations and needs from design. The results of this study can be useful in both architecture, interior architecture, and industrial design education. Design educators can have detailed information about the effects of different teaching techniques in empathic design on inclusive education from this study. They can apply empathic design techniques or develop a variety of educational methods by taking references from this study's pedagogical effects to encourage students to create more universally designed projects. Design students should remember that *all people* have an equal right to live independently, and designers must put an emphasis on the people that they design for.

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APPENDICES

Appendix A. Ethics Committee Approval

**Bilkent Üniversitesi**
Akademik İşler Rektör Yardımcılığı

Tarih : 23 Kasım 2020

Gönderilen : Melis Kocaoğlu Yeşiltepe

Tez Danışmanı : Halime Demirkan

Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı

Konu : "Building Empathy ..." çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 23 Kasım 2020 tarihli görüşme sonucu, "Building Empathy in Interior Architecture Education: Exploring the Effects of Empathic Design and Its Reflections" isimli çalışmanız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüler ve bilgilendirme formu için geçerlidir.

Bu onay, yapmayı önerdiğiniz çalışmanın genel bilim etiği açısından bir değerlendirmedir. Çalışmanızda, kurumumuzun değerlendirmesi dışında kalabilen özel etik ve yasal sınırlamalara uymakla ayrıca yükümlü olursunuz.

Kovid-19 salgını nedeniyle konulmuş olan kısıtlamaların yürürlükte olduğu süre içinde, tüm komite toplantıları elektronik ortamda yapılmaktadır; aşağıda isimleri bulunan Bilkent Üniversitesi Etik Kurulu Üyeleri adına bu yazıyı imzalama yetkisi kurul başkanındadır.

Etik Kurul Üyeleri:

Ünvan / İsim	Bölüm / Uzmanlık	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Erdal Onar	Hukuk	Üye
Prof.Dr. Haldun Özaktaş	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Ayşen Örgen	Psikoloji	Üye
Doç.Dr. Çiğdem Gündüz Demir	Bilgisayar Mühendisliği	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Yedek Üye

Kurul karar/toplantı No: 2020_11_23_01

Bilkent Üniversitesi, 06800 Bilkent, Ankara • Telefon: (312) 290 12 13 • (312) 290 12 14 • Faks: (312) 266 41 52

Appendix B. Interpersonal Reactivity Index (IRI, Davis, 1980, 1983)

Source: <https://www.eckerd.edu/psychology/iri/>

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology*, 10, 85.

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, 44, 113-126.

INTERPERSONAL REACTIVITY INDEX

The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate letter on the scale at the top of the page: A, B, C, D, or E. When you have decided on your answer, fill in the letter next to the item number. READ EACH ITEM CAREFULLY BEFORE RESPONDING. Answer as honestly as you can. Thank you.

ANSWER SCALE:

A	B	C	D	E
DOES NOT DESCRIBE ME WELL				DESCRIBES VERY WELL

1. I daydream and fantasize, with some regularity, about things that might happen to me. (FS)
2. I often have tender, concerned feelings for people less fortunate than me. (EC)
3. I sometimes find it difficult to see things from the "other guy's" point of view. (PT) (-)
4. Sometimes I don't feel very sorry for other people when they are having problems. (EC) (-)
5. I really get involved with the feelings of the characters in a novel. (FS)
6. In emergency situations, I feel apprehensive and ill-at-ease. (PD)
7. I am usually objective when I watch a movie or play, and I don't often get completely caught up in it. (FS) (-)
8. I try to look at everybody's side of a disagreement before I make a decision. (PT)
9. When I see someone being taken advantage of, I feel kind of protective towards them. (EC)
10. I sometimes feel helpless when I am in the middle of a very emotional situation. (PD)
11. I sometimes try to understand my friends better by imagining how things look from

12. Becoming extremely involved in a good book or movie is somewhat rare for me. (FS) (-)
13. When I see someone get hurt, I tend to remain calm. (PD) (-)
14. Other people's misfortunes do not usually disturb me a great deal. (EC) (-)
15. If I'm sure I'm right about something, I don't waste much time listening to other people's arguments. (PT) (-)
16. After seeing a play or movie, I have felt as though I were one of the characters. (FS)
17. Being in a tense emotional situation scares me. (PD)
18. When I see someone being treated unfairly, I sometimes don't feel very much pity for them. (EC) (-)
19. I am usually pretty effective in dealing with emergencies. (PD) (-)
20. I am often quite touched by things that I see happen. (EC)
21. I believe that there are two sides to every question and try to look at them both. (PT)
22. I would describe myself as a pretty soft-hearted person. (EC)
23. When I watch a good movie, I can very easily put myself in the place of a leading character. (FS)
24. I tend to lose control during emergencies. (PD)
25. When I'm upset at someone, I usually try to "put myself in his shoes" for a while. (PT)
26. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me. (FS)
27. When I see someone who badly needs help in an emergency, I go to pieces. (PD)
28. Before criticizing somebody, I try to imagine how I would feel if I were in their place. (PT)

Appendix C. The Kitchen Survey

The Survey is adapted from Afacan and Demirkan (2010).

Source: Afacan, Y., & Demirkan, H. (2010). A priority-based approach for satisfying the diverse users' needs, capabilities and expectations: a universal kitchen design case. *Journal of Engineering Design*, 21(2-3), 315-343.

This survey aims to identify the kitchen needs of diverse user groups (adult, elderly, people with physical and visual disabilities). It lists the design features for a kitchen. Please rate your important level for each feature on a scale of 1-5 (1 being the least important and 5 the most important) and mark the appropriate boxes to identify how important each of the following features is in working successfully within a kitchen environment.

Age:

Gender: Female ☐ Male ☐

Education level:

User Group: Adult ☐ Elderly ☐ Disabled ☐

	Least Important				Most Important
	1	2	3	4	5
A. Circulation					
1. Ease of moving/maneuvering in the kitchen	☐	☐	☐	☐	☐
2. An adequate clear floor area if more than one person using the kitchen	☐	☐	☐	☐	☐
3. An uninterrupted clear floor area in the work triangle between the refrigerator, sink and cooker	☐	☐	☐	☐	☐
4. Non-exhausting walking distances (the work triangle) between the refrigerator, sink and cooking surface	☐	☐	☐	☐	☐
5. An adequate clearance at three sides of the dining table	☐	☐	☐	☐	☐
B. Cabinets and storage areas					
6. Close access to the cabinets	☐	☐	☐	☐	☐
7. Ease of reach to the low portions of the base cabinets	☐	☐	☐	☐	☐
8. Ease of reach to the high portions of the wall cabinets	☐	☐	☐	☐	☐
9. Ease of use of the rear portions of the base cabinets	☐	☐	☐	☐	☐
10. Ease of use of the rear portions of the wall cabinets	☐	☐	☐	☐	☐
11. Cabinets having pull-out shelves	☐	☐	☐	☐	☐
12. Effective and efficient use of corner cabinets by 360° rotating mechanisms/lazy-susan units/moon swing-out shelves	☐	☐	☐	☐	☐
13. Removable base cabinet doors	☐	☐	☐	☐	☐
14. Use of the cabinet door handles with low effort	☐	☐	☐	☐	☐
15. Use of the drawers and its contents without uncomfortable postures	☐	☐	☐	☐	☐

	Least Important				Most Important
	1	2	3	4	5
C. Counters/ work surfaces					
16. Close access to the counter	☐	☐	☐	☐	☐
17. An appropriate counter height	☐	☐	☐	☐	☐
18. Use of the whole surface of the counter without uncomfortable postures	☐	☐	☐	☐	☐
19. Counters at various heights	☐	☐	☐	☐	☐
20. Pull-out work surfaces	☐	☐	☐	☐	☐
21. An appropriate counter space on at least one side of the refrigerator	☐	☐	☐	☐	☐
22. An appropriate counter space on at least one side of the cooking surface	☐	☐	☐	☐	☐
23. An appropriate counter space on at least one side of the same level as the rack	☐	☐	☐	☐	☐
24. An appropriate counter space on at least one side of the sink	☐	☐	☐	☐	☐
25. Rounded edges on the counter	☐	☐	☐	☐	☐
D. Appliances					
26. Close access to the refrigerator	☐	☐	☐	☐	☐
27. Ease of reach to all the essential elements of the refrigerator from preferred positions	☐	☐	☐	☐	☐
28. Close access to cook-top	☐	☐	☐	☐	☐
29. Ease of reach to all the essential elements of the cook-top from preferred positions	☐	☐	☐	☐	☐
30. Close access to the oven	☐	☐	☐	☐	☐
31. Ease of reach to all the essential elements of the oven from preferred positions	☐	☐	☐	☐	☐
32. Close access to dishwasher	☐	☐	☐	☐	☐
33. Ease of reach to all the essential elements of the dishwasher from preferred positions	☐	☐	☐	☐	☐
34. Close access to the hood	☐	☐	☐	☐	☐
35. Ease of reach to all the essential elements of the hood from preferred positions	☐	☐	☐	☐	☐
E. Sink and faucets					
36. Close access to the sink	☐	☐	☐	☐	☐
37. Use of the sink without uncomfortable postures	☐	☐	☐	☐	☐
38. Ease of reach to the faucets from preferred positions	☐	☐	☐	☐	☐
F. Illumination					
39. Adequate natural light in the kitchen	☐	☐	☐	☐	☐
40. Adequate artificial light in the kitchen	☐	☐	☐	☐	☐
41. Adequate illumination levels over the working surfaces	☐	☐	☐	☐	☐
42. Adequate illumination levels above the cook-top	☐	☐	☐	☐	☐
G. Materials					
43. A colour contrast between floor and counter material	☐	☐	☐	☐	☐
44. A heat-resistant countertop material	☐	☐	☐	☐	☐
45. A durable floor material	☐	☐	☐	☐	☐
46. An easy-care floor material	☐	☐	☐	☐	☐
47. A slip-resistant floor material	☐	☐	☐	☐	☐

Appendix D. Design Assessment Sheet (cont'd)

Design Assessment Sheet			
The Principles of Universal Design (The Center for Universal Design, 1997, version 2.0 (4/1/97))			
1. Equitable Use	The design is useful and marketable to people with diverse abilities		
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities.		
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.		
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.		
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.		
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue.		
7. Size and space for approach and use	Appropriate size and space <u>is</u> provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.		
The 47 kitchen needs of diverse user groups (adapted from Afacan & Demirkan, 2010)			
Category 1. Circulation		Category 4. Appliances	
1.Ease of moving/maneuvering in the kitchen.		26. Close access to the refrigerator	
2.An adequate clear floor area if more than one person using the kitchen		27. Ease of reach to all the essential elements of the refrigerator from preferred positions	
3.An uninterrupted clear floor area in the work triangle between the refrigerator, sink and cooker		28. Close access to cook-top	
4. Non-exhausting walking distances (the work triangle) between the refrigerator, sink and cooking surface		29.Ease of reach to all the essential elements of the cook-top from preferred positions	
5.An adequate clearance at three sides of the dining table		30.Close access to the oven	
Category 2. Cabinets and storage areas		31.Ease of reach to all the essential elements of the oven from preferred positions	
6.Close access to the cabinets		32.Close access to dishwasher	

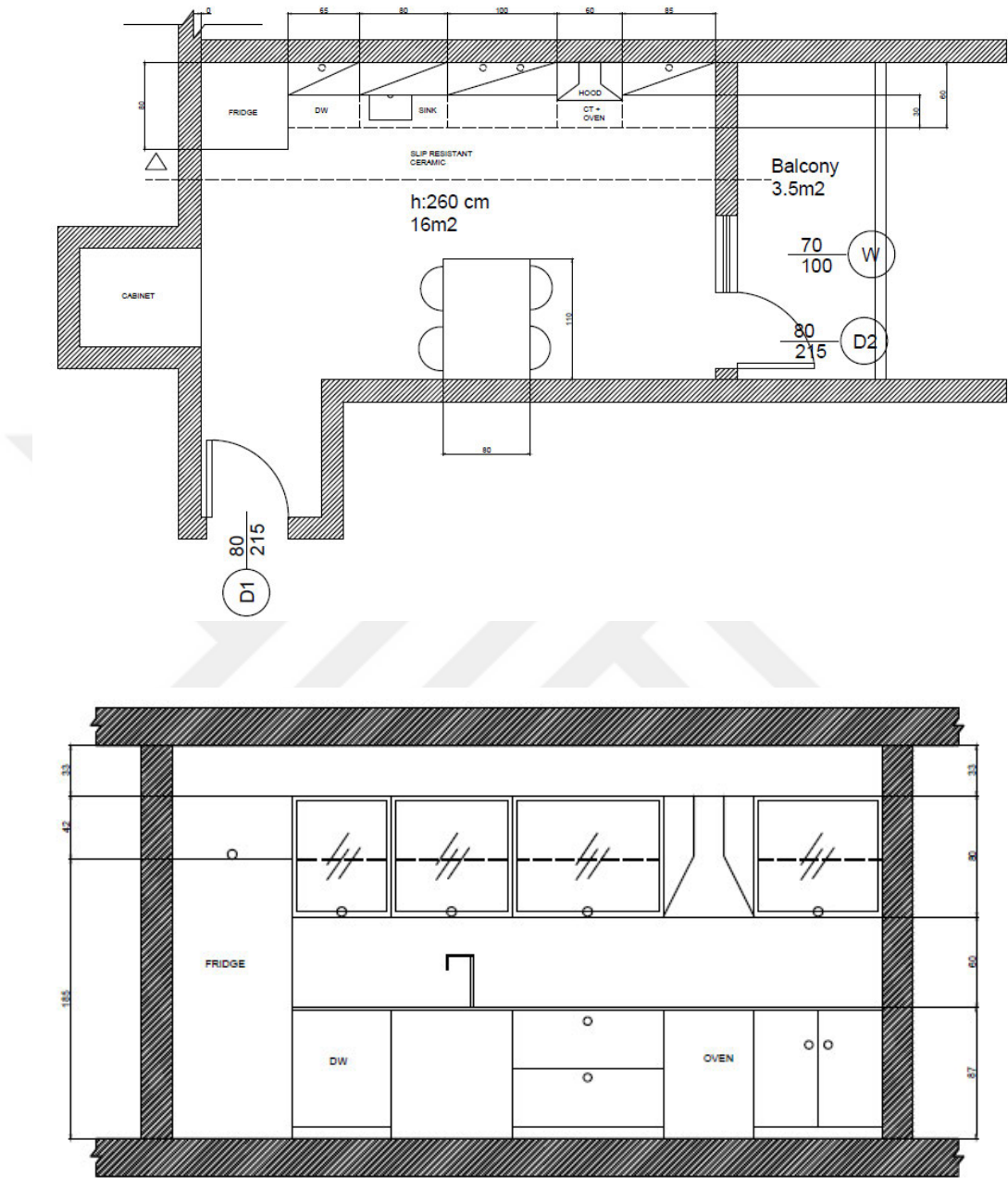
(cont'd)

Appendix D. Design Assessment Sheet (cont'd)

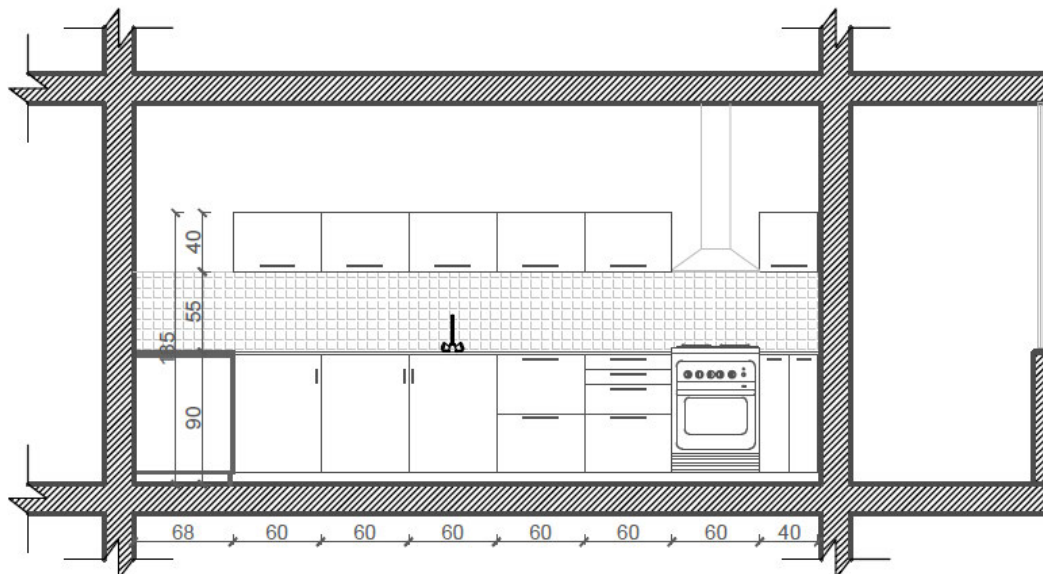
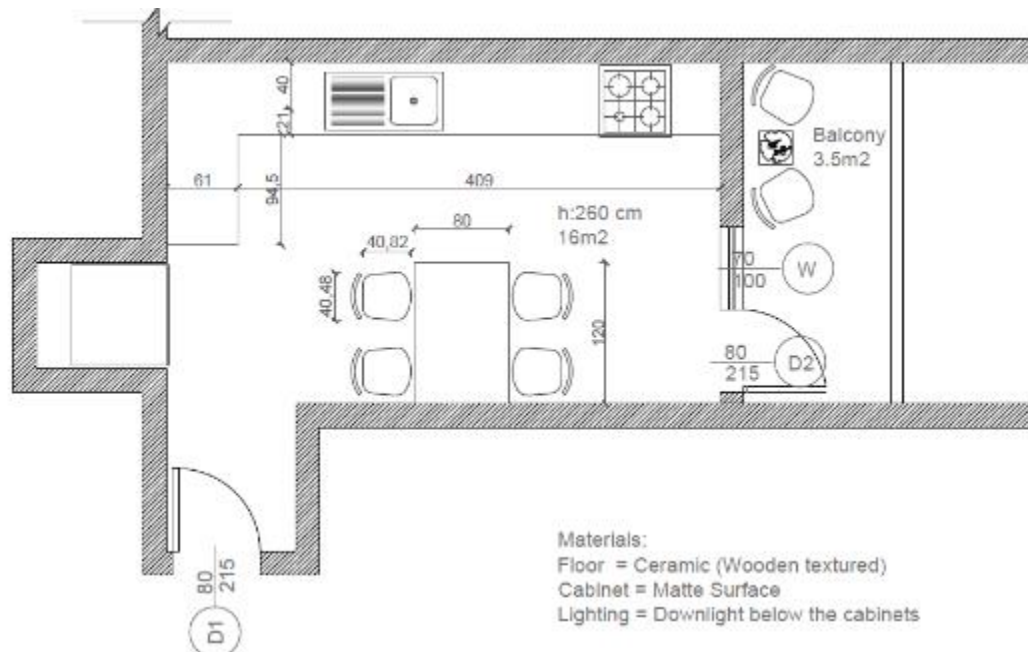
7.Ease of reach to the low portions of the base cabinets		33. Ease of reach to all the essential elements of the dishwasher from preferred positions	
8.Ease of reach to the high portions of the wall cabinets		34.Close access to the hood	
9.Ease of use of the rear portions of the base cabinets		35.Ease of reach to all the essential elements of the hood from preferred positions	
10.Ease of use the rear portions of the wall cabinets		Category 5. Sink and faucets	
11.Cabinets having pull-out shelves		36. Close access to the sink	
12.Effective and efficient use of corner cabinets by 360° rotating mechanisms/lazy-susan units/moon swing-out shelves		37. Use of the sink without uncomfortable postures	
13.Removable base cabinet doors		38. Ease of reach to the faucets from preferred positions	
14.Use of the cabinet door handles with low effort		Category 6. Illumination	
15. Use of the drawers and its contents without uncomfortable postures		39.Adequate natural light in the kitchen	
Category 3. Counters/ work surfaces		40.Adequate artificial light in the kitchen	
16. Close access to the counter		41.Adequate illumination levels over the working surfaces	
17. An appropriate counter height		42.Adequate illumination levels above the cook-top	
18. Use of the whole surface of the counter without uncomfortable postures		Category 7. Materials	
19. Counters at various heights		43.A colour contrast between floor and counter material	
20. Pull-out work surfaces		44.A heat-resistant counter top material	
21. An appropriate counter space on at least one side of the refrigerator		45.A durable floor material	
22. An appropriate counter space on at least one side of the cooking surface		46.An easy-care floor material	
23. An appropriate counter space on at least one side of the same level as the rack		47. A slip-resistant floor material	
24. An appropriate counter space on at least one side of the sink			
25. Rounded edges on the counter			

Architectural floor plan of a kitchen and dining area. The kitchen features a sink, two ovens, and a refrigerator. The dining area includes a table and chairs. Dimensions are provided in millimeters. A circular door is labeled D1.

Pilot Group C



Pilot Group D



APPENDIX F. Design Assessment Sheets of Each Group

Design Assessment Sheet, Group A			
The Principles of Universal Design (The Center for Universal Design, 1997, version 2.0 (4/1/97))			
1. Equitable Use	The design is useful and marketable to people with diverse abilities	–	
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities.	✓	
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	✓	
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	✓	
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.	✓	
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue.	✓	
7. Size and space for approach and use	Appropriate size and space <u>is</u> provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	✓	
The 47 kitchen needs of diverse user groups (adapted from Afacan & Demirkan, 2010)			
Category 1. Circulation		Category 4. Appliances	
1.Ease of moving/maneuvering in the kitchen.	✓	26. Close access to the refrigerator	✓
2.An adequate clear floor area if more than one person using the kitchen	✓	27. Ease of reach to all the essential elements of the refrigerator from preferred positions	✓
3.An uninterrupted clear floor area in the work triangle between the refrigerator, sink and cooker	✓	28. Close access to cook-top	✓
4. <u>Non-exhausting</u> walking distances (the work triangle) between the refrigerator, sink and cooking surface	✓	29.Ease of reach to all the essential elements of the cook-top from preferred positions	✓
5.An adequate clearance at three sides of the dining table	–	30.Close access to the oven	✓
Category 2. Cabinets and storage areas		31.Ease of reach to all the essential elements of the oven from preferred positions	✓
6.Close access to the cabinets	✓	32.Close access to dishwasher	✓
7.Ease of reach to the low portions of the base cabinets	✓	33. Ease of reach to all the essential elements of the dishwasher from preferred positions	✓
8.Ease of reach to the high portions of the wall cabinets	✓	34.Close access to the hood	–

9.Ease of use of the rear portions of the base cabinets	✓	35.Ease of reach to all the essential elements of the hood from preferred positions	–
10.Ease of use the rear portions of the wall cabinets	✓	Category 5. Sink and faucets	
11.Cabinets having pull-out shelves	–	36. Close access to the sink	✓
12.Effective and efficient use of corner cabinets by 360° rotating mechanisms/lazy-susan units/moon swing-out shelves	–	37. Use of the sink without uncomfortable postures	✓
13.Removable base cabinet doors	–	38. Ease of reach to the faucets from preferred positions	✓
14.Use of the cabinet door handles with low effort	✓	Category 6. Illumination	
15. Use of the drawers and its contents without uncomfortable postures	✓	39.Adequate natural light in the kitchen	✓
Category 3. Counters/ work surfaces		40.Adequate artificial light in the kitchen	✓
16. Close access to the counter	✓	41.Adequate illumination levels over the working surfaces	✓
17. An appropriate counter height	✓	42.Adequate illumination levels above the cook-top	–
18. Use of the whole surface of the counter without uncomfortable postures	✓	Category 7. Materials	
19. Counters at various heights	–	43.A colour contrast between floor and counter material	–
20. Pull-out work surfaces	–	44.A heat-resistant counter top material	–
21. An appropriate counter space on at least one side of the refrigerator	✓	45.A durable floor material	–
22. An appropriate counter space on at least one side of the cooking surface	✓	46.An easy-care floor material	–
23. An appropriate counter space on at least one side of the same level as the rack	✓	47. A slip-resistant floor material	–
24. An appropriate counter space on at least one side of the sink	✓		
25. Rounded edges on the counter	✓		

Design Assessment Sheet, Group B			
The Principles of Universal Design (The Center for Universal Design, 1997, version 2.0 (4/1/97))			
1. Equitable Use	The design is useful and marketable to people with diverse abilities	✓	
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities.	–	
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	✓	
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	✓	
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.	–	
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue.	✓	
7. Size and space for approach and use	Appropriate size and space <u>is</u> provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	✓	
The 47 kitchen needs of diverse user groups (adapted from Afacan & Demirkan, 2010)			
Category 1. Circulation		Category 4. Appliances	
1.Ease of moving/maneuvering in the kitchen.	✓	26. Close access to the refrigerator	✓
2.An adequate clear floor area if more than one person using the kitchen	✓	27. Ease of reach to all the essential elements of the refrigerator from preferred positions	✓
3.An uninterrupted clear floor area in the work triangle between the refrigerator, sink and cooker	✓	28. Close access to cook-top	✓
4. <u>Non-exhausting</u> walking distances (the work triangle) between the refrigerator, sink and cooking surface	✓	29.Ease of reach to all the essential elements of the cook-top from preferred positions	✓
5.An adequate clearance at three sides of the dining table	–	30.Close access to the oven	–
Category 2. Cabinets and storage areas		31.Ease of reach to all the essential elements of the oven from preferred positions	–
6.Close access to the cabinets	✓	32.Close access to dishwasher	✓
7.Ease of reach to the low portions of the base cabinets	✓	33. Ease of reach to all the essential elements of the dishwasher from preferred positions	✓
8.Ease of reach to the high portions of the wall cabinets	–	34.Close access to the hood	–

9.Ease of use of the rear portions of the base cabinets	✓	35.Ease of reach to all the essential elements of the hood from preferred positions	–
10.Ease of use the rear portions of the wall cabinets	✓	Category 5. Sink and faucets	
11.Cabinets having pull-out shelves	✓	36. Close access to the sink	✓
12.Effective and efficient use of corner cabinets by 360° rotating mechanisms/lazy-susan units/moon swing-out shelves	–	37. Use of the sink without uncomfortable postures	✓
13.Removable base cabinet doors	–	38. Ease of reach to the faucets from preferred positions	✓
14.Use of the cabinet door handles with low effort	✓	Category 6. Illumination	
15. Use of the drawers and its contents without uncomfortable postures	✓	39.Adequate natural light in the kitchen	–
Category 3. Counters/ work surfaces		40.Adequate artificial light in the kitchen	–
16. Close access to the counter	✓	41.Adequate illumination levels over the working surfaces	–
17. An appropriate counter height	✓	42.Adequate illumination levels above the cook-top	–
18. Use of the whole surface of the counter without uncomfortable postures	✓	Category 7. Materials	
19. Counters at various heights	–	43.A colour contrast between floor and counter material	–
20. Pull-out work surfaces	–	44.A heat-resistant counter top material	–
21. An appropriate counter space on at least one side of the refrigerator	✓	45.A durable floor material	–
22. An appropriate counter space on at least one side of the cooking surface	✓	46.An easy-care floor material	✓
23. An appropriate counter space on at least one side of the same level as the rack	✓	47. A slip-resistant floor material	–
24. An appropriate counter space on at least one side of the sink	✓		
25. Rounded edges on the counter	–		

Design Assessment Sheet, Group C			
The Principles of Universal Design (The Center for Universal Design, 1997, version 2.0 (4/1/97))			
1. Equitable Use	The design is useful and marketable to people with diverse abilities	–	
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities.	✓	
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.		
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	✓	
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.	✓	
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue.	✓	
7. Size and space for approach and use	Appropriate size and space <u>is</u> provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	✓	
The 47 kitchen needs of diverse user groups (adapted from Afacan & Demirkan, 2010)			
Category 1. Circulation		Category 4. Appliances	
1. Ease of moving/maneuvering in the kitchen.	✓	26. Close access to the refrigerator	✓
2. An adequate clear floor area if more than one person using the kitchen	✓	27. Ease of reach to all the essential elements of the refrigerator from preferred positions	✓
3. An uninterrupted clear floor area in the work triangle between the refrigerator, sink and cooker	✓	28. Close access to cook-top	✓
4. <u>Non-exhausting</u> walking distances (the work triangle) between the refrigerator, sink and cooking surface	✓	29. Ease of reach to all the essential elements of the cook-top from preferred positions	–
5. An adequate clearance at three sides of the dining table	✓	30. Close access to the oven	✓
Category 2. Cabinets and storage areas		31. Ease of reach to all the essential elements of the oven from preferred positions	✓
6. Close access to the cabinets	✓	32. Close access to dishwasher	✓
7. Ease of reach to the low portions of the base cabinets	✓	33. Ease of reach to all the essential elements of the dishwasher from preferred positions	✓
8. Ease of reach to the high portions of the wall cabinets	–	34. Close access to the hood	–

9.Ease of use of the rear portions of the base cabinets	✓	35.Ease of reach to all the essential elements of the hood from preferred positions	–
10.Ease of use the rear portions of the wall cabinets	✓	Category 5. Sink and faucets	
11.Cabinets having pull-out shelves	–	36. Close access to the sink	✓
12.Effective and efficient use of corner cabinets by 360° rotating mechanisms/lazy-susan units/moon swing-out shelves	✓	37. Use of the sink without uncomfortable postures	✓
13.Removable base cabinet doors	✓	38. Ease of reach to the faucets from preferred positions	✓
14.Use of the cabinet door handles with low effort	✓	Category 6. Illumination	
15. Use of the drawers and its contents without uncomfortable postures	✓	39.Adequate natural light in the kitchen	–
Category 3. Counters/ work surfaces		40.Adequate artificial light in the kitchen	–
16. Close access to the counter	✓	41.Adequate illumination levels over the working surfaces	–
17. An appropriate counter height	✓	42.Adequate illumination levels above the cook-top	–
18. Use of the whole surface of the counter without uncomfortable postures	✓	Category 7. Materials	
19. Counters at various heights	–	43.A colour contrast between floor and counter material	–
20. Pull-out work surfaces	–	44.A heat-resistant counter top material	✓
21. An appropriate counter space on at least one side of the refrigerator	✓	45.A durable floor material	✓
22. An appropriate counter space on at least one side of the cooking surface	✓	46.An easy-care floor material	✓
23. An appropriate counter space on at least one side of the same level as the rack	✓	47. A slip-resistant floor material	✓
24. An appropriate counter space on at least one side of the sink	✓		
25. Rounded edges on the counter	✓		

Design Assessment Sheet, Group D			
The Principles of Universal Design (The Center for Universal Design, 1997, version 2.0 (4/1/97))			
1. Equitable Use	The design is useful and marketable to people with diverse abilities	✓	
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities.	✓	
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	✓	
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	–	
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.	✓	
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue.	✓	
7. Size and space for approach and use	Appropriate size and space <u>is</u> provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	✓	
The 47 kitchen needs of diverse user groups (adopted from Afacan & Demirkan, 2010)			
Category 1. Circulation		Category 4. Appliances	
1.Ease of moving/maneuvering in the kitchen.	✓	26. Close access to the refrigerator	✓
2.An adequate clear floor area if more than one person using the kitchen	✓	27. Ease of reach to all the essential elements of the refrigerator from preferred positions	✓
3.An uninterrupted clear floor area in the work triangle between the refrigerator, sink and cooker	–	28. Close access to cook-top	✓
4. <u>Non-exhausting</u> walking distances (the work triangle) between the refrigerator, sink and cooking surface	–	29.Ease of reach to all the essential elements of the cook-top from preferred positions	✓
5.An adequate clearance at three sides of the dining table	✓	30.Close access to the oven	✓
Category 2. Cabinets and storage areas		31.Ease of reach to all the essential elements of the oven from preferred positions	✓
6.Close access to the cabinets	✓	32.Close access to dishwasher	✓
7.Ease of reach to the low portions of the base cabinets	✓	33. Ease of reach to all the essential elements of the dishwasher from preferred positions	✓
8.Ease of reach to the high portions of the wall cabinets	✓	34.Close access to the hood	✓
9.Ease of use of the rear portions of the base cabinets	✓	35.Ease of reach to all the essential elements of the hood from preferred positions	✓

10.Ease of use the rear portions of the wall cabinets	✓	Category 5. Sink and faucets	
11.Cabinets having pull-out shelves	✓	36. Close access to the sink	✓
12.Effective and efficient use of corner cabinets by 360° rotating mechanisms/lazy-susan units/moon swing-out shelves	–	37. Use of the sink without uncomfortable postures	✓
13.Removable base cabinet doors	–	38. Ease of reach to the faucets from preferred positions	✓
14.Use of the cabinet door handles with low effort	✓	Category 6. Illumination	
15. Use of the drawers and its contents without uncomfortable postures	✓	39.Adequate natural light in the kitchen	–
Category 3. Counters/ work surfaces		40.Adequate artificial light in the kitchen	–
16. Close access to the counter	✓	41.Adequate illumination levels over the working surfaces	✓
17. An appropriate counter height	✓	42.Adequate illumination levels above the cook-top	–
18. Use of the whole surface of the counter without uncomfortable postures	✓	Category 7. Materials	
19. Counters at various heights	–	43.A colour contrast between floor and counter material	–
20. Pull-out work surfaces	–	44.A heat-resistant counter top material	✓
21. An appropriate counter space on at least one side of the refrigerator	✓	45.A durable floor material	✓
22. An appropriate counter space on at least one side of the cooking surface	✓	46.An easy-care floor material	–
23. An appropriate counter space on at least one side of the same level as the rack	–	47. A slip-resistant floor material	✓
24. An appropriate counter space on at least one side of the sink	✓		
25. Rounded edges on the counter	✓		

Appendix G. Descriptive Statistics for Kitchen Survey Results

		Groups														
		Group A (n=3)			Group B (n=3)			Group C (n=3)			Group D (control gr.) (n=3)			User (n=1)		
Design Features	Items	M	SD	M _d	M	SD	M _d	M	SD	M _d	M	SD	M _d	M	M _d	
Circulation	1	3.67	0.58	4.00	2.67	2.08	2.00	5.00	0.00	5.00	3.33	0.58	3.00	5.00	5.00	
	2	4.00	1.00	4.00	4.00	1.00	4.00	4.67	0.58	5.00	4.33	0.58	4.00	4.00	4.00	
	3	4.00	1.00	4.00	4.33	0.58	4.00	5.00	0.00	5.00	4.33	0.58	4.00	4.00	4.00	
	4	3.00	1.00	3.00	4.33	0.58	4.00	5.00	0.00	5.00	2.67	1.15	2.00	4.00	4.00	
	5	3.00	1.00	3.00	4.00	0.00	4.00	4.00	1.00	4.00	4.00	1.00	4.00	3.00	3.00	
	Total	3.53	0.91	4.00	3.87	1.12	4.00	4.73	0.59	5.00	3.73	0.88	4.00	4.00	4.00	0.71
Cabinets and Storage	6	4.00	1.41	4.00	3.67	1.53	4.00	4.00	1.00	4.00	3.67	1.15	3.00	5.00	5.00	
	7	4.33	0.58	4.00	4.00	0.00	4.00	4.33	0.58	4.00	3.00	1.73	2.00	5.00	5.00	
	8	5.00	0.00	5.00	4.33	0.58	4.00	5.00	0.00	5.00	4.67	0.58	5.00	5.00	5.00	
	9	4.00	1.00	4.00	4.00	0.00	4.00	4.33	0.58	4.00	2.67	0.58	3.00	5.00	5.00	
	10	4.00	1.00	4.00	4.00	0.00	4.00	4.67	0.71	5.00	4.00	1.15	5.00	5.00	5.00	
	11	4.00	0.00	4.00	4.00	1.00	4.00	4.50	0.71	4.50	4.33	1.15	5.00	5.00	5.00	
	12	4.00	0.00	4.00	3.67	0.58	4.00	3.33	1.15	4.00	4.00	1.73	5.00	5.00	5.00	
	13	3.67	0.58	4.00	3.33	0.58	3.00	4.00	1.00	4.00	2.00	1.00	2.00	5.00	5.00	
	14	4.33	1.15	5.00	5.00	0.00	5.00	5.00	0.00	5.00	3.33	1.53	3.00	5.00	5.00	
	15	4.33	1.15	5.00	4.33	1.15	5.00	4.33	0.58	4.00	4.33	0.58	4.00	5.00	5.00	
	Total	4.18	0.772	4.00	4.03	0.76	4.00	4.34	0.77	4.00	3.60	1.27	3.50	5.00	5.00	0.00

		Group A (n=3)			Group B (n=3)			Group C (n=3)			Group D (n=3)			User		
Design Features	Items	M	SD	M _d	M	SD	M _d	M	SD	M _d	M	SD	M _d	M	M _d	
<i>Counters and Work surfaces</i>	16	4.00	1.00	4.00	5.00	0.00	5.00	4.33	0.58	4.00	4.33	0.58	4.00	4.00	4.00	
	17	4.67	0.58	5.00	4.00	1.73	5.00	5.00	0.00	5.00	5.00	0.00	5.00	4.00	4.00	
	18	4.67	0.58	5.00	4.33	0.58	4.00	5.00	0.00	5.00	4.67	0.58	5.00	4.00	4.00	
	19	3.33	0.58	3.00	4.00	0.00	4.00	3.67	0.58	4.00	3.33	2.08	4.00	3.00	3.00	
	20	4.00	1.00	4.00	4.33	0.58	4.00	4.33	1.15	5.00	3.00	1.73	4.00	3.00	3.00	
	21	4.33	0.58	4.00	4.67	0.58	5.00	5.00	0.00	5.00	4.33	1.15	5.00	4.00	4.00	
	22	4.67	0.58	5.00	4.67	0.58	5.00	5.00	0.00	5.00	5.00	0.00	5.00	5.00	5.00	
	23	4.33	0.58	4.00	4.67	0.58	5.00	4.67	0.58	5.00	3.67	1.53	4.00	2.00	2.00	
	24	4.67	0.58	5.00	4.67	0.58	5.00	5.00	0.00	5.00	5.00	0.00	5.00	4.00	4.00	
	25	3.33	1.53	3.00	3.33	2.08	4.00	4.00	0.00	4.00	3.33	1.53	3.00	4.00	4.00	
	Total	4.20	0.85	4.00	4.37	0.93	5.00	4.60	0.62	5.00	4.17	1.23	5.00	3.70	4.00	0.82
<i>Appliances</i>	26	3.67	1.53	4.00	3.33	1.15	4.00	4.33	1.15	5.00	4.33	1.15	5.00	5.00	5.00	
	27	4.67	0.58	5.00	4.67	0.58	5.00	4.67	0.58	5.00	5.00	0.00	5.00	4.00	4.00	
	28	4.33	1.15	5.00	3.67	0.58	4.00	4.67	0.58	5.00	5.00	0.00	5.00	5.00	5.00	
	29	4.33	0.58	4.00	4.33	0.58	4.00	4.67	0.58	5.00	5.00	0.00	5.00	5.00	5.00	
	30	4.00	1.00	4.00	3.67	0.58	4.00	4.33	0.58	4.00	5.00	0.00	5.00	5.00	5.00	
	31	4.33	0.58	4.00	4.00	1.00	4.00	4.67	0.58	5.00	5.00	0.00	5.00	4.00	4.00	
	32	4.00	0.58	4.00	4.00	1.00	4.00	4.33	0.58	4.00	4.33	1.15	5.00	3.00	3.00	

		Group A (n=3)			Group B (n=3)			Group C (n=3)			Group D (n=3)			User		
	Items	M	SD	M _d	M	SD	M _d	M	SD	M _d	M	SD	M _d	M	M _d	
	33	4.33	0.58	4.00	4.33	0.58	4.00	4.33	0.58	4.00	4.67	0.58	5.00	3.00	3.00	
	34	4.00	0.00	4.00	3.67	0.58	4.00	4.33	0.58	4.00	4.67	0.58	5.00	4.00	4.00	
	35	4.33	0.58	4.00	4.33	1.15	5.00	4.33	0.58	4.00	4.67	0.58	5.00	3.00	3.00	
	Total	4.20	0.76	4.00	4.00	0.79	4.00	4.47	0.57	4.50	4.77	0.57	5.00	4.10	4.00	0.88
<i>Sink and Faucets</i>	36	4.00	1.00	4.00	4.00	1.00	4.00	4.33	1.15	5.00	4.67	0.58	5.00	4.00	4.00	
	37	4.33	0.58	4.00	4.67	0.58	5.00	4.67	0.58	5.00	4.67	0.58	5.00	4.00	4.00	
	38	4.33	0.58	4.00	3.33	0.58	3.00	5.00	0.00	5.00	4.67	0.58	5.00	4.00	4.00	
	Total	4.22	0.67	4.00	4.00	0.87	4.00	4.67	0.71	5.00	4.67	0.50	5.00	4.00	4.00	0.00
<i>Illumination</i>	39	3.33	1.53	3.00	3.00	1.73	4.00	4.00	0.00	4.00	4.67	0.58	5.00	4.00	4.00	
	40	3.33	1.53	3.00	3.00	2.00	3.00	4.00	1.00	4.00	5.00	0.00	5.00	4.00	4.00	
	41	3.33	1.53	3.00	3.33	1.15	4.00	4.67	0.58	5.00	4.67	0.58	5.00	3.00	3.00	
	42	3.33	1.53	3.00	3.33	1.15	4.00	5.00	0.00	5.00	4.67	0.58	5.00	3.00	3.00	
	Total	3.33	1.30	3.00	3.17	1.34	4.00	4.42	0.67	4.50	4.75	0.45	5.00	3.50	3.50	0.58
<i>Materials</i>	43	2.33	1.15	3.00	2.33	1.15	3.00	3.67	0.58	4.00	2.33	1.53	2.00	3.00	3.00	
	44	3.00	2.00	3.00	3.00	1.00	3.00	4.67	0.58	5.00	4.67	0.58	5.00	3.00	3.00	
	45	4.00	1.00	4.00	4.33	0.58	4.00	4.67	0.58	5.00	4.33	0.58	4.00	3.00	3.00	
	46	4.00	1.00	4.00	4.67	0.58	5.00	4.67	0.58	5.00	4.67	0.58	5.00	3.00	3.00	
	47	4.00	1.00	4.00	5.00	0.00	5.00	4.33	1.15	5.00	5.00	0.00	5.00	5.00	5.00	
	Total	3.47	1.30	3.00	3.87	1.25	4.00	4.40	0.74	5.00	4.20	1.21	5.00	3.80	4.00	0.84

Appendix H. Association Analyses Results

The SPSS Crosstabs for the association between the importance rank given to the universal design features and the number of features used in the universal design process.

Directional Measures				Value	Asymp. Std. Error ^a
groups					
Group A	Ordinal by Ordinal	Somers' d	Symmetric	,621	,129
			Implevel Dependent	,474	,174
			numberofeatures Dependent	,900	,114
Group B	Ordinal by Ordinal	Somers' d	Symmetric	,385	,167
			Implevel Dependent	,250	,205
			numberofeatures Dependent	,833	,152
Group C	Ordinal by Ordinal	Somers' d	Symmetric	-,059	,339
			Implevel Dependent	-,050	,291
			numberofeatures Dependent	-,071	,409
Group D	Ordinal by Ordinal	Somers' d	Symmetric	-,207	,298
			Implevel Dependent	-,167	,253
			numberofeatures Dependent	-,273	,381
Total	Ordinal by Ordinal	Somers' d	Symmetric	,082	,163
			Implevel Dependent	,073	,145
			numberofeatures Dependent	,095	,188

Directional Measures				Approx. T ^a	Approx. Sig.
groups					
Group A	Ordinal by Ordinal	Somers' d	Symmetric	2,630	,009
			Implevel Dependent	2,630	,009
			numberofeatures Dependent	2,630	,009
Group B	Ordinal by Ordinal	Somers' d	Symmetric	1,261	,207
			Implevel Dependent	1,261	,207
			numberofeatures Dependent	1,261	,207
Group C	Ordinal by Ordinal	Somers' d	Symmetric	-,173	,863
			Implevel Dependent	-,173	,863
			numberofeatures Dependent	-,173	,863
Group D	Ordinal by Ordinal	Somers' d	Symmetric	-,657	,511
			Implevel Dependent	-,657	,511
			numberofeatures Dependent	-,657	,511
Total	Ordinal by Ordinal	Somers' d	Symmetric	,504	,615
			Implevel Dependent	,504	,615
			numberofeatures Dependent	,504	,615

The SPSS Crosstabs for the associations between the number of features used in the universal design process and the frequency of sub-themes 5 indicated.

Symmetric Measures

groups				Value	Asymp. Std. Error ^a	Approx. T ^b
1	Ordinal by Ordinal	Gamma	Zero-Order	,263	,368	,709
	N of Valid Cases			7		
2	Ordinal by Ordinal	Gamma	Zero-Order	,412	,337	1,136
	N of Valid Cases			7		
3	Ordinal by Ordinal	Gamma	Zero-Order	,579	,264	2,301
	N of Valid Cases			7		
4	Ordinal by Ordinal	Gamma	Zero-Order	,667	,272	2,575
	N of Valid Cases			7		
Total	Ordinal by Ordinal	Gamma	Zero-Order	,488	,134	3,647
			First-Order Partial	,479		
	N of Valid Cases			28		

Symmetric Measures

groups				Approx. Sig.
1	Ordinal by Ordinal	Gamma	Zero-Order	,478
	N of Valid Cases			
2	Ordinal by Ordinal	Gamma	Zero-Order	,256
	N of Valid Cases			
3	Ordinal by Ordinal	Gamma	Zero-Order	,021
	N of Valid Cases			
4	Ordinal by Ordinal	Gamma	Zero-Order	,010
	N of Valid Cases			
Total	Ordinal by Ordinal	Gamma	Zero-Order	,000
			First-Order Partial	
	N of Valid Cases			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix I. Data Matrix indicating the relationship results of sub-themes 5 and Kitchen Survey for Each Group

GROUP A		47 Kitchen Design Features (adapted from Afacan & Demirkan, 2010)																																																
		Kitchen Design Features																																																
		Design Feature 1 (C)					Design Feature 2 (CS)										Design Feature 3 (CW)										Design Feature 4 (A)										Design Feature 5 (SF)			Design Feature 6 (I)				Design Feature 7 (M)						
Sub-theme 5.		C1	C2	C3	C4	C5	CS6	CS7	CS8	CS9	CS1	CS1	CS1	CS1	CS1	CS1	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35	SF3	SF3	SF3	I39	I40	I41	I42	M4	M4	M4	M4	M4		
5.1.	✓	✓	✓	✓	✓	✗																																												
5.2.	✓																																																	
5.3.	✓						✓	✓	✓	✓	✓	✗	✗	✗	✓	✓																																		
5.4 1.	✓																																																	
5.4 2.	✓																																																	
5.4 3.	✗																																																	
5.5.	✓																✓	✓	✓	✗	✗	✓	✓	✓	✓	✓																								
5.6 1.	✗																									✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓											
5.6 2.	✓																																																	
5.6 3.	✗																																																	
5.7.	✓																																																	
5.8.	✓																																																	
5.9 1	✓																																					✓	✓	✓	✗									
5.9 2	✓																																																	
5.9 3	✓																																																	
5.10	✓																																													✗	✗	✗	✗	✗

GROUP B		47 Kitchen Design Features (adapted from Afacan & Demirkan, 2010)																																														
		Kitchen Design Features																																														
		Design Feature 1 (C)					Design Feature 2 (CS)										Design Feature 3 (CW)										Design Feature 4 (A)										Design Feature 5 (SF)			Design Feature 6 (I)				Design Feature 7 (M)				
Sub-theme 5.		C1	C2	C3	C4	C5	CS6	CS7	CS8	CS9	CS10	CS11	CS12	CS13	CS14	CS15	CW16	CW17	CW18	CW19	CW20	CW21	CW22	CW23	CW24	CW25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35	SF36	SF37	SF38	I39	I40	I41	I42	M43	M44	M45	M46	M47
5. 1.	✓	✓	✓	✓	✓	✗																																										
5.2.	✓						✓	✓	✗	✓	✓	✓	✗	✗	✓	✓																																
5.3.	✓																																															
5.4.1.	✗																																															
5.4.2.	✓																																															
5.4.3.	✗																																															
5.5.	✓																✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✗																					
5.6.1.	✓																										✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✓	✓	✓									
5.6.2.	✗																																															
5.6.3.	✓																																															
5.7.	✓																																															
5.8.	✗																																															
5.9.1	✗																																					✗	✗	✗	✗							
5.9.2	✗																																															
5.9.3	✗																																															
5. 10	✓																																											✗	✗	✗	✓	✗

GROUP C		47 Kitchen Design Features (adapted from Afacan & Demirkan, 2010)																																																	
		Kitchen Design Features																																																	
		Design Feature 1 (C)					Design Feature 2 (CS)										Design Feature 3 (CW)										Design Feature 4 (A)										Design Feature 5 (SF)			Design Feature 6 (I)				Design Feature 7 (M)							
Sub-theme 5.		C1	C2	C3	C4	C5	CS6	CS7	CS8	CS9	CS10	CS11	CS12	CS13	CS14	CS15	CW16	CW17	CW18	CW19	CW20	CW21	CW22	CW23	CW24	CW25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35	SF36	SF37	SF38	I39	I40	I41	I42	M43	M44	M45	M46	M47			
5.1.	✓	✓	✓	✓	✓	✓																																													
5.2.	✓						✓	✓	×	✓	✓	×	✓	✓	✓	✓	✓																																		
5.3.	✓																																																		
5.4.1.	✓																																																		
5.4.2.	✓																																																		
5.4.3.	✓																																																		
5.5.	✓																✓	✓	✓	×	×	✓	✓	✓	✓	✓	✓																								
5.6.1.	×																										✓	✓	✓	×	✓	✓	✓	✓	×	×	✓	✓	✓												
5.6.2.	✓																																																		
5.6.3.	×																																																		
5.7.	×																																																		
5.8.	✓																																																		
5.9.1	×																																							×	×	×	×								
5.9.2	×																																																		
5.9.3	×																																																		
5.10	✓																																											×	✓	✓	✓	✓			

GROUP D		47 Kitchen Design Features (adapted from Afacan & Demirkan, 2010)																																														
		Kitchen Design Features																																														
		Design Feature 1 (C)					Design Feature 2 (CS)										Design Feature 3 (CW)										Design Feature 4 (A)										Design Feature 5 (SF)			Design Feature 6 (I)				Design Feature 7 (M)				
Sub-theme 5.		C1	C2	C3	C4	C5	CS6	CS7	CS8	CS9	CS10	CS11	CS12	CS13	CS14	CS15	CW16	CW17	CW18	CW19	CW20	CW21	CW22	CW23	CW24	CW25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35	SF36	SF37	SF38	I39	I40	I41	I42	M43	M44	M45	M46	M47
5.1.	✓	✓	✓	✕	✕	✓																																										
5.2.	✓						✓	✓	✓	✓	✓	✓	✕	✕	✓	✓																																
5.3.	✓																																															
5.4.1.	✓																																															
5.4.2.	✕																																															
5.4.3.	✓																																															
5.5.	✓																✓	✓	✓	✕	✕	✓	✓	✕	✓	✓																						
5.6.1.	✓																										✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
5.6.2.	✓																																															
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5.9.1.	✓																																					✕	✕	✓	✕							
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Appendix J. Data Analysis Based on the Merrill's First Principles of Instruction

Merrill's First Principles of Instruction	Learning Activities of the Study	Examples of Participants' reflections
<i>Principle 1-Problem/Task centered</i>	Real-word tasks (interview, observation, co-design, role-playing, lecture, design, interview), real kitchen problem, problems of a broken arm person.	<i>Since when you do something standard, you got a UD, but it was a bit more difficult to do it for the user and keep it universal at the same time, we had to think more (S2A).</i>
<i>Principle 2- Activation</i>	Existing knowledge from Empathic design experience, 'Human Factors', 'Construction and Materials', 'Interior Design Studio' courses.	<i>As we learned in 'Human Factors' course, while we are locating the dining area, the circulation and working zone should be separated. If I remembered correct from Human Factors course the sequence of the work should be sink-counter-cooker-counter (S1B).</i>
<i>Principle 3- Demonstration</i>	New knowledge: Empathy map, the role-playing video recording, pictures from empathic design experiences etc.	<i>Empathy mapping was especially useful while starting the design. Since we had something that we could turn to look at when we needed to check our design (S1B).</i>
<i>Principle 4- Application</i>	New knowledge was applied in redesign a kitchen.	<i>Let's locate the oven and dishwasher at the eye level since in the role-playing exercise, I had a trouble and could not bend (S2C)</i>
<i>Principle 5- Integration</i>	Design Process, Co-design, End Products, Group Interview.	<i>In general, we are designing our projects by thinking of the UD principles. For instance, when we get critics, we have a chance to apply them, then we can get critics again. If empathic design understanding is emphasized in the criticism received it may be useful to think about it and take it critical later. I do not know if it should be a separate lesson, but I think it should be one of the topics that needs be discussed in the studio courses (S1B).</i>

