ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

DEVELOPING STUDENT PERFORMANCE IN INDUSTRIAL DESIGN STUDIOS THROUGH SELF-REGULATED LEARNING STRATEGIES

Ph.D. THESIS

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Department of Industrial Design

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ

ENDÜSTRİYEL TASARIM STÜDYOSUNDA ÖĞRENCİ PERFORMANSININ ÖZ DÜZENLEMELİ ÖĞRENME STRATEJİLERİYLE GELİŞTİRİLMESİ

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Aysun ATEŞ AKDENİZ a Ph.D. student of ITU Graduate School student ID 502142906, successfully defended the thesis/dissertation entitled "DEVELOPING STUDENT PERFORMANCE IN INDUSTRIAL DESIGN STUDIOS THROUGH SELF-REGULATED LEARNING STRATEGIES", which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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To my beloved husband and daughter,

FOREWORD

Learning has always been the focus of my pragmatic side, yet during this dissertation, I have learned “to learn”. It has been an enlightening journey in which I have understood the importance of curiosity, commitment, and awareness even more. Hereupon, I hope to encourage people to discover their own way of learning.

Throughout this dissertation, I have received a great deal of support and assistance. I would like to express my gratitude to those who have taken part in my academic journey.

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My special thanks go to my dear daughter, Eylül. Even if she will never remember, I would like to write here as a note for the future. We have overcome many difficulties in this thesis together. She has been the most justified and happy reason for my breaks. I’m thankful for all the sacrifices she has made, albeit unknowingly, during this process. Her presence has been my greatest motivation to improve myself. She is the primary power behind my desire to “learn”. So glad that we have her.

December 2021

Aysun ATEŞ AKDENİZ
(Industrial Designer, M.Sc.)

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ABBREVIATIONS

IBU **:** İstanbul Bilgi University
ID **:** Industrial Design
PBL **:** Problem-based Learning
SRIIDS **:** Self-regulation Intervention in Industrial Design Studio
SRL **:** Self-regulated Learning
SSRL **:** Scale on Self-regulation in Learning

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DEVELOPING STUDENT PERFORMANCE IN INDUSTRIAL DESIGN STUDIOS THROUGH SELF-REGULATED LEARNING STRATEGIES

SUMMARY

Perpetual changes in the world require individuals with deep knowledge and skills to navigate the economy and society, and as a result, the twenty-first century necessitates agency, awareness, and the ability of learners to deal with complex problems. Providing learners with these skills is important at all education levels. Industrial design (ID) studios in universities can facilitate these abilities as they provide students with essential skills and experiences to cope with complex real-world problems that are accepted as key characteristics of design practice. Along with the changing target competencies, self-regulated learning encompassing metacognitive, motivational, and behavioral strategies has attracted much attention in the last four decades due to its contribution to academic skills. These academic skills promote future competencies related to learning strategies. The value of self-regulated learning skills for academic achievement has been shown in different domains. However, the role they play in design studio education has been understudied. This thesis investigated the self-regulated learning strategies in the 3rd-year industrial design studio to improve the design learning process of the industrial design students in the studio regarding self-regulation. Underpinned by the social-cognitive view of self-regulated learning, this study used a two-phase mixed-method research design in which both quantitative and qualitative data collection and analysis methods were utilized. In each step of the research, several research questions were examined, which eventually influenced the overarching research question: How can an efficient design learning environment be designed in terms of SRL strategies to improve students' design performance?

In the first research phase of this thesis, an exploratory research design was conducted to uncover the differences in the use of self-regulated learning strategies and motivational factors between high and low-achieving industrial design students in the 3rd-year industrial design studio course. We applied a convergent mixed methods design with Scale on Self-regulation in Learning (i.e., self-report questionnaire) and semi-structured interviews to gain a comprehensive understanding of students' strategy use. The integrated analysis of quantitative data from 47 industrial design students and qualitative data from 16 industrial design students demonstrated differences between high and low achieving design students' self-regulated learning skills in relation to the use of metacognitive, motivational, and behavioral strategies.

Building on the first phase, in the second research phase of this thesis, an experimental research study was conducted. An intervention study that was developed based on the findings of the first phase was conducted to promote self-regulated learning strategies in an industrial design studio. Similar to the first phase, a convergent mixed-method research design was applied while collecting data from the intervention study through both quantitative (i.e., pre and post-test self-report questionaries, grades of the students, and feedback questionary) and qualitative methods (i.e., semi-structured interviews). The analysis of this phase aimed to explore the impact of the intervention

study on students' design learning process in a design studio, particularly on gaining self-regulated learning skills and design performances of the students. The integrated analysis of the quantitative and qualitative data on self-regulated strategy changes revealed that design students who engaged with an intervention that is aimed at supporting self-regulated learning strategies demonstrate increases in metacognitive strategies (i.e., goal planning, self-monitoring, and self-evaluation); motivational strategies (i.e., self-efficacy, goal orientation, and task value), and behavioral strategies (i.e., seeking information and seeking help). Besides, the quantitative analysis (i.e., grade comparisons) demonstrated that design students who engaged with an intervention that is aimed at supporting self-regulated learning strategies demonstrate increased grades compared to the students who did not engage with the intervention in the same studio class. In brief, the intervention study supporting self-regulated learning strategies in industrial design studios had a developmental effect on students' engagements with some of the self-regulated learning strategies and on their design performances.

Questioning the claims of the learner-centered and constructivist approach to studio education, this study has moved the focus to learner autonomy using a self-regulation approach. The findings helped to understand the variability of students' learning styles and delineate areas of self-regulated learning strategies that should be strengthened to support students – especially underachievers.

The explanatory and experimental studies that were conducted in this dissertation aimed to provide design educators, students, and researchers with a foundation to understand the self-regulated learning strategies in the industrial design studio. Instead of providing instructions with generalizable conclusions, the findings of this dissertation should be read in the light of the research context. The implications are shared to assist with design educators and learners with regards to several facets of teaching, learning, and searching in industrial design education. Besides, with the guidance of the findings, and based on the self-regulated learning theory, a model for the self-regulated learning process regarding the relationship between and within the three design studio actors (i.e., design learner, design project, and design studio) could be proposed. This model suggests that the communication between the actors of the design studio can be regulated through self-regulated learning strategies. In this sense, *experience sharing* as a motivational activity to develop social self-efficacy, *watching self-recordings* as a metacognitive strategy for self-realization of deficiencies, and *meta-studio activities* as a behavioral strategy to strengthen the accessibility of the studio environment were proposed as self-regulated learning activities which can be engaged in the studio process.

To the best of our knowledge, this study is known to be the first to examine SRL strategies quantitatively and qualitatively through SRL intervention in an industrial design studio. Hence, through this study, we anticipate our contribution in two levels. First, by providing insights from design studio education, which is a creativity-focused learning environment with natural learning conditions and simulation of real-life, this study contributes to the education literature. Second, regarding the ongoing deep changes in both educational, theoretical, and practical aspects of design -which is signifying a new order of design and a new generation of designers who tend to become decision-makers- this study fills a gap within the existing body of design pedagogy and instruction in industrial design relative to self-regulated learning. It highlights the importance of students' self-awareness, learning strategy preferences, and motivational aspects in the studio education process. Design studios will not fulfill

their potential to foster SRL skills through the signature pedagogy unless individual student differences are paid attention to. Studio education needs improvement to encourage students to develop their learning skills. The implementation of SRL strategies based on individual differences in design learning environments can help to improve the design performance, especially, of less accomplished students.

ENDÜSTRİYEL TASARIM STÜDYOSUNDA ÖĞRENCİ PERFORMANSININ ÖZ DÜZENLEMELİ ÖĞRENME STRATEJİLERİYLE GELİŞTİRİLMESİ

ÖZET

Sürekli değişen dünya şartları, ekonomiyi ve toplumu yönlendirmek için derin bilgi ve beceriler gerektirmektedir. Dolayısıyla yirmi birinci yüzyıl, farkındalığı ve karmaşık problemlerle başa çıkma becerisi yüksek öğrenenlere ihtiyaç duymaktadır. Öğrencilere bu becerileri kazandırmak tüm eğitim seviyelerinde önemlidir. Yüksek öğrenimde endüstriyel tasarım stüdyo eğitimi, tasarım pratiğinin temel özelliği olan karmaşık ve gerçek problemlerle başa çıkabilme yetisi kazandırabilmesi sebebiyle, ihtiyaç duyulan bu becerileri sağlayabilen nadir disiplinlerdendir. Değişen ve dönüşen yetkinlikler ile, üstbilişsel, motivasyonel ve davranışsal stratejileri kapsayan öz düzenlemeli öğrenme yaklaşımı, akademik becerilere katkısı nedeniyle son kırk yıldır büyük ilgi görmektedir. Bu akademik beceriler, öğrenme stratejileriyle ilgili yetkinlikleri teşvik eder. Akademik başarı için öz düzenlemeli öğrenme becerilerinin değeri farklı alanlarda gözlemlenmektedir. Ancak, tasarım stüdyosu eğitiminde nadiren doğrudan incelenmiştir. Bu tez, endüstriyel tasarım öğrencilerinin öz düzenlemeli öğrenme stratejilerini geliştirmek için 3. sınıf endüstriyel tasarım stüdyosunda öz düzenlemeli öğrenme deneyimini araştırmıştır. Öz düzenlemeli öğrenmenin sosyal-bilişsel bakış açısıyla desteklenen bu çalışmada nicel ve nitel veri toplama ve analiz yöntemlerinin kullanıldığı iki aşamalı karma yöntem araştırma deseni kullanılmıştır. Araştırmanın her adımında çeşitli araştırma soruları kullanılmış ve temel araştırma sorusu olarak "Öğrencilerin tasarım performansını geliştirmek için, öz düzenlemeli öğrenme stratejileri açısından verimli bir tasarım öğrenme ortamı nasıl tasarlanabilir?" sorusu hedeflenmiştir.

Bu tezin ilk araştırma aşamasında, 3. sınıf endüstriyel tasarım stüdyosu dersinde yüksek ve düşük başarılı endüstriyel tasarım öğrencilerinin öz düzenlemeli öğrenme stratejileri kullanımındaki ve onları etkileyen motivasyonel faktörlerdeki farklılıkları incelemek üzere keşfedici araştırma tasarımı uygulanmıştır. Öğrencilerin strateji kullanımı hakkında kapsamlı bilgi elde etmek için Öğrenmede Öz Düzenleme Ölçeği (öz bildirim anketi) ve yarı yapılandırılmış birebir görüşmeler ile paralel karma yöntem tasarımı uygulanmıştır. 47 öğrenciden elde edilen nicel verilerin ve bu öğrencilerin 16'sından elde edilen nitel verilerin bütünleşik analizine göre, yüksek ve düşük başarılı tasarım öğrencilerinin üstbilişsel, motivasyonel ve davranışsal stratejilerin kullanımına ilişkin öz düzenlemeli öğrenme becerileri arasında farklılıklar olduğu ortaya çıkmıştır.

Tezin ikinci araştırma aşamasında deneysel bir araştırma çalışması yapılmıştır. Endüstriyel tasarım stüdyosunda öz düzenlemeli öğrenme stratejilerini teşvik etmek için ilk aşamanın bulgularına dayalı olarak geliştirilen bir müdahale çalışması uygulanmıştır. Birinci aşamaya benzer şekilde, müdahale çalışmasının verileri hem nicel (ön ve son test öz bildirim anketi, öğrenci notları ve geri bildirim soruları) hem

de nitel yöntemlerle (yarı yapılandırılmış birebir görüşmeler) toplanarak paralel karma yöntem araştırma tasarımı uygulanmıştır. Bu aşamanın analizi, uygulanan öz düzenleme müdahalesinin öğrencilerin tasarım öğrenme süreci üzerindeki, özellikle öz düzenlemeli öğrenme becerileri ve tasarım performansları üzerindeki etkisini araştırmayı amaçlamıştır. Nicel ve nitel verilerin bütünleşik analizine göre, stüdyoda öz düzenlemeli öğrenme stratejilerini geliştirmeyi amaçlayan bir etkinliğe katılan tasarım öğrencilerinin üstbilişsel stratejilerinde (hedef planlama, kendini izleme ve öz değerlendirme); motivasyonel stratejilerinde (öz-yeterlik, hedef yönelimi ve göreve verilen değer) ve davranışsal stratejilerinde (bilgi arama ve yardım arama) artış gözlemlenmiştir. Ayrıca, öğrencilerin stüdyodaki performansları üzerinden aldıkları puanlar kullanılarak yapılan karşılaştırmalı nicel analiz göstermiştir ki, stüdyoda öz düzenlemeli öğrenme stratejilerini geliştirmeyi amaçlayan bir etkinliğe katılan tasarım öğrencileri, aynı stüdyoda olup etkinliğe katılmayan öğrencilere kıyasla daha yüksek puanlar elde etmişlerdir. Özetle, endüstriyel tasarım stüdyolarında öz düzenlemeli öğrenme stratejilerini destekleyen müdahale çalışması, öğrencilerin öz düzenlemeli öğrenme stratejilerinin bazılarında ve tasarım performansları üzerinde gelişimsel bir etkiye sahiptir.

Stüdyo eğitiminin öğrenci merkezli ve yapılandırmacı yaklaşım iddiasını sorgulayan bu çalışma, odağı öz düzenleme yaklaşımı kullanarak öğrenen özerkliğine kaydırmaktadır. Çalışmanın bulguları öğrencilerin öğrenme stillerinin değişkenliğini anlamayı sağlamakta ve özellikle stüdyoda başarısız olan öğrencileri desteklemek için güçlendirilmesi gereken öz düzenlemeli öğrenme stratejilerini tanımlamaya yardımcı olmaktadır.

Bu tezde yürütülen bu açıklayıcı ve deneysel çalışmalar, endüstriyel tasarım stüdyosunda öz düzenlemeli öğrenme stratejilerinin anlaşılabilmesi için bir temel sağlamayı amaçlamıştır. Genellenebilir sonuçlar yerine, bu tezin bulguları araştırma bağlamı ışığında okunmalıdır. Çalışma sonucunda endüstriyel tasarım stüdyosunun öğretme, öğrenme ve araştırılma yönleriyle ilgili olarak tasarım eğitimcileri, öğrencileri ve araştırmacıları için çıkarımlar paylaşılmıştır. Ayrıca, bulguların rehberliğinde ve öz-düzenleyici öğrenme teorisine dayalı olarak, üç tasarım stüdyosu aktörü (tasarım öğreneni, tasarım projesi ve tasarım stüdyosu) arasındaki ilişkiye ilişkin öz-düzenleyici öğrenme süreci için bir model önerisi yapılmıştır. Bu modelde, tasarım stüdyosunun aktörleri arasındaki iletişimin öz düzenlemeli öğrenme stratejileri aracılığıyla düzenlenebileceği belirtilmektedir. Bu anlamda, sosyal öz yeterliliği geliştirmeye yönelik motivasyonel bir etkinlik olarak *deneyim paylaşımı,* eksikliklerin fark edilebilmesi için üstbilişsel bir strateji olarak *öz kayıtların izlenmesi* ve stüdyo ortamının erişilebilirliğini güçlendirmeye yönelik davranışsal bir strateji olarak *meta-stüdyo etkinlikleri* stüdyo sürecine dahil edilebilecek öz düzenlemeli öğrenme etkinlikleri olarak önerilmiştir.

Bu çalışmanın endüstriyel tasarım stüdyosunda öz düzenlemeli öğrenme müdahalesi yoluyla öz düzenleme stratejilerini nicel ve nitel yöntemlerle inceleyen ilk çalışma olduğu bilinmektedir. Bu bağlamda çalışmanın literatüre katkıları iki yönden açıklanabilir. İlk olarak, bu tez çalışması doğal öğrenme koşulları ve gerçek hayatın simülasyonu ile yaratıcılık odaklı bir öğrenme ortamı olan tasarım stüdyosu eğitiminden eğitim literatürü için iç görüler sağlamaktadır. İkinci olarak, yeni bir tasarım düzenini ve karar verici olmaya meyilli yeni nesil tasarımcıları ifade eden tasarımın hem eğitimsel hem teorik hem de pratik yönlerinde süregelen derin değişimlerle ilgili olarak, bu çalışma mevcut tasarım pedagojisi bünyesinde ve endüstriyel tasarım öğretiminde öz düzenlemeli öğrenme ile ilgili bir boşluğu

doldurmaktadır. Stüdyo eğitiminde öğrencilerin öz farkındalıklarının, öğrenme stratejisi tercihlerinin ve stüdyodaki motivasyonel etkenlerin önemini vurgular. Tasarım stüdyosu, öğrenci farklılıklarına dikkat edilmediği sürece, imza pedagojisi aracılığıyla öz düzenleme becerilerini geliştirme potansiyelini gerçekleştiremeyecektir. Stüdyo eğitimi, öğrencileri kendi öğrenme becerilerini geliştirmeye teşvik etmek için iyileştirilmelere ihtiyaç duymaktadır. Tasarım öğrenme ortamlarında bireysel farklılıklara ilişkin öz düzenleme stratejilerinin uygulanması, özellikle daha az başarılı öğrencilerin tasarım performansının iyileştirilmesine yardımcı olacaktır.

1. INTRODUCTION

The greatest thing in the world is to know how to be self-sufficient.

— Michel de Montaigne, The Complete Essays

Montaigne's ideas on any subjects and reflections of his experiences can be tracked in his idiosyncratic works and provide an insight into his deeper understandings. He studied himself as the main character of his 'essays'.

Educational studies from several disciplines have focused on the learning process to develop teaching approaches. In other words, similar to Montaigne, education has studied the learner as the main character of its environment since Dewey, Piaget, and Vygotsky's studies during the twentieth century, in which, as Mayer (2008) states, they studied the development of student learning from different perspectives. With the perpetual changes in the world and consequently the shift from the industrial to the information age, the current society demands individuals as learners with deep knowledge and flexible and adaptive skills. Twenty-first-century competencies defined by organizations such as the Organisation for Economic Co-operation and Development (OECD), World Economic Forum, and the United Nations Educational, Scientific and Cultural Organization (UNESCO) concur regarding the need for agency, awareness, and ability of learners to deal with complex problems (Rieckmann, 2018; Schleicher, 2018; World Economic Forum, 2020). Providing learners with these skills are important at all education levels.

Industrial design (ID) studios in universities can facilitate these abilities as they provide students with essential skills and experiences to cope with complex real-world problems that are accepted as key characteristics of design practice. Placing the teacher among the students in the studio both physically and procedurally, the design studio creates a learner-centered learning environment and aims to develop students designing abilities through design activities and critical conversations on the outcomes. Therefore, design learning in the studio demands an intent cognitive process with intense social interaction.

Along with the changing target competencies, self-regulated learning (SRL) – representing metacognitive, motivational, and behavioral strategies within a social-cognitive learning perspective– has attracted much attention in the last four decades due to its contribution to academic skills (Zimmerman, 1989b, 2008). These academic skills promote future competencies related to learning strategies. While some studies indicate that design studio education fosters SRL skills (e.g., Greene et al., 2019), SRL strategies in ID studios remain under-studied. This dissertation aims to identify the dynamics of SRL in the industrial design studio to improve design studio education regarding self-regulation.

This chapter introduces the study by first discussing the background and context, followed by the significance of the study, its research aims and objectives as well as the research questions. The chapter concludes with outlining the structure of the thesis.

1.1 Background to the Study

Designing is a multidimensional activity that aims to identify and solve ill-defined problems (Eastman, 1968; Simon, 1973). It usually starts with a basic project brief in which the conditions, needs, or restrictions about the subject are outlined. And finally, this written text transforms into an experiential or tangible output. This transformation requires a high-level cognitive process including several stages of information analysis and synthesis (Lawson, 1980). While designing involves a variety of deep-thinking processes and tacit knowledge, learning to design requires relatively more complex processes since it is more open to the impact of various internal and external factors in a learning environment like a design studio. Besides, technological, social, economic, and environmental changes in the world effectively cause a change in both teaching and learning principles and practices. Contemporary design education is struggling to keep pace with the rapid evolution of the field (Meyer & Norman, 2020). Instead of depending solely on the transfer of tacit knowledge through a relationship between instructor and student as Stoltermen (1994) and later on Meyer and Norman (2020) criticize, design studio education needs more supportive instructional methods for the construction of tacit knowledge, since learning to deal with complex problems requires advanced knowledge levels (Ertmer & Newby, 2013). Even though there is an assumption that learning in the studio promotes knowledge construction (Venkatesh

& Ma, 2021), the tacit and ambiguous form of the studio's instructional content might lead to confusion amongst novice students (Ledewitz, 1985). Design education has used a student-centered lens since Schön's concept of the 'reflective practitioner' was incorporated into studio education (Iftikhar et al., 2018). However, to maintain student-centeredness, learner characteristics should also be considered and monitored for personal and social transformation (Thompson, 2020). Taking learner characteristics into account creates space for students to acknowledge their agency in shaping their learning process. Therefore, learner-oriented guidance can advance design learning in the studio, especially for underperformers. Hence, this thesis questions the claims of the learner-centered and constructivist approach to studio education, moving the focus to learner autonomy using a self-regulation approach.

Self-regulated learning (SRL), which refers to a student's self-generated thoughts, strategies, and goal-directed behaviors (Schunk & Zimmerman, 1998), is a crucial learning ability in our fast-changing society in which students must take an active role in their learning processes metacognitively, motivationally, and behaviorally (Zimmerman, 2000). Although there is not a universal definition of SRL, scholars agree that self-regulated learners are those who have a purpose/goal, utilize goal-directed acts, observe themselves and regulate their attitudes for achievement (Schunk, 1982). Greene (2018) draws attention to the fact that self-regulation is studied in the field of education in two ways: formal and informal education areas. While the first refers to self-regulated processes of informal educational environments that focus on goals that enable academic development, the other includes self-regulated processes that can be sustained cognitively and motivationally in the face of difficulties (for example, to lose weight or save money, or establish positive social relationships). The design studio is at the intersection of these two areas because it is a social learning environment and relationships play a far more influential role than other learning environments since the learning process mostly depends on the conversation with the instructors.

Self-regulated learning has been found to improve learning and performance in a wide range of academic subjects, including medicine, engineering, and business, particularly when dealing with complicated, uncertain problems (Powers & Miller, 2008). Although there are some studies which indicate that SRL is already promoted (Greene et al., 2019), or is employed to some degree in design studios (Powers, 2006;

2016), little is known about how SRL reveals itself in terms of learning strategies employed by design students.

Motivated by observations during years of experience in industrial design studio education, we have taken on the task to explore the reasons for differences in students' design performances. Remembering and considering our personal experience of being a design student, we aimed to find an educational basis in the literature regarding the psychology of design learning. Hence, the primary goal of this thesis is to provide new information that fills the gap about learning strategies in the existing body of knowledge in industrial design studio education to qualify the learning process.

1.2 Significance of the Study

Design studios as learning environments generate many challenges for design students. A growing number of scholars have studied educational and pedagogical aspects in design studios for decades. However, up to now, far too little attention has been paid to the efficiency of the design performance of students from the point of educational learning theories. This points at a need to understand the various factors that impact design learning in the design studio. Therefore, design students' learning experience in the studio is a proper starting point to understand the personal, behavioral, and environmental factors affecting design performance. In this sense, a self-regulated learning approach that includes these three types of factors is a promising avenue. Student self-regulation has been proven to be critical to students' motivation, achievement, and learning over the past two decades of research (Zimmerman, 2000). Furthermore, it is obvious that design students are already expected to be self-regulated since the design process highly depends on the student's self-performance in the studio. With this motivation, this thesis study examines SRL strategies in an industrial design studio to find out how design students operate self-regulated learning strategies for their design learning and performance during their studio projects. It further develops an intervention study to promote SRL in the design studio process, especially for underperforming students.

This thesis is significant for the reasons listed below:

- This thesis provides insights for education literature via presenting findings from design studio education, which is a creativity-focused learning environment with a natural learning condition and simulation of real-life.
- Taking into consideration the ongoing deep changes in both educational, theoretical and practical sides of design -which is signifying a new order of design and a new generation of designers who tend to become decision-makers- this thesis fills a gap within the existing body of design pedagogy and instruction in industrial design relative to self-regulated learning.
- This dissertation examines the industrial design studio using both explorative and experimental research within the theoretical perspective of self-regulated learning from a social-cognitive view.
- In this thesis, for the first time, industrial design students were examined by assessing their use of self-regulated learning strategies on design projects through mixed-method research in which both quantitative and qualitative data collection and analysis methods were used.
- Furthermore, for the first time, an industrial design studio was used as a learning environment for an intervention study to promote self-regulated learning strategies.
- The findings of this thesis address some of the growing needs in higher education, such as the skills for students to be aware of and responsible for their learning.
- Within educational studies, design-based research is a very popular subject. In this thesis, the process of designing a learning environment from the point of industrial design discipline is a unique approach, and it provides a different point of view and create new knowledge in the area of SRL.

1.3 The Research Aims, Objectives, and Questions

Given the lack of research regarding SRL in design studio education, this thesis aims to identify and evaluate SRL strategies utilized by the students and develop SRL skills through an intervention study in the third-year industrial design studio in the Department of Industrial Design at Istanbul Bilgi University in Turkey.

Within the framework of this aim, the objectives of this dissertation are presented as follows:

- To identify the differences in the use of SRL strategies among industrial design students according to academic achievement levels
- To identify how industrial design students perceive their studio experience
- To evaluate the impacts of promoting SRL strategies to the industrial design students during the studio course regarding the use of SRL strategies
- To evaluate the impacts of promoting SRL strategies to the industrial design students during the studio course regarding design performance
- To revise and refine industrial design education policies in terms of individual differences between students and their awareness of their learning process
- To discuss how design education can benefit from SRL theories and approaches
- To promote self-regulated learning skills of design students to make them telic designers

With these objectives, this thesis is framed within the formal undergraduate industrial design education. Based on these aims and objectives, five research questions with five sub-questions were formulated to guide this thesis:

R.Q.1. What is the level of reported use of SRL among industrial design learners before participating in SRL based learning environment in a design studio?

R.Q.1-a. Are there meaningful differences between the SRL skills and motivation of ID students with different academic achievement levels?

R.Q.1-b. What are the SRL skills frequently used by ID students with different academic achievement levels?

R.Q.1-c. What is the correlation level between self-regulation and motivation levels?

R.Q.1-d. How do high and low-achieving ID students perceive their own studio course experiences?

R.Q.1-e. To what extent do qualitative and quantitative results converge and/or diverge?

R.Q.2. To what extent does SRL-based studio affect design learners' reported use of SRL strategies in their design learning?

R.Q.3. What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?

R.Q.4. How does students' self-regulation influence their design performance?

R.Q.5. How can an efficient design learning environment be designed in terms of the SRL strategies to improve students' design performance?

1.4 Thesis Structure

This thesis is structured in six chapters: Introduction, Literature Review, Phase1 Exploratory Study, Phase 2 Experimental Study, Findings and Discussions, Conclusions and Recommendations. An overview of this dissertation's structure will be provided in this section. Figure 1.1 illustrates the process that was used to accomplish the research questions.

Chapter 1 discusses the background and context of the study, followed by the significance of the study and research aims and objectives of the study including the research questions.

Chapter 2 provides a clear base for the intersections of self-regulation and design studio education literature through selective reference to some of the relevant and contemporary studies and sources. This chapter is divided into two main sections. In the first section, self-regulated learning theory including its social-cognitive learning roots, processes, and strategies is explored. The relationship between academic achievement and assessing and developing techniques of SRL skills is discussed, subsequently. In the second section, design studio education is discussed from two perspectives: the pedagogical structure affecting design teaching (i.e., signature pedagogy) and the actors of the design learning process in the studio (i.e., learner, project, and studio). In the remainder of the chapter, a discussion of the relations between SRL and design studio is disclosed through existing related studies.

Chapter 3 describes the exploratory phase of this dissertation in three sections. In the first section, key features of the research methodology are explained including data collection and data analysis. The second section discusses the findings of the exploratory study including integrated analysis. The last section presents the discussion of the findings for this chapter.

Chapter 4 reveals how the experimental study in the second phase of this dissertation is designed and conducted in four sections. The first one explains the methodology of the experimental research. The second section reveals information about the intervention including the development of the content. In the third section, the implementation of the intervention study including the information about settings, participants, and procedure is exposed. The last section discusses the evaluation of the intervention study involving quantitative and qualitative data collection, measures, analysis, and findings.

Chapter 5 describes and discusses the integration process of the quantitative and qualitative data of the experimental study and major findings of the study under the relevant research questions. It also presents the content of the intervention study and the findings of the first phase of this dissertation.

Chapter 6 summarizes the study findings, recommends some implications resulting from the findings, proposes a model for self-regulated learning in the industrial design studio, and discusses the limitations of the study. The recommendations are shared for design educators and learners in relation to several facets of teaching, learning, and searching in industrial design education.

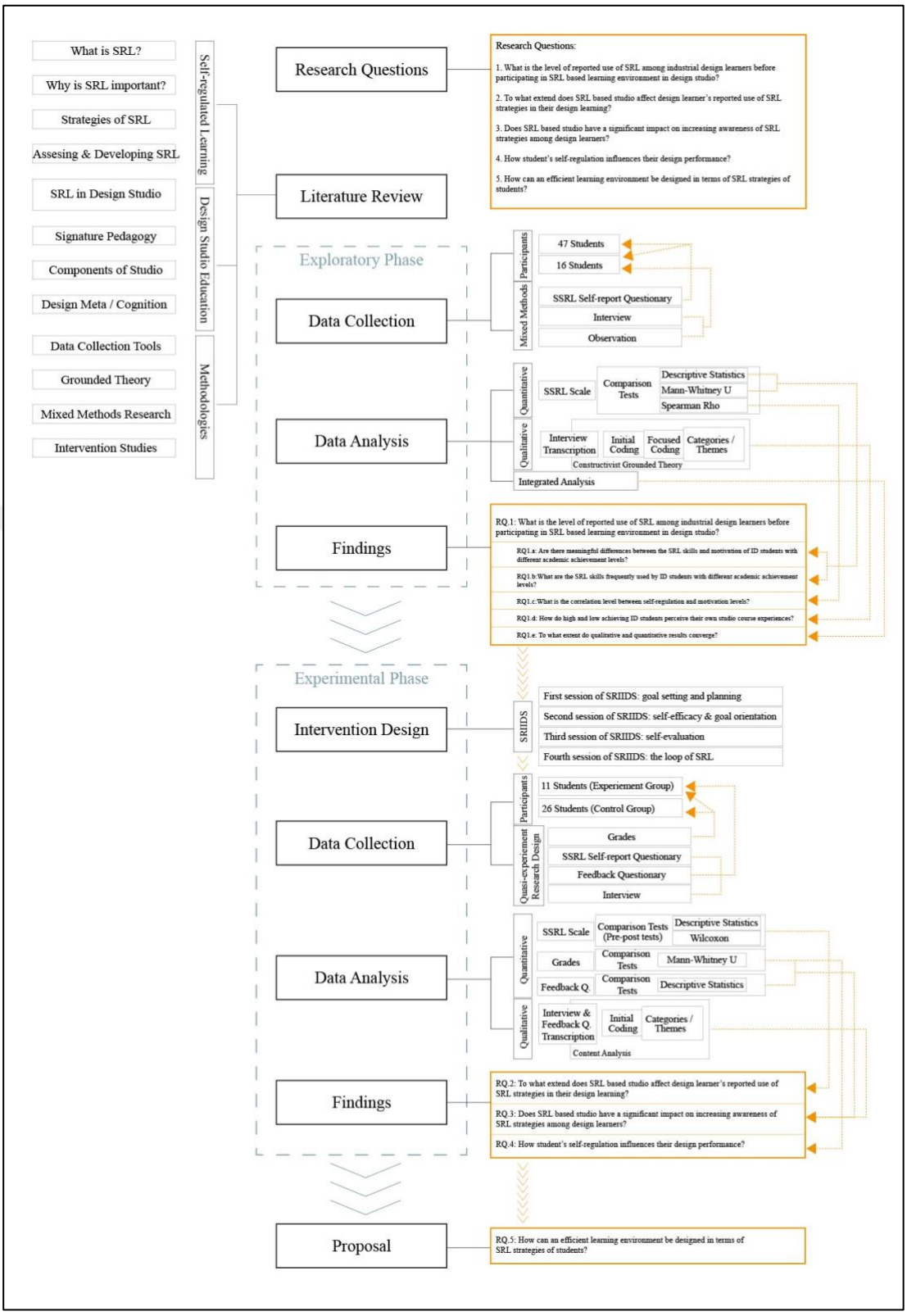

Figure 1.1 : Research overview.

2. REVIEW OF RELEVANT LITERATURE

This chapter aims to provide a clear base for the intersection of self-regulation and design studio education through relevant and contemporary studies and sources from the literature. The chapter is divided into two sections. The first section provides an understanding of the self-regulated learning theory, disclosing its strategies and processes. The relationship between academic achievement, and in relation to that assessing and developing techniques of SRL skills are explored, respectively. The subject of the second section is the pedagogical aspect of design studio education. The components of design learning in the studio are outlined. The remainder of the chapter is devoted to a discussion of the relations between SRL and design studios through existing literature.

2.1 Self-regulated Learning and Social Cognitive Theory

Self-regulation consists of cyclical thoughts, feelings, and attitudes that are developed by the individuals to reach their goals (Zimmerman, 2000). A growing body of literature has investigated self-regulated learning since 1980. Schunk (2014, as cited in Sakız, 2014) categorizes the historical development of SRL studies into three eras; the developmental era in which theories are developed through research until the 1990s; the intervention era in which researchers inquire the variables of SRL and its relationship with academic achievement until the 2000s, and the processing era in which deeper investigations on cyclical and dynamic SRL process have been conducted until today. Today, emergent trends in digitalization provide the education and psychology circles with a link between assessment, interventions, and use of technology (Bembenutty et al., 2013). Within the various theories on self-regulation (e.g., behavioral, information processing, social constructivism, social cognitive, and others) Bandura's studies and Zimmerman's implementations with social cognitive approach appear to be the most well-known, the most cited (Oz, 2019), and most commonly used theory in the literature. It is the focus of this section to provide a

review of the SRL literature regarding the social cognitive view with its factors and processes.

Social cognitive theory is the theory that has introduced self-regulation to education literature. This theory defines learning as behavioral potential which occurs through experience (Schunk, 2001) and positions the learner as the subject of the learning process (Zimmerman, 2001). The triadic reciprocal determinism is the basic principle of social-cognitive theory, according to which, personal factors, the environment one is in, and behavior exhibited by the person mutually affect each other and determine the resulting behavior of the individual (Bandura, 1986). The direction of the relationship between these three factors changes due to the individuals, activities, and circumstances (Bandura, 1997). Linked to this theory, self-regulation is not a characteristic feature, on the contrary it depends on the condition and occasional structures (Schunk, 2001). Figure 2.1 depicts the triadic relations between personal, behavioral, and environmental self-regulation. Self-regulated people observe themselves and regulate individual performance with the help of strategies (behavioral regulation); observe environmental conditions with the outputs and regulate accordingly (environmental regulation); observe their cognitive and affective processes implicitly and regulate accordingly (covert regulation) (Zimmerman, 2000). The theoretical framework that Bandura proposes for self-regulation has a process-oriented approach (Wirth & Leutner, 2008), which focuses on the actions and events that enable self-regulating and examines what the person did or should do during these actions (Ader, 2014). The interaction between personal, behavioral, and environmental processes is constantly intertwined; at any one time, one or more of these elements may exert a greater effect than the others (Thomas, 2013). Hence, a different learning environment can cause a learner's SRL skills to alter, therefore they should be expressly encouraged in the development of SRL abilities. Design studio as a learning environment with more process-oriented and collaborative facilities needs to consider the relationship between students and the context. A social-cognitive perspective provides a design studio learning environment with an appropriate foundation to consider the learner’s varying internal and external factors.

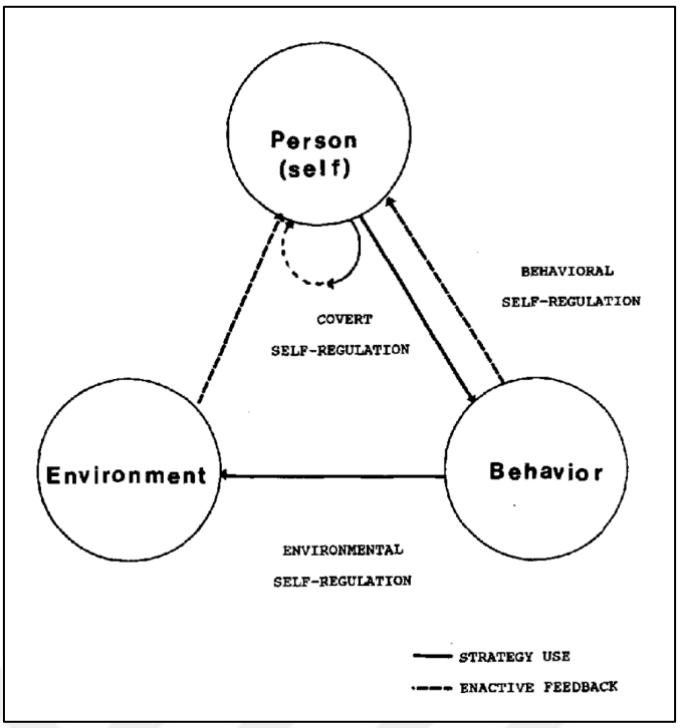

Figure 2.1 : The triadic analysis of self-regulated functioning. From "Social Cognitive View of Self-Regulated Academic Learning" by Zimmerman, 1989.

In this review, no attempt has been made to provide an analysis of all SRL theories or models and the advantages of each. Rather, we employ Zimmerman's (2000) model which was developed based on social-cognitive theory to show how design learning in the studio might be included in the SRL framework. We selected this model for several reasons which will be explained in the following section.

2.2 Zimmerman's Model of Self-regulated Learning

Multiple SRL models have been proposed based on different theoretical perspectives during the last four decades in the literature. For example, Model of Adaptable Learning by Boekaerts (1991) integrates cognitive, motivational, personal and situational factors. Pintrich (2000), with his study on General Framework for SRL, investigates forethought, monitoring, control and reflection phases. Winne and Hadwin (1998) proposes Four-stage Model of Self-regulated Learning aiming task definition, goal setting and planning, stimulating strategies, and metacognitive study techniques. Social Cognitive Model of Self-regulation developed by Zimmerman (1989a, 1990, 2000) emphasizes personal, behavioral and environmental aspects. Although there are differences between models, there is a significant overlap between the core concepts and processes that underlie them. A common feature of these models

is that students use different activities, skills, or strategies to control and regulate their learning (Jansen et al., 2019; Schunk & Zimmerman, 1994; Zimmerman & Schunk, 2011). Panadero's (2017) comparison of the four established models (i.e., Pintrich's (2000), Zimmerman's (1989a), Boekaerts' (1991), and Winne and Hadwin's (1995) models assert that Zimmerman's model has been more commonly used because of its more specific subprocesses that provide researchers with a comprehensive vision. Within the scope of social cognitive theory, Bandura (1986) and Zimmerman (1989a, 2000) define self-regulation as interaction within personal, behavioral, and environmental factors. In learning environments, the changes in these factors necessitate the regulation of the learner (Zimmerman, 1989a; Zimmerman & Cleary, 2009). The environmental and contextual aspects that influence learning regulation throughout a task are more prominent in social cognitive theories (Bandura 1986; Zimmerman 2000). Therefore, Zimmerman's model as a social cognitive model may prove to be more helpful when researching creative tasks or processes in different learning environments (Rubenstein et al., 2018).

Although their focus is different, all models refer to self-regulation as a phenomenon that includes certain processes (such as preparation, realization, and post-evaluation) and occur in different dimensions (cognitive, metacognitive, motivational, behavioral, among others) (Sakız & Yetkin-Özdemir, 2014). According to Schunk and Usher's (2013, as cited in Sakız, 2014) explanation on Zimmerman's model, it is the best example where both process and component-oriented classifications co-exist in one approach. According to this approach, students who self-regulate their own learning process are active in their learning using metacognitive, behavioral, and motivational strategies and they proceed through three cyclical phases: forethought, performance, and reflection phases (Zimmerman, 1986, 2002). In the following sections, we give a general overview of the three-phase process and then describe the components and strategies used during the SRL process.

2.2.1 Self-regulated learning process

The nature of the self-regulatory process is perceived by social cognitive learning scholars in terms of cyclical steps (Zimmerman, 2002). In his three-phase SRL model, Zimmerman (2000) expands the notion of student's feedback loop which is a central feature of academic learning that includes the phases of forethought (before the study),

performance (during study), and self-reflection (after study) (Zimmerman & Clearly, 2009). Each phase covers a set of procedures that a person may employ when seeking to learn, improve, or perform a skill; and is supposed to impact (or feed) the next phases (Rubenstein et al., 2018) As depicted in Figure 2.2, the model has multiple sub-processes with significant correlations in between (Zimmerman, 2008).

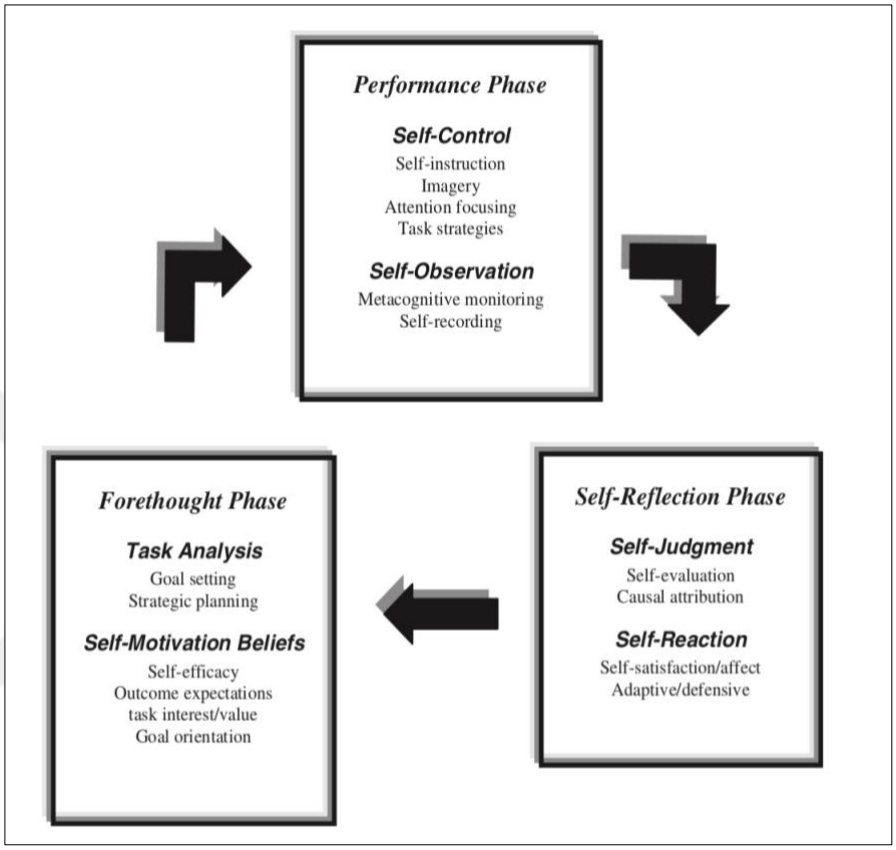

Figure 2.2 : Phases and subprocesses of self-regulation (Zimmerman and Campillo, 2003).

In the context of this dissertation, the three-phase model of SRL was employed to develop the content of the intervention sessions (see section 4.2.3). The exploratory and experimental studies were conducted focusing on the dimensions and strategies of the SRL process particularly. To present a relevant review on the model, the features of each phase will be briefly discussed in relation to the design studio conditions in the following sub-sections.

Forethought Phase

Students' preparedness and willingness to self-regulate their learning are influenced by the forethought phase, which pertains to proactive learning processes and sources of motivation that occur before attempts to learn (Zimmerman & Moylan, 2009). The

forethought phase consists of cognitive processes for analyzing the task and motivational condition of the learners that prepare them for action. In this phase, especially goal setting and planning are the key starting points, since the students decide on their acts and expectations of the consequence (Sakız & Yetkin-Özdemir, 2014). Defining goals also lead the students to evaluate their abilities to accomplish the task, which is defined as *self-efficacy* by Bandura (1986). In this sense, self-motivational factors have also a counter effect on the goals and strategies of the learners (Zimmerman, 2000). In the design studio, students who come from an exam-oriented learning experience encounter a more student-centered and constructivist learning environment, which focuses on learning by doing and collaboration. This confrontation causes some students to question and doubt their abilities. To start the SRL cycle, design students need explicit explanations and feedback on the why and how of the design process. Through this guidance, they can realize their own expectations, define personal goals, and increase self-motivation to proceed forward in the loop.

Performance Phase

The performance phase includes cognitive strategies which affect concentration and performance during the learning actions (Zimmerman & Moylan, 2009). Self-regulated learners are expected to monitor their progress, regulate their strategies, and use their resources as efficiently as possible (Jansen, 2019). Self-control, one of the sub-processes in the model, indicates the arrangement of the strategies employed in the first phase. Self-observation, the first of three self-regulatory processes in Bandura's (1986) study, has a critical role in this phase since it is required for personal feedback. Zimmerman and Moylan (2009) discuss the two forms of self-observation: self- (or metacognitive) monitoring and record-keeping. Self-monitoring refers to mental tracking of particular aspects of performance, and record-keeping refers to tangible records on one's performance (Zimmerman and Moylan, 2009). Keeping a design logbook (e.g., via drawing) is one of the requirements in a design studio. However, this can be frustrating for some students who do not know how to do it or who feel discouraged to create such an output. In this sense, allowing and encouraging students to use different recording tools according to their capabilities ought to be helpful in developing student agency in the design studio. Therefore, design students can track their mental process efficiently, have a chance to engage their ideas deeply,

develop ideas progressively and have a medium to criticize their work by themselves when they use recordings.

Self-Reflection Phase

The reflection phase refers to the reactions and responses to the learning activities. The learners compare their performance with their previous criteria and regulate their attitudes accordingly (Zimmerman, 2000). The self-reflection phase consists of two sub-processes: self-judgment and self-reaction (Zimmerman, 2002). Comparisons of self-observed performances versus an established standard, such as one's previous performance, are referred to as self-evaluation, which is a form of self-judgment. Another form of self-judgment is casual attribution, which is associated with beliefs about the reasons for success or failure. During the self-reaction sub-process, learners regulate their attitude about evaluating their progress. If the performance is satisfactory for the learner, the frequency of that act increases (Schunk, 2001). The learner's inferences from the activities and processes help to make decisions for their next performance. They can ascertain from the situation adaptively or defensively according to their attributive approach, which suggests students to consider the controllable factors to regulate the subsequent strategies constructively (Schunk, 2001). The design process reflects the designers' thinking and judgment performance (Powers, 2006). Thus, defining a design as failure could affect its designer motivationally. Especially design students can be demoralized against harsh critics since they develop defensive beliefs and state reasons on uncontrollable external factors such as fault of criticizer or the education system. Therefore, design students' reflective considerations on their learning process are necessary.

The self-regulatory cycle is completed when these self-reflections impact forethought about potential learning strategies (Zimmerman and Moylan, 2009). Self-regulation is not a mental ability or academic skill, on the contrary, it is a reflexive process consisting of sub-processes that are relationally interlaced and that are needed to redirect mental abilities towards academic skills (Zimmerman, 2002). Therefore, self-regulation cycles can vary greatly depending on the occurrence and timing of the feedback from the phases, which is also dependent on the external sources (Zimmerman and Moylan, 2009). Zimmerman's three-cyclical model emphasizes contextual and environmental factors with well-defined time-points for an occurrence during the learning process (Rubenstein et al., 2018). As the design studio has

dominant characteristics of a social collaborative learning environment with multiple external factors, this model is chosen for the studies in this dissertation.

2.2.2 Self-regulated learning dimensions and strategies

Each phase of the SRL allows students to engage in a variety of strategies. Strategies are of course fed by theory; however, by establishing a theory-practice relationship, they can be a guide for educators and students in learning environments (Ader, 2014). Zimmerman's SRL perspective (see Zimmerman, 1989a, 1990) defines self-regulated learners as individuals who actively engage in and manage their learning through metacognitive, motivational, and behavioral activities (Zimmerman, 1989b, 2002, 2008), and proposes a model consisting of 14 strategies within these categories (Zimmerman & Martinez-Pons, 1986). In terms of metacognitive processes, self-regulated students plan their learning process, determine goals, monitor, evaluate and reflect on their cognitive strategies (Dinsmore et al., 2008; Veenman, 2017). In terms of motivational processes, they have a high level of self-efficacy; i.e., belief in the ability to complete a task successfully; they have an intrinsic interest in tasks; and responsibility for their achievement outcomes (Zimmerman, 2008). For behavioral processes, they seek information and help, and select and structure learning environments (Sebesta & Speth, 2017; Zimmerman & Martinez-Pons, 1986, 1990).

For the strategies discussed in this section, three dimensions and 14 strategies of Zimmerman and Martinez-Pons's (1986) model were used. As the theoretical background, especially Bandura's social learning theory and Zimmerman's self-regulation approach were taken as a basis. However, there are different approaches to strategies of self-regulation (e.g., Pintrich and de Groot, 1990), and these studies were evaluated in relation to how they explain the strategies. Besides, the self-report questionnaire, which is developed by Erdogan (2006) (See section 3.1.1.2) was conducted for this research. The list of self-regulation strategies in that questionnaire was also developed based on 14 strategies of Zimmerman and Martinez-Pons (1986). To provide a clear understanding of the strategies used in this dissertation, Table 2.1 summarizes the list of dimensions of strategies. These strategies will be discussed under the dimensional groups in the following sections.

Table 2.1 : Self-regulated learning strategies and dimensions.

Zimmerman & Martinez-Pons (1986)	**Scale on Self-Regulation in Learning (SSRL) (Erdogan, 2006)**	**Dimensions of strategy**
Goal setting and planning	Arrangement of study time	Metacognitive learning strategies
	Planning	Metacognitive learning strategies
Environmental structuring	Environmental structuring	Behavioral learning strategies
Organizing and transforming	Organizing and transforming	Cognitive learning strategies
Seeking information	Seeking appropriate information	Behavioral learning strategies
	Seeking easily accessible information	Behavioral learning strategies
Rehearsing and memorizing	Rehearsing and memorizing	Cognitive learning strategies
Keeping records and self-monitoring	Self-monitoring	Metacognitive learning strategies
Seeking social assistance (peers, teachers, and adults)	Seeking peer, teacher, or adult assistance	Behavioral learning strategies
Self-evaluation	Self-evaluation	Metacognitive learning strategies
Self-consequences	Self-consequences after success	Metacognitive learning strategies
	Self-consequences after failure	Metacognitive learning strategies
Reviewing records (tests, notes, and textbooks)	*excluded from the questionnaire*	Cognitive learning strategies
Motivational factors	Self-efficacy	Motivational learning strategies
	Goal orientations	Motivational learning strategies
	Task value	Motivational learning strategies
	Attributions for failure	Motivational learning strategies
	Anxiety	Motivational learning strategies

2.2.2.1 Metacognitive strategies

Metacognition means knowledge about or control over cognition (Flavell, 1979). It is hard to dissociate metacognition from cognitive activities. Zimmerman's model (2000) defines the phases of SRL through a relationship between metacognitive and motivational processes, whereas Pintrich (1999) distinguishes cognitive and metacognitive strategies as different components of SRL. While some scholars define SRL strategies as only cognitive strategies (e.g., Bauer & Sapona, 1991), others categorize them as metacognitive only (e.g., Cole & Chan, 1994) (Fitriyeni & Widyastuti, 2018; as cited in Oz, 2019). Dinsmore, Alexandre, and Laughlin (2008) emphasize that these two notions have become intertwined and inseparable over the years. Although there are different views in SRL literature, it is not possible to dissociate meta- and cognition from one another because of the strong relationship between them. This thesis, which implements the model of Zimmerman and Martinez-Pons (1986) addresses SRL as an umbrella term involving metacognitive and cognitive strategies together and refers to metacognitive strategies as planning, monitoring, and reflecting on the cognitive ones. Accordingly, goal setting and planning, self-

monitoring, self-evaluating, and self-consequences are covered under metacognitive strategies; organizing and transforming, rehearsing and memorizing, and reviewing records (tests, notes, and textbooks) were discussed under cognitive strategies.

Goal setting and planning

All of the goals that students can set, including long- or short-term goals, general academic goals or goals for a single exam, and all kinds of planning to reach the determined goal can be considered under this strategy (Ader, 2014). Planning can include all dimensions outlined in Zimmerman's model, such as cognitive functions, time, behavior, social or physical environment. According to Zimmerman and Martinez-Pons (1992), to manage time effectively, students should set specific goals, direct the results to the use of strategy, and feel active to learn the task in the allotted time. These proactive strategies are mostly expected to be used in the forethought phase of the SRL cycle.

Self-monitoring

Zimmerman and Martinez-Pons (1986) include keeping records in this strategy. Self-regulated learners are expected to record their actions and results and observe their process systematically within the scope of their academic goals. These recording and monitoring activities include information related to both interior (self) and exterior factors. The tools (e.g., writing, drawing, audio or video recording) can change according to the preferences of the students. These strategic activities can be conducted during the learning process, which corresponds to the performance phase of SRL.

Self-evaluation

Self-evaluation is the evaluation that students make about both the process they are in and the products they produce in the academic activity that they are working on (Ader, 2014). This assessment specifically targets cognitive actions but may also apply to metacognitive strategies or actions. It is important that this assessment is initiated and performed by the student by defining previous activities, current situation, and quality of the results (Zimmerman & Martinez-Pons, 1986). Schunk (1995) relates effective SRL to the evaluation abilities of the learner, which helps to sustain the motivation of learning. It is the strategy expected to be used in the self-reflection process after the learning performance.

Self-consequences

This strategy refers to designing rewards or punishments for success and failure. Learners determine short- or long-term rewards for themselves to increase their motivation in the learning process or punish themselves to prevent the repetition (Ader, 2014). According to Zimmerman (2002), learners can compare the results of their behaviors according to predetermined criteria, and then reward or punish themselves (self-reinforcement) according to whether they have achieved their goal or not.

Cognitive Strategies:

As explained at the beginning of this section, these strategies were explained under cognitive strategies.

Organizing and transforming

Within this strategy, students try to reassemble the information or materials they gathered and turn it into a different structure. Taxonomic classification of items or phenomena, grouping according to their similarities and differences, separating the information body into meaningful elements, showing the auxiliary points in a text, and the relationships between them can be counted as the techniques that are used frequently (Demirel, 2020, p. 156). Summarization and mapping activities that help students to get associations about the subject and to generate new ideas are suggested as useful organizing techniques by Zimmerman and Schunk (2003).

Rehearsing and memorizing

Although they provide academic achievement to a limited value, rehearsing and memorizing are still effective strategies for some academic goals indirectly. Trying to repeat the information verbally or in writing helps students to keep the short-term memory, however, it doesn't help to relate that information with previous knowledge. Underlining the text is an important method for repeating, yet if it contains too much data, it loses its effectiveness (Schunk, 2009).

Reviewing records (tests, notes, and textbooks)

Students review their notes, questions, or materials (books, previous tests, among others), especially before the exam. The important thing is that this activity is planned by the students themselves and is focused on their goals.

2.2.2.2 Motivational strategies

Different theories of self-regulated learning (SRL) conceptualise motivation in different ways (Panadero, 2017). Learning motivation has been viewed as an integral aspect of self-regulation by some scholars (e.g., Boekaerts, 1992; Zimmerman, 2002, 2008), whereas others have viewed persistence of motivation as a prerequisite for effective SRL (e.g., Efklides, 2011; Pintrich, 1999; Schunk, 2001). One of the important common features of theories about self-regulated learning is that learning and motivation are seen as interdependent processes that cannot be fully understood when taken separately (Zimmerman, 1990, p. 6). Zimmerman and Martinez-Pons (1986) did not include the motivational strategies in the 14-strategy list; however, they (1990) stress its importance and effect on students' decision to use certain self-regulated learning skills. Especially self-efficacy, as a prominent factor in Bandura's social-cognitive view, is highlighted and widely studied as a necessary factor in the SRL process (Zimmerman, 1990). These motivational factors with other sub-components they cover and their relationship with self-regulated learning skills are explained below, respectively.

Self-efficacy

Self-regulated learners can define personal goals; choose, develop and perform appropriate strategies; monitor their process, and regulate according to outcomes with a belief of self-efficacy (Nilson, 2013; Zimmerman & Schunk, 2011). Bandura (1986) defines perceived self-efficacy as an individual's own judgment about his capacity to organize and successfully perform the necessary activities to show a certain performance (as cited in Senemoglu, 2007). There is a positive relationship between self-efficacy and self-regulated learning (Pintrich & De Groot, 1990), and self-efficacy and academic achievement (e.g., DiFrancesca et al., 2016; Kryshko et al., 2020).

Goal orientation

According to their individual needs and competencies or the requirements of the situation they are in, students can pursue different goal orientations such as being learning-oriented or performance-oriented (Meece et al., 1988). Learning-oriented students use more self-regulated learning skills, show more persistence, participate in more in-depth learning activities, choose topics that exceed or raise their own competence, where they will acquire new knowledge and skills, and participate more in the lessons. On the other hand, students with performance-oriented goals apply

fewer self-regulated learning skills, learn superficially, and choose easier activities or subjects to show their proficiency levels to their teachers and other students, even if they do not learn anything (Meece, 1994).

Task value

The value attached to the task is assumed to have three components: individuals/students' perceptions of the importance of the task, interest in the task, and perceived usefulness of the task for future purposes (Erdogan, 2012). It is claimed that students who see the activities or tasks related to the lessons interesting, important, and beneficial for them use their self-regulated learning skills more (Pintrich, 1999; Pintrich & De Groot, 1990). Besides, improved academic performance has been linked to a student's task value (i.e., how much the student values the assignment and how much they enjoy doing it) (Pintrich & Schunk, 2002).

Attribution for failure

When students fail a task, their attribution for reasons of this failure differs according to their goal orientations (Licht & Dweck, 1984). Performance-oriented students see the reason for their failure as their inability or other uncontrollable factors (such as talent, health, luck, instructors, education system, etc.), while mastery-oriented students see the reason for their failure as their insufficient effort. Students who accept uncontrollable factors as a reason for their failure tend not to take responsibility for their learning performance, since they think that uncontrollable factors are unchangeable and therefore, they do not show persistence to complete tasks (Erdogan, 2012).

Anxiety

Zimmerman (1989) underlines that anxiety affects the function of self-regulated learning and prevents some cognitive and metacognitive learning processes. According to the principle of reciprocal determinism, using SRL strategies decreases anxiety and develops positive attitude against the courses (Sakız, 2014, p. 98). Therefore, with SRL strategies, these kinds of negative emotions can be controlled, helping to increase academic success.

2.2.2.3 Behavioral strategies

Behavioral self-regulated strategies include the activities that mostly interact with the outsider factors such as the environment, people, time, and information sources.

Strategies that fall into this category include the management and control of other people (teacher, family members, and peers) within the scope of time, effort, learning environment, and even help (Pintrich, 1999; Zimmerman and Martinez-Pons, 1986, 1988). Some of these strategies will be explained below.

Environmental structuring

In terms of behavioral processes, self-regulated learners select, construct, and create their learning environments to feed learning in the best way possible (Zimmerman, 1990; Zimmerman and Martinez-Pons, 1988). They organize and structure the physical place that they use while studying and remove the disrupting elements.

Seeking information

Self-regulated learners procure information and resources that may be required for their study. They visit the library and gather as much information and resources as possible before starting work. The basic element of this process, the need, is the starting point of learning (Oz, 2019). The format of the information that is needed also determines the type of the source (e.g., libraries, observation, experiment, media, written materials -encyclopedias, books, dictionaries- and the internet). Due to the rapidly developing and changing technology, the ability to make the necessary arrangements to reach the information in the shortest time and in the most effective way has become one of the requirements of the age (Oz, 2019).

Seeking peer, teacher or adult assistance (help)

A unique feature of self-regulated learners is the ability to use others as a resource to cope with the uncertainty and difficulties encountered in the learning process (Newman, 1994; Zimmerman & Martinez-Pons, 1990). When students are working on a task, they may need advice or help to sustain studying. In such a situation, students should know that they need help (metacognition), decide to seek help (motivation), and be aware of applying strategies to seek help from another person (behavior) (Newman, 1994). Although SRL strategies require mostly individual processes, this strategy requires social interaction. Zimmerman and Martinez-Pons (1986) classify this strategy as social information seeking. Yet, to decide on what to ask and whom to ask requires a proactive effort. Studies show that help seeking has a positive correlation with academic achievement (e.g., Karabenick & Knapp, 1988; Zimmerman & Cleary, 2009).

2.2.3 Self-regulated learning and academic achievement

There is vast evidence that SRL strategies help students to accomplish their academic goals (Sungur & Yerdelen, 2011; see also Zimmerman, 2000; Zimmerman & Schunk, 2011). However, even in tertiary education, most students still do not know how to learn (Nilson, 2013). Students at this level may have difficulties with making strategic choices that prevent them from achieving, especially in their professional lives (Sakız, 2014). Thus, the goal of higher education should involve providing academic and professional knowledge and teaching effective learning strategies to create life-long learners (Tas & Sungur, 2012; Zimmerman, 2002).

To better understand the complex relationship between SRL strategies and academic achievement, students' strategy use must be compared within the context of their achievement levels. Studies have compared the related characteristics and attitudes of high and low achieving students attending different levels of education and learning environments (e.g., Broadbent, 2017; Coertjens et al., 2016; DiFrancesca et al., 2016; Donche et al., 2013; Erdogan, 2011; Fadlelmula et al., 2015; García-Pérez et al., 2020; Geduld, 2016; Khan et al., 2020; T.-H. Lee et al., 2010; Nandagopal & Ericsson, 2012; Sungur & Yerdelen, 2011). Despite different domains and tools, the general results of these studies were similar, i.e., SRL positively affects academic achievement. However, a few descriptive studies have demonstrated that SRL strategies are more nuanced, depending on the specific event (Nandagopal & Ericsson, 2012). For example, Greene et al. (2015) affirmed changes in high-level cognitive strategies depending on the discipline. How these domain-specific differences in self-regulation will be detected remains a gap in the literature (Alexander et al., 2011; Greene et al., 2015).

In design education literature, there are very few empirical studies which have focused on the implementation/execution of SRL in a design studio (e.g., Oluwatayo et al., 2015; Powers & Miller, 2008), which will be explain in section 2.3.3.1. Thus, the first phase of this thesis attempts to explore subjective ideas and perspectives of design students regarding domain-specific learning strategies in ID studio education approach to develop a primary perspective on individual differences, especially for low achieving design students. Afterwards, in the second phase, the experimental study

attempts to develop these SRL strategies, since they are defined as the possible reasons of the academic differentiation between students.

2.2.4 Assessing self-regulated learning skills

SRL skills are teachable (Panadero & Alonso-Tapia, 2014). However, as some students already possess these skills (Nilson, 2013), defining and assessing the level of existing strategy use is an important first step. Self-report (i.e., questionnaires, interviews, think-aloud and learning diaries) have been identified by many scholars to be the most common methods for identifying and evaluating SRL strategies (see Azevedo et al., 2009; Kavousi et al., 2019; Kryshko et al., 2020; Loeffler et al., 2019; Räisänen et al., 2016). Although these measures do not track real-time performance and are prone to recall distortions (Veenman, 2017), they play a crucial role in reporting psychological processes in SRL (i.e., cognitive, affective, physiological, and behavioral aspects) (Pekrun, 2020). However, using only one type of tool has been criticized because of its inherent weakness in capturing the learning strategies (Perry, 2002). Clearly et al. (2012) indicate that a multifaceted approach to evaluation might be the most useful method for increasing knowledge of self-regulation strategies (e.g., Baldan Babayigit & Guven, 2020; Coertjens et al., 2016; Foerst et al., 2017; Hendriks et al., 2020; Jansen et al., 2020; Pekrun et al., 2002; van Laer & Elen, 2020). Mixed methods approach offers advantages for SRL studies in compensating for missing data and confirming overlapping data (see Plano Clark, 2019).

In parallel with the mixed-method idea, both research phases of this dissertation aim to identify design students' SRL strategy use, taking advantage of both questionnaires and interviews. The researcher also observed students for an entire semester participating in all classes. This made the current study more data-intensive than existing research, and it was hypothesized that this would provide more reliable estimates of strategy use.

2.2.5 Developing self-regulated learning skills

In the context of design studio education, to our knowledge, no prior study has examined developing SRL skills of design students. For this reason, this literature review study was needed to conduct a wider investigation of literature pertaining to

SRL interventions. The review of literature at the intersection of studio education and self-regulation reveals that most studies focus on problem-based learning (PBL) environments. Besides, in some studies, design studio education is classified as a problem-based or project-based learning environment (e.g., Bridges, 2007; Maitland, 1997; Powers, 2016). The reason for this could be the similarities between design learning and PBL. They have some parallel approaches with respect to problem solving methods (Danfulani & Anwar, 2015), case-driven structure and master-apprentice relationship (Burroughs et al., 2009) and learner-centeredness (Barak, 2012; Savery, 2006; Zairul, 2020). However, while PBL aims to solve problems, studio learning (also defined as design-based learning) engages with both problems and solutions to create the value for the user (Danfulani & Anwar, 2015). Besides, developed within the context of medical schools, PBL has been implemented in settings that resemble conventional classrooms where teachers provide a framework, while design studio is a collective and collaborative working space where learners frequently propose their process and critique (Burroughs et al., 2009). This thesis questions the design studio education regarding its idiosyncratic qualities rather than through a specific learning notion. However, since PBL has the most similar approach to design learning within SRL literature; while reviewing the previous studies about developing SRL, problem-based environments were included specifically and critiqued considering the differences mentioned above. Reviewing these studies in the following paragraphs provides a guide while developing the intervention study in a learner-centered learning environment.

There are conflicting assumptions in the literature of SRL in PBL environments. A premise asserts that obtaining SRL skills is an apparent outcome of PBL (Loyens et al., 2008), and there is no need for any additional support in PBL to provide SRL. On the other hand, there are studies which reveal that SRL strategies may not be used and that they may not result in PBL environments always, since the learners are under a significant pressure (Evensen et al., 2001; Lloyd-Jones & Hak, 2004). PBL both demands and supports SRL by giving the responsibility of learning and the control over how to employ it to the students (Paris & Paris, 2001) and this may create a motivational and emotional pressure on them during learning (Senemoglu, 2007). Hence, it can be deduced that a PBL environment is suitable to develop self-regulatory skills (Tas & Sungur, 2012) not automatically but by supporting it explicitly (Thomas,

2013). In this sense, similar to PBL, design studio's unprescribed demanding structure might create pressure on some students who need more definite explanations of tasks. Although Greene et al. (2019) claim that design studio has already an impact on students to guide them to self-regulate their learning, some students need more explicit support during their project developments.

It should be noted that most of the PBL studies in SRL were not conducted in natural learning conditions (Loeffler et al., 2019), which means that these researchers created a problem-based module in their non-problem-based learning environment. These kinds of artificial learning conditions are a common shortcoming of such experimental research (Loeffler et al., 2019). Therefore, this thesis conducting an SRL intervention in industrial design studio as a natural PBL-like environment will provide insights from different points of view in SRL literature.

2.2.5.1 Self-regulated learning interventions

The existing literature has already illustrated that in learning environments such as STEM, history, and language, among others, support for SRL nourishes noticeable strategy development (e.g., Azevedo & Cromley, 2004; Masui & de Corte, 2005; van den Boom et al., 2007; Zimmerman & Kitsantas, 1997). These support attempts are provided through intervention studies implemented in learning environments such as mathematics (Zimmerman et al., 1996; Panaoura and Philippou, 2007), computer science (Bergin et al., 2005), physical education (Cleary et al. 2006), science (Schraw et al. 2006), technology education (Barak, 2010), ergonomics (Bures, 2015), and language (Seker, 2016), among others. These studies are mostly about applying an SRL model or designing a new model customized to the discipline or are about developing and validation of scales on self-regulation.

According to the studies on interventions, common elements of successful interventions can be summarized in four points: discipline-focused content, implementation by the teacher, faded support approach, explicit and direct promoting. The discipline-oriented approach and applications provide more efficient intervention studies (Hattie et al., 1996; Perels et al., 2009). The contents are suggested to be developed according to the relevant curriculum. In addition, according to the meta-analysis of Hattie et al. (1996), the interventions in the literature are implemented by

mostly researchers and to a more limited extent. However, effective interventions require more time (Dignath & Büttner, 2008), and this might create limitations regarding long-term outcomes for SRL skills. Therefore, SRL interventions that are led by the teachers of the class are highly recommended (Ader, 2014). Thirdly, in the interventions, scaffolding and faded support should be provided for student to gain and apply SRL skills (Greene, 2018). One of the main points of developing SRL is that it is difficult for students to understand what they should always pay attention to, which skills they should develop, and how they should develop these skills on their own. Thus, a certain amount of support is required from teachers, especially in the early stages of their development (Sakız, 2014). Holton and Clarke (2006) suggest giving students a high level of support while developing self-regulation skills with a scaffolding logic, which means that the level of support should decrease as skills begin to develop. As a final aspect, the interventions should provide information about SRL and the whole process of developing SRL explicitly. The interventions differ according to their approaches and methods. Kistner et al. (2010) categorize the types of promoting SRL strategies as indirect and direct. Indirect promoting creates an appropriate learning environment, hence students can develop self-regulated strategies by themselves. In direct promoting, teachers aim for teaching the strategies through activities which they conduct in the classroom. Approaches to direct teaching are also divided into two groups: implicit and explicit approaches (Sakız, 2014). Implicit approaches are the ones where teachers work with methods which may not be understood by the students as targeting the development of self-regulation (A. L. Brown et al., 1981). On the other hand, in explicit approaches teachers specifically ask students to take a specific action or undertake an activity and specify that it is a self-regulated strategy and that it is important to learn how to use it (Sakız, 2014). Brown et al. (1981) state that through both approaches, self-regulated strategies of the students can be developed, however, with the implicit way, it is more difficult for students to transfer these strategies to different environments or contexts. Likewise, Veenman (2005) emphasizes that defining when and how to use these strategies is a more successful way to make especially students with low achievement levels develop these skills.

To sum up, for an ultimate success in SRL development, it can be deduced that discipline-focused interventions should be implemented by the teachers who provide

scaffolding and faded support in a direct and explicit way. Jivet et al.'s (2018) study on thirteen different SRL tools indicates that SRL can be supported through tools which provide awareness for learners and trigger the reflection on the learning process. Nevertheless, we still need more information about how to promote SRL in the most efficient way. As Perez-Alvarez et al. (2016) suggest, more evaluations are needed to understand the characteristics to be considered in designing new tools, since we do not have any guide for that yet. In line with the existing literature, the intervention in this thesis was designed according to a theoretical-based model which pays attention the recommendations discussed above.

This section has attempted to provide a summary of the literature that relates to the characteristics of self-regulated learning with the social-cognitive approach. In the next section, design studio education will be discussed in relation to its features, factors, and futures.

2.3 Design Studio Education

Design education literature has been contributed to by various design disciplines such as architectural design, interior design, industrial design, visual-communicational design and design engineering. In the existing literature, design education refers to a broader term, including curriculum studies, which consist of other courses addition to the studio. This dissertation's theoretical perspective of design education was framed by only studio education with the relevant works from the fields.

Kowaltowski et al. (2010) identify two stimuli that progress the design effort in studio education: the pedagogical way, whereby instructors include their presented personalities, and the individual way, which engages with how students approach their design. These stimulative factors can be considered as two dimensions of design education: design teaching and design learning. Building on this approach, in this section, design studio education will be discussed from these two perspectives: the pedagogical structure affecting design teaching (i.e., signature pedagogy) and the actors of the design learning process (i.e., learner, project and studio).

2.3.1 Studio education as a signature pedagogy

University students need to be independent learners with the capacity to plan, monitor and evaluate their work and control their motivation and emotion (Vosniadou, 2020). Some professions demand these skills in different approaches, which creates characteristic forms of teaching and learning. Shulman (2005) defines these unique preparations for the professions as 'signature pedagogies' and describes the characteristic of these pedagogies with three level structures: (a) a surface structure of teaching and learning activities, (b) a deep structure of assumptions about transferring a particular knowledge, and (c) an implicit structure of a moral dimension including professional beliefs, values, and attitudes. These three aspects affect the ability of thinking and acting like a professional, and prepares the grounds for becoming one (Shulman, 2005), which is the main goal of higher education. Another crucial aspect of professionalism is namely dealing with the uncertainty which signature pedagogies consist of, since every profession must aim to provide skills to manage and balance its intrinsic tension of making judgements under uncertain situations (Shulman, 2005).

Design studio education is one of these signature pedagogies with its distinct pedagogical method (Shreeve, 2015; Shulman, 2005; Zairul, 2018) that includes learner-centered activities, knowledge construction through interaction between the actors and the studio as a social environment (Yorgancioglu, 2020). Design as a discipline involves a highly organized mental process like manipulating and blending many kinds of information into ideas and generating their realization (Lawson, 1980). The tacit form of design knowledge makes it impossible to improve specific instructional materials (Ozdemir, 2013). The "studio" as a design profession term refers to both the physical social space in which teaching and learning activities occur and the pedagogical approach applied within these spaces (Crowther, 2013). The unpredictable and serendipitous environment of the design studio (Crowter, 2013) and the ambiguity of the pedagogy (Austerlitz et al., 2008) require another capacity to deal with the factors motivationally. Leading a novice to try this acting and thinking style requires a strategy that includes a social and cognitive approach. According to Oxman (1999), there is a fundamental deficiency in design education in terms of educational learning theories since design learning has not been studied much in terms of its cognitive features. Although several studies which focus on cognitive aspects of designing have attempted to solve this problem of design education in the last five

decades, more research is needed to have a comprehensive understanding of design learning with its personal, behavioral, and environmental factors.

Educating inventive designers is becoming increasingly more important in current design education, as students are dealing with more complex difficulties that demand a synthesis of knowledge on various subjects (Lugt et al., 2004; as cited in Fındık, 2012). The pedagogical approach of the instructor is the most central determinant affecting the education process in studio. Interaction with experienced professionals through unstructured talks about the design challenges are key components of this instructional approach (Kowaltowski et al., 2006). Therefore, the diversity, complexity, and culture of the various actors involved in the process are part of the studio environment. Cross (2007) suggests that design instructors are first professionals and then incidentally teachers. Since most design instructors do not have pedagogical degrees (Goldschmidt et al., 2010), their instructional approaches vary depend on their learning experiences (Koyuncugil, 2001). Because of the difficulty in externalization of tacit knowledge, they largely prefer an apprenticeship process in studio education (Cross, 2007). Criticizing this approach, Cross (2007) indicates the importance of articulation during teaching and having a foundation for deciding the content and methodology of the instructions. Besides, this apprenticeship relation between instructor and student can only be observed in feedback conversations during the critic sessions, since instructors mostly do not demonstrate any designing activity (i.e., sketching, 3D drawing, making a model) in design studios. Because of this traditional and common assumption of design learning as 'learnt by doing' rather than explanation of what designing is (Dorst & Reymen, 2004; Lawson, 2005), students are expected to carry out their own design process with only guidance of instructors.

In his study about the dichotomy of design learning strategies, Stoltermen (1994) emphasizes the role of the design process of the learners as follows:

> Design learning should not be a process of conservation where an existing practice is taken for granted and as the only answer. Design learning is not only a question of a simple transfer of established knowledge from experienced to inexperienced designers. Design learning should strive towards the situation where new designers constantly reflect upon and critically examine their design practice. They should regard the design practice itself as a result of a design process and therefore possible to change and redesign. Design learning is in

> itself a design process. It should be a creative and self-creating process where future designers are given the opportunity to develop their own ideas of what reason, aesthetics and ethics they want to be 'guided' by in their design work (p. 458).

To improve the reflective skills of learners, design activity (i.e., doing) is one of the necessities, yet not the only one. Before the praxis, students need an explanation about 'doing what for what reason'. In doing so, instructors can play an articulative role, and can enable the recreation of a design learning environment based on cognitive approach (Oxman, 1999) and provide more possibilities to create space for learners' agency.

Learner-centered approach cannot be provided through only a non-hierarchical physical feature of the studio. It requires the development of instructional strategies considering characteristics of students, which is more experiential and emotional especially in recent years (Tzeng, 2011). Design instructors should analyze the learning characteristic features of students and develop strategies accordingly (Ozdemir, 2013). To assist students in overcoming obstacles when they are "stuck" in the design process, educational approaches and tools are very important (Kowaltowski et al., 2010). Most of these approaches fail to deal with students' refusal to accept responsibility for their own learning and their lack of capacity to participate fully in the studio project (Powers, 2006). Thus, instructors need to realize the differences in thought and act processes of students regarding their design projects and develop learner-oriented instructional methods accordingly.

2.3.2 Actors of design learning in studio

The design studio, the core subject of design education, is the environment where design students experience learning through, with Schön's (1982) definition, "reflective conversations on the materials of the situation". The studio has a complex and multilayered nature and requires interactive engagement of its actors such as students, instructors, peers, and projects (Yorgancioglu, 2020). In some studies, the actors of a design studio pedagogy are defined in relation to the study context. For example, in their study, Wendler and Rogers (1995) discuss the verbal interactions in design studio and define the social construction of the "Design Life Space" (as they labelled) with three perspectives: design studio and project as instruments; the students

with their attributes, internal and external expectations; and the teacher with their attributes and internal and external expectations. Similarly, Shaffer (2003) offers the Oxford Studio model with its three features: studio environment, instructional landscape, and epistemological principles. While conceptualizing their research on the effect of teams on design learning, Okudan and Mohammed (2006) consider several dynamic actors for design learning environment such as design instructors, tasks, expectations, process, teams, and outcomes. In their study about criticism in design studio, Tok and Ayyildiz Potur (2016) describe the actors of the studio as design students, peers, and others (such as instructors and guests). In contrast, focusing on the acquisition, Crowther (2013) signifies the three main features of signature pedagogy of design studio as design knowledge, design ability, and becoming professional. Even though different actors were assigned different names, the common point in these studies is that they all discuss the dynamic and complex communicational relations between the actors.

In the design pedagogy literature, the interactional relation in design studio is mostly elucidated over one-to-one conversations between student and instructor (e.g., Goldschmidt et al., 2010; McDonald & Michela, 2019; Oh et al., 2013; Peterson, 1979; Uluoğlu, 2000). This is one of the distinctive features of design studio that sets it apart from lectured class format. Since the knowledge of how to design, which can be named mostly as "tacit knowledge" (Polanyi, 2009) cannot be taught, the ways of developing tacit knowing of design are embedded in communication and action (Yorgancioglu, 2020). Additionally, studios provide students with social spaces that are conducive to the sharing of experiences and support construction of tacit knowledge (Venkatesh & Ma, 2021). Accordingly, the culture of working in collaboration in the studio creates another way of communication: conversation with peers (e.g., Crolla et al., 2019; Yorgancioglu & Tunalı, 2020). Another actor with whom conversation supports the knowledge construction in design studio is the student themselves. The internal conversations students have with themselves assist them to experience the attitude of the reflective practitioner outlined by Schön (1987). As Brown, Collins and Duguid (1989) exemplify in their study about culture of learning, when these vertical (student to instructor), horizontal (peer to peer) and internal (self-reflection) relationships are enhanced in a meaningful way, learning becomes more engaging.

Although the dialogical structure of the studio consists of personal actors, there are other elements that have roles in the convergence of meaning. Ferreira (2018) discusses the design artefacts through which the communication is mediated between the individuals in the studio. He outlines visual representations as artefacts of the design process, which make the design process understandable and form a link between the teacher and the student. Visual representations are an outcome of a multi complex actions in which students go through a variety of cognitive and affective processes. The design process can be represented by visual studies, which is the overt process of a student (i.e., behaviour), yet there are other kinds of covert factors (i.e., feelings, thoughts) affecting the design learning process. A closer look at the literature on design teaching and learning reveals a shortcoming on this topic. Most of the studies that have been published on design education investigate how designers think and develop creative ideas and (Carvalho & Goodyear, 2018; Dym et al., 2005; Oxman, 1999; Tobón et al., 2021; Wendler & Roges, 1995), rather than covert factors of design learning such as how learners feel and thought.

Accordingly, this dissertation aims to expand the instructional vision of the studio through various communicational approaches to understand the factors affect design learning process and help students to regulate them. Learning strategies which students can use to develop their learning process and use as conversational tools to explain themselves to both themselves and others should be introduced to the studio pedagogy. In this sense, self-regulated learning strategies can help design students to make interpretations of external situations and adjustments to their thoughts, moods, or feelings and to communicate them effectively (Jadhav & Gupta, 2014). These strategies that establish the relationship between theory and practice guide educators and students about what can be strategized (Sakız, 2014) in design learning environments regarding social-cognitive learning. In the following sections, the actors of design studio are viewed from the social-cognitive perspective of self-regulation, which describes the learning environment with regards to the relation between personal, behavioral, and environmental factors. Accordingly, the actors in design studio are examined under three headings: design students as personal factor, design project as behavioral factor, and design studio as environmental factor.

2.3.2.1 Design learner in the center

Learner-centered learning traits can be observed in most forms of design studio education (i.e., architectural, interior, landscape, and industrial design). Such approaches include problem-based learning (Boyer & Mitgang, 1996; Galford et al., 2015; Smith, 2010), project-based learning (Bell, 2010; Kuhn, 2001), the alternative student-centered framework described by Lee and Hannafin (E. Lee & Hannafin, 2016) in response to criticisms of other studio-oriented/based learning (Cennamo et al., 2011; Kjesrud, 2021; Zairul, 2018) and practice-based learning (Bull, 2015). These learning-based studies highlight the essential characteristics of the studio pedagogy, which are more about experiencing and understanding the design process than the content knowledge (Smith, 2010). Design studio teaching widely places the student in the center of the education with active participation (Powers, 2016), however the learner-centered learning technique tends to be disregarded in studio instruction (Zairul, 2020). In their review study, de la Harpe and Peterson (2009) revealed a greater emphasis on teaching techniques rather than student learning in studies of studio learning and teaching (e.g., use of learning styles/approaches/strategies such as SRL). Therefore, more scaffolding improvements are needed which focus on differentiation in the learning process of design students.

In the studio, starting with a project brief involving 'ill-defined' (Casakin & Goldschmidt, 1999) or 'wicked' (Simon, 1973) problems, design students are expected to develop solutions and bring them to the studio showing weekly progress to discuss with the instructor or sometimes with peers and guests (Goldschmidt et al., 2010), known as studio critics. Instructors provide feedback on the work, and students need to respond to the feedback in each class until mid and final 'jury days' when projects are presented to the entire studio. Critics help students to move forward while developing their projects and iteratively provide them with a constructive learning process (Tovey, 2015). Conversation between the student and the instructor centers around the student's work (Schön, 1985). Thus, students are the main actors in a studio environment and are fully responsible for constructing self-knowledge. However, this critical and self-constructive process may create challenges for students who struggle to engage with the socio-cultural context. They may not meet the expectations of the studio and their self-confidence may decline (Masatlıoğlu & Takkeci, 2016). Two main stimuli help students sustain their design performance in the studio: their

approach to design and the pedagogical approach of the instructor in the studio (Kowaltowski et al., 2010). The individual approach of a design student is developed progressively through the activities of design education which is founded on gaining design skills through repeated exercising, largely based on trial and error or on trial and feedback in a studio situation (Casakin & Goldschmidt, 1999). On the other hand, expert designers have more creative solutions by employing integrated design strategies, in contrast to the novices' trial-and-error approach (Ahmed et al., 2003). They have their idiosyncratic starting points for their design processes (Ates Akdeniz, 2015), they are prone to developing their self-design approaches. The fuzzy ambiguity of the design knowledge and the different ways in which designers choose to acquire this knowledge make it impossible for design instructors to develop a specific teaching strategy (Ozdemir, 2013). At this stage, students need to have a good self-understanding and self-evaluation about the various stages of their designing process which is linked to each other and influence the entire process (Almendra & Christiaans H., 2011). They need a 'safe space' to realize and develop their design approach without the fear of failure (Bull, 2015). Thus, studio instructors need to be supportive and encourage the development of skills (e.g., critical thinking, self-reflection, self-directed and self-regulated learning, perseverance) that are needed to confront with the fluidity of design problems (Smith, 2005).

2.3.2.2 Design project as an expression and communication tool

Another main actor of studio education is the design project. Multiple phases of investigation, exploration, and resolution are part of this long-term teaching activity (Powers, 2016). It undertakes different roles during design teaching and learning processes in the design studio. Powers (2006) defines the design project as a pedagogical vehicle which is used for training students on the skills, knowledge, and experience required for design profession. While deciding on the subject of the project according to the level of design studio, the studio instructors use the design project as an instructional tool to develop the student's design knowledge. On the other hand, during their design projects, students engage with the specific problem and solution domains aiming to find alternative approaches to the defined subject. Learning occurs at that self-directed time which students experience, and they use the design project as a learning material to construct their design knowledge. Beyond this, the design project has another role as a communicational tool between teaching and learning. It

is used as a medium to communicate. The interactions between design instructors and students are built upon the ongoing project, which depends on the performance of the students since they are expected to present students' design progress (Ferreira et al., 2016).

Especially in the early phases of the design project, students present their performances in sketches or models, and the instructor makes comments on them regarding the project subject. There is a vast amount of studies about the representational tools in the design process such as sketching (e.g., Goldschmidt, 2014; Purcell & Gero, 1998; Suwa & Tversky, 1997) and modeling (e.g., Akalin & Sezal, 2009). These studies unfold the cognitive effect of these activities in the design process. These artifacts become a vehicle to communicate with others and to obtain a self-expression about the mental processes of the designers themselves (Akalin & Sezal, 2009). Similarly, in the design learning process, these activities are seen as the outcomes of students' study skills, hence instructors evaluate both the project content and the students' learning progress as well. Therefore, these representational ways have an excessive effect on the process of design learning since the instructors consider them as the only evidence of studying. The representations can be related to behavioral factors and presentations can be related to expressional factors affecting the design project. Gross and Do (1997) criticize this approach and argue that students are encouraged to focus on self-expression too much rather than learning the profession. Some students may have been performing or need to perform different kinds of activities in the studio hence they can comprehend and express their process of designing.

Seeking the help of others or seeking the information through accurate sources can also refer to behavioral activities indicating the learning process. As stated before, the design project is an instructional tool for instructors. Rather than seeing it as the result of a study performance, the design project should function as a pedagogical approach hence students can realize their abilities, regulate their behavior accordingly, and participate in their own learning processes (Boyer & Mitgang, 1996). The conversation in the studio is constructed depending on the nature of the design projects and can develop students' confidence by nurturing self-efficacy through transforming capabilities and behaviors (Venkatesh & Ma, 2021). Hence, expressional and communicational factors of design projects put an emphasis on design learning process in studio education. This creates opportunities for the students who make sense the

complexity of the design, while creating challenges for the ones who do not. The reason of this difference and its effects on students' approaches to the design project need to be unpacked.

2.3.2.3 Design studio as a learning environment

Learning environment refers to the physical, contextual, and cultural settings in which learning occurs. It can be inside or outside of the classroom. Therefore, it is important to note that the spatial condition is only one of the factors affecting the learning process. Hence, the term learning environment is more accurate and preferred to explain the aspects of learning.

Design studio as a learning environment is one of the main actors in design education. It consists of several features affecting the design learning process. Wang (2010) describes the culture of the design studio as a combination of material representation, social collaboration, creativity, and emotionality with a tolerance for uncertainty. Similarly, Blevis et al. (2007) points out the complexity of studio as being creative, collaborative and highly material. When we look at these definitions from students' point of view, we can refer the effect of the design studio to mostly environmental factors. Materiality refers to the physical conditions, objects and spaces of the studio, collaboration refers to the social interactions with others (peers, instructors, users), whereas creativity and emotionality refer to the perception and reaction of students to these external factors. These environmental factors such as choosing physical spaces, instructors, or subjects may not be controlled entirely. However, the effects, perceptions, and reactions against them can be controlled by the students. Studio provides the students with an environmental infrastructure for developing active participation in experiential learning and facilitating critical and participatory discourses (Kurt, 2009; Uçar & Kandemir, 2011). From a pedagogical perspective, studio learning is promising, as it fosters knowledge construction through a student-centered approach which demands the teacher to be mobile while engaging in dialogues with students (Shreeve, 2015). However, the spatial availability is not enough to create a learner-oriented learning environment. Some students need guidance on uncontrollable factors that affect their learning process. The critique which scaffolds for student agency offering the metacognitive area (Gray, 2014) encourage the students for self-reflection on their performance (Cardella et al., 2016;

Dannels & Martin, 2008). It also provides an exemplary of designing process (Budge, 2016), thus students can manage their motivational process against external factors in the studio (Michela & McDonald, 2020).

2.4 Research Related to This Study

According to the review of design education literature in the previous section, it can be deduced that design studio pedagogy with its aspects of learner-centered approach, process-oriented structure of the projects, and constructive learning environment resembles the features of self-regulated learning to some degree. This assumption may promote the belief that, as Greene et al. (2019) claim, design studio education already demands and supports SRL skills. On the contrary, there is much less information about SRL-related strategies as employed in the design studio. An intersectional review of design studio education and self-regulated learning literatures illustrates that most studies focus on cognitive and metacognitive facets of the design process, while few studies have investigated SRL in the design studio. Table 2.2 presents the relevant studies from the intersection of the two fields.

Table 2.2 : Studies related to design education and self-regulated learning.

	SRL	Metacognition	Cognition	Self-efficacy	Motivation	Art / architecture / design education	Industrial design education	Design practice	Creativity	Studies in Turkey
Chien et al. (2021)				+			+			
Carlson et al. (2020)		+	+					+		
Kavousi et al. (2020)		+	+			+				
Ball, L. J., & Christensen, B. T. (2019)		+	+			+		+		
Greene et al. (2019)	+					+			+	
González-Tobón et al. (2019)		+				+				
Wu et al. (2018)	+				+		+			
Mozafar et al. (2017)	+					+				
Gelmez, K. (2016)		+	+				+			+
Kurt, M., & Kurt, S. (2016)		+				+				
Oluwatayo et al. (2015)	+				+	+				
Hargrove, R. (2012)	+	+				+			+	
Powers, M.N. (2006)	+					+				

In the following sections, the related studies will be discussed in two parts. First, cognitive and metacognitive approaches to design education will be reviewed since they are the most proximate and common subjects of design education to SRL.

Secondly, studies focusing on SRL in design studio will be addressed to justify the contribution of this research.

2.4.1 Cognitive and metacognitive approaches in design studio education

Design entails the highly organized mental process of manipulating and blending several forms of information into ideas and then generating outputs based on them (Lawson, 2005). Cognitive studies about expert designers' idea-generation process when creatively solving problems provide some instructional information for studio education (Björklund, 2013; Cross, 2001; Haupt, 2015; Kavakli & Gero, 2002; Kim & Kim, 2015; Newstetter et al., 2001). Research in cognitive science mostly focuses on defining the cognitive strategies that designers use. However, how designers choose and organize these strategies is essentially a metacognitive process that has been a less observed part of cognition in design (Ball & Christensen, 2019). The limited number of studies on design metacognition (e.g., Ball & Christensen, 2019; Carlson et al., 2020; Kavousi et al., 2019) indicate the importance of metacognitive processes for understanding each aspect of design activity. Nevertheless, design learning is a different process to designing and should be studied as an independent subject with educational theories of learning serving as a foundation for design education (Oxman, 1999). To date, several studies have examined design education by means of cognitive and metacognitive aspects (e.g., Alamäki, 2018; Casakin & Goldschmidt, 1999; Christiaans, 2002; Esjeholm & Bungum, 2013; Fındık, 2012; Gabriela Goldschmidt, 2001; Gelmez, 2016; Goel, 2001; Hargrove, 2007; Hasirci & Demirkan, 2007; Kurt & Kurt, 2016; Oxman, 2001; Ozdemir, 2013; Tobón et al., 2021; Uluoğlu, 2000). Metacognitive knowledge – as an aspect of SRL – would help novice designers to understand their learning process from a more holistic perspective. Although a few studies have investigated motivational (e.g., Garner & Evans, 2015; Kreitler & Casakin, 2009; McDonald & Michela, 2019) and affective (e.g., Gelmez, 2016) factors in design studio pedagogy, there are still many unanswered key issues regarding self-regulation in design learning.

2.4.2 Self-regulated learning in design studio

Studio instructors' pedagogical approach influence students' learning about how to design and develop their skills and self-perception as designers (Yorgancioglu &

Tunalı, 2020). It can be said that studio instructors care more about the students' understanding of the creative process rather than the product, and this type of teaching approach aims to develop reflection and self-regulation (Greene et al., 2019). However, neither design instructors nor design students in design studio are fully aware of SRL strategies. Even though some design students may intuitively think or act in a self-regulated way with the help of reflective conversation with the materials of the situation (Schön, 1987) , learning occurs when the students go beyond their capability and self-understanding. Therefore, the learning approach needs to be promoted and aligned with the SRL potential of studio education.

There are limited cross-sectional studies which explore SRL in design studio education specifically. One of the researchers addressing this issue is Matthew Powers. In his PhD thesis (2006) and book named "Self-Regulated Design Learning" (2016), he proposes a methodology for design education that incorporates SRL and the process of design learning. He highlights "pro-active engagement", which consists of cognitive and behavioral strategies, "choice" as an ownership of projects, and "goals" as critical determinants of self-regulated learning in design studio. In this model, which is developed within a landscape design program in Virginia, USA through interviews with students, students are responsible for actively contributing to their design learning through SRL. The instructors' role is to design studio objectives for each student. The limitation of this model is that the lack of an intervention study which exemplify and evaluate the assumptions stated in the study.

Another study about SRL in design education is conducted by Oluwayato and his colleagues (2015). They investigate the relationship between self-regulation and motivation in an architecture studio in Nigeria by surveying architecture students about their self-regulated learning process. The study highlights the influence of motivational factors. Nevertheless, the major source of limitation of this descriptive study is due to the survey method which is conducted with a local and limited sample size.

As another related study, Mozafar et al (2017) study SRL in basic design studio with architecture students in Iran. They investigate self-regulation in basic design studio considering architectural design factors. Especially the basic design studio, being a transitional phase of a university students, requires more regulatory guidance and this study highlights its importance.

In another study of architecture studio education, Zairul (2018) advances a model named "SOLE (Studio Oriented Learning Environment) model" based on self-regulated theory, which focuses on peer review during studio hours and supporting SRL through individual critique beyond studio hours. The implementation of the model is relatively new and needs to include the tutor's input to the process.

Beside these, there are two research studies which mention self-regulation's focus on the metacognitive process of design learning in the design studio. Starting with his thesis study and related research, Hargrove (2007, 2011) introduces a self-regulated metacognitive approach to design process. He practices this approach in several undergraduate design courses aiming to enhance students' creativity. Similarly, Kavousi (2017) applies a study for her thesis aiming to understand the effect of metacognition on students' design activities. She conducts the study in an explorative approach, which is the main difference of her study from Hargrove's (Kavousi, 2017). Afterwards, in related articles of Kavousi and her colleagues (2019, 2020) they indicate the contribution of metacognition on the designs especially of first-year design students. Both researchers posit metacognition as an involvement of self-regulation, yet they both remain narrow in focus, as they engage with/employ only with one factor of SRL.

Finally, in their developmental study, Wu et al. (2018) improve a web-based learning system for particularly architecture students. They construct an online interaction and self-regulation system. Through a survey, they investigate if online interaction has an impact on student performance through the mediation of self-regulation. Although they find a positive impact based on the subjective viewpoints of the students, they do not measure the academic performance of the students, which limits the evaluation of effectiveness of the system.

The study of relevant literature reveals a significant gap in the current research area. Despite limitations and practical challenges for studio instructors, these studies contain valuable insights for self-regulated learning in design studios. Nonetheless, the ID studio in which this thesis is conducted has its domain-specific dynamics, and therefore necessitates a deeper understanding of the SRL approach. This thesis, addressing this need, explores the self-regulated activities employed by the students during design studio, and experiments an intervention study introducing the SRL strategies to design students.

3. PHASE I: EXPLORATION OF SELF-REGULATED STRATEGIES

This chapter describes the exploratory phase of this dissertation in three sections. In the first section, key features of the research methodology are explained, including data collection and data analysis. The section provides descriptions of mixed-method research which consists of self-report questionnaires and in-depth interviews as data collection methods, and constructivist grounded theory as the framework for data analysis. The second section discusses the findings of the study including integrated analysis. The last section is the discussion of the findings presented in this chapter.

The main purpose of this dissertation is to enhance the design performance of the design students by using self-regulation theories. As a first step, to have a comprehensive understanding of the existing situation in the studio, the following first question was asked, "What is the level of reported use of SRL among industrial design learners before participating in an SRL-intervened learning environment in the design studio?". To be able to answer this main question, five sub-questions were formulated and mentioned in the relevant sections respectively:

R.Q.1-a. Are there meaningful differences between the SRL skills and motivation of ID students with different academic achievement levels?

R.Q.1-b. What are the SRL skills frequently used by ID students with different academic achievement levels?

R.Q.1-c. What is the correlation level between self-regulation and motivation levels?

R.Q.1-d. How do high and low-achieving ID students perceive their own studio course experiences?

R.Q.1-e. To what extent do qualitative and quantitative results converge and/or diverge?

3.1 Methodology for Phase I: Convergent Mixed Method

In this study, we followed a convergent mixed-methods procedure (see Creswell & Plano Clark, 2018) by undertaking quantitative and qualitative investigation concurrently. Briefly, "Scale on Self-Regulation in Learning" (Erdogan, 2006) questionnaire was used as a quantitative approach to define the level of SRL used by the students, and interviews as a qualitative approach provided more information about students' learning, achievements, and behaviors. We integrated the results through merging and interpreted them to gain a realistic and holistic understanding of students' strategy use.

3.1.1 Data collection

This section presents the data collection process of the first phase, which was conducted as an exploratory study in the Department of Industrial Design at İstanbul Bilgi University (IBU) during the Industrial Design Studio III course. In the following, the participants of the study, their backgrounds, settings, and the procedure of the study will be explained.

3.1.1.1 Participants

This exploratory study was conducted in an Industrial Design Department at Istanbul Bilgi University (IBU), a Turkish private university located in Istanbul. Industrial design undergraduate education in Turkey occurs over eight semesters and a minimum of 4 years. ID studio teaching occupies about 30% of the entire curriculum.

In industrial design education at IBU, first-year students are obliged to general university curriculum requirements and do not take industrial design studio courses. Industrial design courses start at the second year, therefore students in the second year are only in their first industrial design education and are less likely to have learned how to self-regulate their behaviors within studio settings, because the projects in the second year are mostly externally regulated by the instructors. To assess the self-regulated learning approaches of students in-depth, the participants of this study were chosen in third-year students who have taken all two years' courses in the curriculum of the industrial design department including visualization and at least two design project courses. This is the main reason that this study focuses on third-year design

students as, at this level, they have completed at least four semesters of the curriculum, including four design studio courses. Additionally, in the third year, the focus of the studio content moves from a general introductory level controlled by the instructors to an individual development level managed by the students themselves (Uluoğlu, 2000). This more individualized studio context helps students to experience more self-processing time and allows us to observe their approaches to design.

In the fall semester of the 2017-2018 academic year, the entire Industrial Design Studio III course consisted of 56 students (37 F, 19 M), 5 instructors, and 1 teaching assistant. For the quantitative data collection, 56 students were asked to participate and 47 of them (33 females, 14 males) answered the self-report questionnaire. They were on average 21.2 years old (SD = 0.98), and all were in their fifth semester.

In the Industrial Design Department of IBU, different design studios are opened each semester according to the subjects that they are related to. In the fall semester of 2017, four different subjects were studied in four design studio courses, which were a coffee machine redesign project for a client which had a strict protection policy for design rights, a transportation project which had a more undefined project definition, a sustainable system design project which was conducted in a small village in Turkey, and a sanitary space design project for wellbeing in corporation with a client. The qualitative part of this exploratory study was conducted within the studio course in which 20 students, 2 instructors, and an assistant study on design project about sanitary space for wellbeing. This studio (hereinafter Wellbeing Studio) was selected as the research environment for the following reasons:

Wellbeing Studio:

1. was designed for only junior (3rd year) students, although the other studios had both 3rd and 4th-year students,
2. was coordinated by a full-time design academician and a ten-year experienced design professional with a bachelor's degree in industrial design,
3. was a client project for a big design and production company in Turkey, and the company preferred not to interfere in the studio process but to evaluate the design solutions,
4. focused on realistic design solutions while enabling abstractions and a creative research process.

Due to these reasons stated above, Wellbeing Studio was selected as the environment for qualitative data collection. The term started with 20 students in the studio, however, one of the students had to leave due to health issues, and another one wanted to withdraw from the studio after the midterm jury due to personal reasons. The students were asked via email if they want to participate in this study, and 16 students (10 females, 6 males) of the 18 students, who were all in their 3rd year, wanted to participate in the study voluntarily.

Students who participated in this study started their undergraduate education in year 2014. At this time, students had to take a central exam with the scores in Mathematics-Science 4 (MF-4) which consists of Turkish, social sciences, mathematics, geometry, physics, chemistry, and biology. The exam was conducted by a governmental institution named The Student Selection and Placement Center (ÖSYM). The total quota of the department was 50 for that year (URL-1). Since IBU is a private university, the scholarship quotas depend on exam success. The quota was 5 for the full scholarship, 33 for 50% scholarship, and 12 for full scholarship (URL-1). In 2014, the success ranking of the students with the lowest score for the department was 229.000 for full paid quota, 146.000 for 50% scholarship, and 28.200 for full scholarship among 2.086.115 students (URL-2). These success rankings placed the IBU ID department within the first five ID departments in Turkey among 32 university.

3.1.1.2 Settings and procedure

The project content of ID301 Industrial Design Studio III: Wellbeing was written by the instructors of the studio in the project brief document as in following:

> This studio explores sanitary spaces as the site of well-being with a focus on generating life-enhancing user experiences, and a strong emphasis on human behavior, mood, and atmosphere. Participants will dive into both new and existing scenarios, examining what is at stake and developing proposals based on sensorial and emotional experience while tackling issues of sustainability and material awareness. We aim to re-think the subject of sanitary as a concept beyond hygiene, aesthetics, and functionality and reflect upon our multisensory relationships with sanitary objects and environments.

The education period of each term is 14 weeks. Except for 2 days, 143 hours of the Wellbeing Studio were undertaken face-to-face during the term. Studio days were

twice a week; Tuesdays were 7 hours and Fridays 4 hours. The first 4 weeks were used for a short project which aimed to make the students start researching in the field and on the desk about sanitary spaces. These research activities were about the final project subject, too. In the last 10 weeks, students were focused on idea generation, design development, and detailed designs for the final project. 10 studio days were used for desk critic sessions which allow the instructors and students to discuss the ideas and developments of the students. 4 studio days were used for in-class activities and technical trips or seminars. Jury judgments on the projects took 5 studio days, and the critics on students' working strategies were observed during the juries by the researcher. Table 3.1 depicts the detailed instructional process of the studio with the studies conducted.

Table 3.1 : The term process of Wellbeing Studio.

2017-2018 Fall Term ID301 Industrial Design Studio: Wellbeing																										
Weeks	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14
Hours	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*4*
Dates	26-Sep	29-Sep	3-Oct	6-Oct	10-Oct	13-Oct	17-Oct	20-Oct	24-Oct	27-Oct	31-Oct	7-Nov	10-Nov	14-Nov	17-Nov	21-Nov	24-Nov	28-Nov	1-Dec	5-Dec	8-Dec	12-Dec	15-Dec	19-Dec	22-Dec	29-Dec
Studio Process	Introduction	Ass.1 Historical Research	Ass.3 Designer Research	Crit	critic+ Ass.2 Field Research	Erdem Akan Vitra	Short Project Final Jury	Crit	Trip: Vitra Innovation Center	Crit	Seminar: Materials	Pin Up 1	Crit	Crit	MidJury1	Workshop: Ceramics	Crit	SSRL	Crit	Pin Up 2	Focus Group Discussion	Crit	Crit	Pin Up 3	Crit	Final Jury	8-19 January
Observation for Wellbeing Studio																										
Conducting SSRL (with 47 third-year students)																										
Conducting Interviews (with 16 students from Wellbeing Studio)																										

All participants were native Turkish speakers, and all documents and conversations were in Turkish. The data were stored and transferred using multidigit codes to ensure anonymity. Participants were provided with written information on the project prior to participating, were assured of confidentiality, and gave their informed consent to participate. The questionnaire and interviews were administered at the end of the semester so that students could reflect on their current studio projects.

3.1.1.3 Quantitative measure: SSRL self-report questionnaire

Self-report questionnaires are the most common measuring tools for SRL, as they are easy to design, administer, and score (Winne & Perry, 2000). These self-report scale

studies (e.g., Self-Regulatory Learning Inventory, SRLI of Gordon et al., 1996; Self-Regulated Learning Skill Inventory, SRLSI of Heo, 1998; Motivational Strategies for Learning Questionnaire, MSLQ of Pintrich & de Groot, 1990; Self-Regulatory Learning Interview Schedule, SRLIS of Zimmerman & Martinez-Pons, 1986) have focused on self-regulated learning skills of students at secondary and college level, however, they employ different frameworks on cognitive, metacognitive, and motivational dimensions (Erdogan & Senemoglu, 2016). None of these example scales are in Turkish, and even though some studies (Büyüköztürk et al., 2004) have adapted these scales into Turkish, the designing language of a scale and questionnaires should be in the native language, too. Motivated by that, Erdogan (2006; for the English version see Erdogan & Senemoglu, 2016) developed and validated a self-report scale, named "Scale on Self-Regulation in Learning (SSRL)" that can be used to evaluate self-regulated learning skills of university students (age 18 or above) in Turkey focusing on Turkish learners and their learning traditions. Besides, the authors handle more thoroughly the cognitive and metacognitive learning strategies together with the related motivational dimensions. This scale consists of two sub-scales: The SRL skills section covers 12 dimensions that have been developed based on Zimmerman and Martinez-Pons's (see 1986) Self-Regulated Learning Interview Schedule (SRLIS), while the motivational section covers five dimensions (Erdogan & Senemoglu, 2016) (see Table 3.2). The scale has 17 dimensions with 67 items in total and is scored on a five-point Likert scale ranging from 'Never' to 'Always'. According to Erdogan (2012), the reliability coefficient was calculated as Cronbach Alpha 0.91 for the entire scale, showing high internal consistency.

Table 3.2 : Sub-scales and factors of the Scale on Self-Regulation in Learning (SSRL) and strategy types used in this study.

Scale on Self-Regulation in Learning (SSRL) (Erdogan, 2006)	**N**	**Type of strategies used in this study**
Self-Regulated Learning Skills		
Arrangement of study time	4	Metacognitive strategies
Planning	5	Metacognitive strategies
Environmental structuring	4	Behavioral strategies
Organizing and transforming	5	Cognitive/Metacognitive strategies
Seeking appropriate information	3	Behavioral strategies
Seeking easily accessible information	2	Behavioral strategies
Rehearsing and memorizing	4	Cognitive/Metacognitive strategies
Self-monitoring	2	Metacognitive strategies
Seeking peer, teacher, or adult assistance	3	Behavioral strategies
Self-evaluation	6	Metacognitive strategies
Self-consequences after success	4	Metacognitive strategies
Self-consequences after failure	3	Metacognitive strategies
Motivational factors		
Self-efficacy	5	Motivational strategies
Goal orientations	3	Motivational strategies
Task value	5	Motivational strategies
Attributions for failure	4	Motivational strategies
Anxiety	5	Motivational strategies

The structure of studio education is different from regular classes. Thus, terms related to class courses in the scale had to be slightly adapted for studio conditions and the terminology was altered to enable the students to understand and respond regarding their studio process (e.g., the word ‘studio coordinator’ was used instead of ‘teacher,’ and ‘jury presentation’ instead of ‘exam’) (see Appendix B).

The SSRL scale was conducted with hard copy documents, and students were asked to think of how they studied in that studio course. The researcher facilitated the questionnaire process with the students and responded to any questions asked.

3.1.1.4 Qualitative measure: interview

"Qualitative research is designed to inductively build rather than to test concepts, hypotheses, or theories" (Merriam, 1998, p. 45). This is one of the reasons why in this study qualitative research is also preferred. Qualitative research is an effective tool to understand the relationship between student attributes and the learning environment (Araz & Sungur, 2007) and between SRL and motivation in a design learning context (Powers, 2006). In this study, the qualitative and quantitative study components were implemented independently. Therefore, the design of the interview was focused on not only understanding the scale items but also on giving the students more space to talk deeply about their learning experience. Semi-structured interviews were designed for students to talk deeply about their learning experience in general and in the studio course that they had recently completed. The interview questions were developed by considering the interviews used in other SRL studies (see Coertjens et al., 2016; Kitsantas, 2002; Ley & Young, 1998; Nandagopal & Ericsson, 2012; Powers & Miller, 2008; Sundre & Kitsantas, 2004; Zimmerman & Martinez-Pons, 1986) and rephrased using design terminology (Appendix C). Without asking directly about SRL, it was possible to see how important self-regulation was in their process (Räisänen et al., 2016). Based on the qualitative analysis approach of this study, interviews and their analysis proceeded simultaneously and iteratively, enabling the interviewer to probe with follow-up questions.

In the following sections, information about the content of the interviews used in this phase and how they were conducted will be explained.

Interview

Interviewing is a common research method used in qualitative research. Interviews can be highly structured, as in the case of fixed response questionnaires, or minimally structured, as in the case in the narrative method (Heyink & Tymstra, 1993; Kleinman, 1988). Despite its difficulties, interviewing has significant advantages for this study. It allows the researcher to examine largely unknown facts: self-regulated learning of design students. Within the complexity of the design studio process, trying to understand the phenomenon of self-regulated learning can be accomplished only by talking with the student. Also, interviews provide the needed flexibility to probe ideas that emerge during the dialogue to understand the phenomenon of SRL.

The Interview Guide

Semi-structured interviews require a questionnaire form to guide the flow of the conversation and to remain on topic. The form usually consists of a few standard questions to start a dialogue in the interview and to get some specific information from all the respondents. This study aims to understand SRL strategies which industrial design students use, as well as the motivational factors by which the students were affected during a project process. Thus, some existing questions found in the SRL literature were rephrased accommodately and specified systematically in the questionnaire form (see Appendix C). Seven main questions and probe questions were established as semi-structured interview questions. The reasons why these questions are established will be explained below.

The first question focuses on how the studio subject is defined by the students. To see the way that students see the characterization of a studio provides information on the factors that affect the self-regulation of the students.

The second question and its probe questions focus on students' learning experiences on their projects and related tasks. This step-by-step story provides an understanding of the self-regulated behavior, students' goals, as well as of the differentiation between students' behavioral and thought processes across different aspects of the project.

The third question and its following questions focus on the effects of motivational and social interaction within the studio as a physical space and an environment on the learning process of students.

The fourth question and its following questions help the researcher to understand the motivational factors of the studio achievement and self-evaluation criteria of the students.

The fifth question, allowing students to think themselves as if they are the head of the department, provides students with the power to change and/or regulate studio education. This power will reveal the ideas and feelings of the students about what is effective and ineffective in their learning process.

The sixth question opens up another level of conversation between the researcher and the participant in that they start to talk about the studio learning process of design education in a holistic view. This also provides another discussion of the student's own goals in the studio.

Conducting the interview

Sixteen third-year ID students were interviewed at the end of the term. Conducted by the researcher, the interviews were recorded using a digital voice recorder and each interview lasted 40 to 60 minutes depending on follow-up questions and probes. A total of 645 minutes was recorded, saved, and transcribed verbatim. As interviews were being conducted, the researcher also took field notes.

The participants of interviews had also answered the SSRL questionnaire previously. With the questionnaire form, in a personal information form, all students were asked if they wanted to participate in interviews later, and 16 of 47 students answered in the affirmative. The design studio was in the fall term, interviews were conducted at the end of it, after the final juries. The timing of the interviews was important, it should not be too early since students had to finish their projects, and not to be too late that students should not forget about the process. The researcher approached each student via e-mail and reminded them of their answer about participating in the study and arranged the date and time. To ensure an accurate transcription, students were informed that the interview would be audio recorded. They were also assured that their names would be kept confidential. Interviews were conducted with sixteen students who accepted to participate. Participation in the study was not rewarded, and students were not under the impression that they would be punished for not participating.

The researcher located the meeting in a silent coffee shop on the university campus to make it easy for the student to access (see Figure 3.1). The interviewing schedule lasted two weeks.

Figure 3.1 : Meeting place for the interview.

3.1.2 Data analysis

This study used a convergent mixed method with qualitative and quantitative data collection occurring concurrently and then integrated for analysis.

3.1.2.1 Grouping procedure

For the quantitative analysis, the sample (N=47) was divided into high and low-achieving groups to investigate the SRL skills of students with different achievement levels. The division into groups took place according to the students' averages of the last two official studio grades, which were accepted as indicators of consistent achievement (see Boud & Falchikov, 2006; as cited in García-Pérez et al., 2020; Soderstrom & Bjork, 2015). Twenty-three students with grades above 77 out of 100 (M=81.7, SD=4.06) were assigned to the high achieving group, and 24 students with grades below 77 (M=65.8, SD= 8.51) were assigned to the low achieving group. Mann-Whitney U test showed the total scale scores for these two groups to be significantly different with mean rank for high achievers = 13.85, and mean rank for low achievers = 34.59 (U=32.5, z= -5.186, $p < .001$).

For qualitative analysis, 16 interview participants were again divided into two achievement groups. Six students with grades above 77/100 (M=83.6, SD=2.96) were assigned to the high achieving group, and 10 students with grades below 77/100 (M=66.6, SD=6.08) were assigned to the low achieving group. Mann-Whitney U test showed the total scale scores for these two groups to be significantly different again.

3.1.2.2 Data validation

In qualitative analysis, feelings are captured in the data, making it subjective (Morgan, 2013). The researcher excavates tacit meanings and actions (Charmaz, 2021). These inferences need to be valid and reliable by using all available methods and techniques. In this respect, the transcriptions of the interviews were reviewed and verified for validity by the students. As a research assistant, the researcher was also able to observe students during the semester before and after the data collection. For peer examination, the researcher with the advisor of this thesis discussed the data collection, data analysis, and interpretations of results in detail together.

As qualitative research needs an intense and prolonged connection with participants in their natural settings (Miles et al., 2014), results must be read in light of the research context rather than generalized outside its construction (Charmaz, 2008).

3.1.2.3 Quantitative analysis

In this study, Cronbach's alpha coefficient was calculated as 0.84 for the whole scale, 0.81 for Self-regulated Learning Skills, and 0.67 for Motivation.

Descriptive statistics were used to describe the sample population. The normal distribution of the data was examined and confirmed: the Shapiro-Wilk test concluded that the significance value was higher than .05 in all sub-scales; Kurtosis and Skewness values were within the ±1 range for all variables, and the histogram chart showed the data had a normal distribution. However, as the sample size for each group was less than 30 participants, it was decided to use non-parametric tests. The Mann-Whitney U test was performed to determine which achievement level caused significant differences between scale mean scores. Spearman's Rho correlation test was used to measure the relationship between SRL and Motivation.

3.1.2.4 Qualitative analysis: constructivist grounded method

According to Strauss and Corbin, grounded theory is a methodology that develops theory from the information embedded in the data which was collected and analyzed systematically (1990: 24; 1994: 273). It is also directly related to daily reality (1994: 276) and is applicable for studies with a small number of participants (1998). These specifications make grounded theory generally suitable for data analysis of this study. Furthermore, a newer approach to grounded theory, called 'constructivist grounded theory (CGT)' has more suitable properties (see Figure 3.2) for this study. This alternative vision of grounded theory was developed by Kathy Charmaz (2000, 2006). The most important difference of CGT from traditional grounded theory related to this study is about the active stance of the researcher during data collection. Despite the objectivist theory's "researcher as a neutral observer" definition, Charmaz (2008) argues that the researcher's values, priorities, positions, and actions affect views. Therefore standpoints, relativity, and reflexivity should be considered during the data collection. In this study, the researcher was both a designer and teacher, and she had an active stance in the studio education process. Thus, the data was constructed with mutual interaction between the researcher and the research itself (Arik and Arik, 2016) as CGT assumes.

Objectivist Grounded Theory	Constructivist Grounded Theory
Assumes an external reality	Assumes multiple realities
Assumes discovery of data	Assumes mutual construction of data
Assumes conceptualizations emerge from data	Assumes researcher constructs categorizations
Views representation of data as unproblematic	Views representation of data as problematic, relativistic, situational, and partial
Assumes the neutrality, passivity, and authority of the observer	Assumes the observer's values, priorities and positions, and actions affect views
Views data analysis as an objective process	Acknowledges subjectivities in data analysis, recognizes co-construction of data; engages in reflexivity
Gives priority to researcher's views	Seeks participants' views and voices as integral to the analysis
Aims to achieve context-free generalizations	Views generalizations, as partial, conditional, and situated in time, space, positions, action, and interactions
Focuses on developing abstractions	Focuses on constructing interpretations
Aims for parsimonious explanation	Aims for interpretive understanding

Figure 3.2 : Comparison of objectivist and constructivist grounded theory (See Charmaz, 2000; 2006).

In this study, the researcher, as a research assistant, had an active involvement in the design of the studio process from which the data were collected. Both the qualitative data collection and the analysis process were based on constructivist grounded theory (CGT) because of the researcher's active stance, the relatively small sample, and data construction with mutual interaction between the researcher and the research itself (see Arik & Arik, 2016; Charmaz, 2006, 2008; Strauss & Corbin, 1994, p. 273, 1990, p. 24)

Coding

The analysis of the interviews was conducted in two phases. In the first phase, we aimed to elucidate the elements of the studio processes and students' understanding by analyzing the data gathered from the interviews without theoretical assumptions. To follow the procedure of CGT, data collection and analysis proceeded simultaneously and iteratively. The audio records (645 minutes) were transcribed by the researcher after the interviews were finished. They were written in a Word document, and then arranged in an Excel sheet (see Figure 3.3). No interpretation or changes were executed

during the transcription, however, some of the speech habits, such as “you know” and “like”, were removed by the researcher. The transcriptions were then transferred into the MAXQDA’18 Qualitative Data Analysis Program, which provided us with the tools to organize and analyze the data. As Charmaz suggests (2021), the first step of coding, termed ‘initial coding,’ was carried out line-by-line using the interviewees’ words (in vivo) whenever possible to preserve the sense of action (see Figure 3.4). In vivo coding enabled us to see similar actions of the students with different statements and to ask more focused follow-up questions during the interviews. The second step of coding proceeded with focused coding, which consisted of reviewing and synthesizing the initial codes and identifying relationships among them to create categories. In this phase, the transcriptions were grouped into the two achievement levels and the initial codes were reviewed within the groups to transform them into more abstract categories. Categories were reread and regrouped to develop patterns and create core categories.

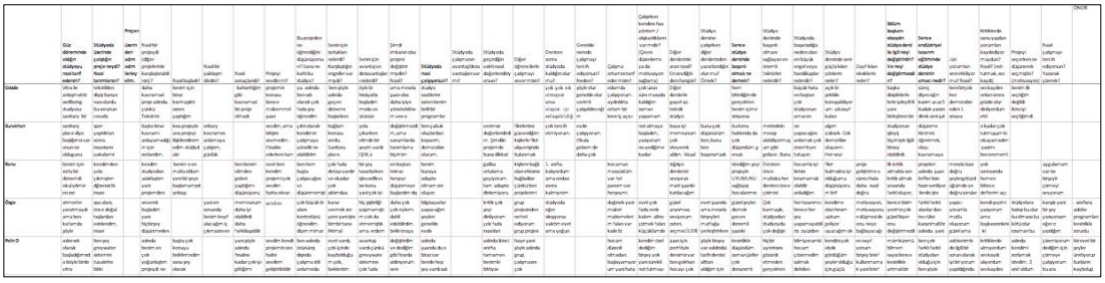

Figure 3.3 : A snapshot from the Excel sheet of data transcription.

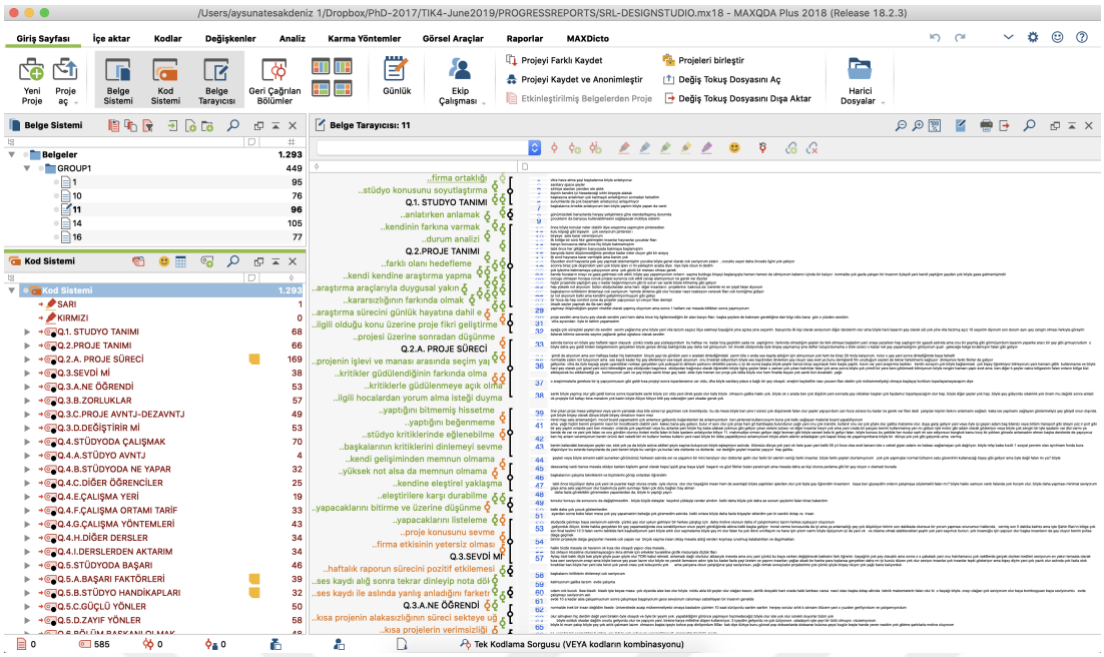

Figure 3.4 : A snapshot from the coding process (MAXQDA'18 Qualitative Data Analysis Program).

In the second phase of the analysis, we aimed to identify the differences between high and low performers and the factors related to individual differences in the SRL approach and motivation, with a more theory-driven approach. The descriptions in the categories were conceptualized and coded according to the SRL dimensions of Zimmerman's theory (2000; see Zimmerman & Moylan, 2009).

3.1.2.5 Integrated analysis

As this study followed a convergent mixed methods design, quantitative and qualitative findings were integrated under the guidance of the fifth sub-question. As suggested by Creswell and Plano Clark (2018) and O'Cathain (2010), a comparison matrix (Table 3.3) was used to assess both data sets and determine the levels of agreement. There is an agreement when the qualitative findings are explanatory, and 'dissonance' when findings are inconsistent. Such intra-method discrepancies can be harnessed to examine each data set more sufficiently (Moffatt et al., 2006). Thus, we used dissonances to identify potential explanations from theory (as cited in Fetters et al., 2013; Pluye et al., 2005). The coherence of the results is an important aspect of integration. Fetters (2013) identifies that the degree of integration, termed as 'fit,' may either be confirmation, expansion, or discordance. As the findings from the two sources diverge and expand the insights, the level of integration was considered as expansion in this study.

Table 3.3 : Comparison of quantitative and qualitative findings.

SRL strategies & Motivational factors	Quantitative	Qualitative	Agreement, partial agreement, dissonance, expansion, no match
Arrangement of study time	-		No match
Planning	++	+	Partial agreement
Environmental structuring	-		No match
Organizing and transforming	++	++	Agreement
Seeking appropriate information	-	+	Dissonance/Expansion
Seeking easily accessible information	-	+	Dissonance/Expansion
Rehearsing and memorizing	-		No match
Self-monitoring	-		No match
Seeking peer, teacher, or adult assistance	-	+	Dissonance/Expansion
Self-evaluation	++	++	Agreement
Self-consequences after success	-		No match
Self-consequences after failure	++	++	Agreement
Self-efficacy	-	+	Dissonance/Expansion
Goal orientations	-	+	Dissonance/Expansion
Task value	++	+	Partial agreement
Attributions for failure	++	++	Agreement
Anxiety	-		No match

++: exact information related to a finding
+: supporting/related information related to a finding
-: contrasting information related to a finding
No symbol: no information

3.2 Findings

The quantitative and qualitative analyses associated with each of the five sub-questions are presented in turn.

3.2.1 Findings from quantitative analysis

The first sub-question *Are there meaningful differences between the SRL skills and motivation of ID students with different academic achievement levels?* was studied using quantitative data. Descriptive statistics (Table 3.4) were used to describe the sample population. Means of SRL total and Motivation were calculated as 3.30±0.34, and 3.16±0.39, respectively. Within SRL factors, self-evaluation was the most frequently used, while seeking easily accessible information was the least used

strategy. Within motivation factors, task value had the highest use whereas anxiety obtained the lowest scores.

Table 3.4 : Descriptive statistics of scale results of students.

SRL Skills	N	Number of items	Mean	Std. Deviation	Minimum	Maximum
Arrangement of study time	47	4	2,98	0,59	1,75	4,00
Planning	47	5	3,09	0,58	1,80	4,40
Environmental structuring	47	4	3,78	0,87	1,00	5,00
Organizing and transforming	47	5	3,50	0,76	2,20	5,00
Seeking appropriate information	47	3	3,12	0,74	2,00	4,67
Seeking easily accessible information	47	2	2,30	0,95	1,00	4,50
Rehearsing and memorizing	47	4	3,15	0,58	2,00	4,50
Self-monitoring	47	2	3,55	0,96	1,00	5,00
Seeking peer, teacher, or adult assistance	47	3	3,60	0,79	1,67	5,00
Self-evaluation	47	6	3,84	0,73	1,83	5,00
Self-consequences after success	47	4	2,94	1,20	1,00	5,00
Self-consequences after failure	47	3	3,45	1,00	1,00	5,00
SRL Total	**47**	**45**	**3,30**	**0,34**	**2,33**	**3,92**
Self-efficacy	47	5	3,63	0,65	2,00	4,60
Goal orientations	47	3	3,18	0,93	1,33	5,00
Task value	47	5	4,03	0,87	1,00	5,00
Attributions for failure	47	4	2,56	0,81	1,00	4,50
Anxiety	47	5	2,42	0,73	1,00	4,00
Motivation	**47**	**22**	**3,16**	**0,39**	**2,41**	**4,04**
SSRL TOTAL	**47**	**67**	**3,24**	**0,31**	**2,44**	**3,90**

Table 3.5 shows the differences between the SSRL mean scores of students, which were 235.3 (SS= 15.48) for high achievers and 205.1 (SS=16.41) for low achievers. To determine if differences are significant in scale scores between groups, the Mann-Whitney U test was run. Total scale scores were found to be significantly higher for high achievers (mean rank=13.85, U=32.5, z= -5.186, $p< .001$) than for low achievers (mean rank=34.59, U=32.5, z= -5.186, $p< .001$), as were the scores of subscales (i.e., SRL Total and Motivation).

Table 3.5 : Group statistics and Mann-Whitney U test results of scale and subscale scores of students with different achievement levels.

Dimensions	Achievement Level	N	Mean	Std. Deviation	Std. Error Mean	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
SSRL TOTAL	High achieving	23	235,3	15,48	3,23	32,500	332,500	-5,186	**0,000***
	Low achieving	24	205,3	16,41	3,35				
SRL Total	High achieving	23	159,87	11,226	2,341	62,500	362,500	-4,548	**0,000***
	Low achieving	24	139,67	14,699	3,000				
Motivation	High achieving	23	75,43	6,953	1,450	91,000	391,000	-3,944	**0,000***
	Low achieving	24	65,63	7,534	1,538				
Arrangement of study time	High achieving	23	12,26	2,508	0,523	225,500	525,500	-1,084	0,278
	Low achieving	24	11,58	2,244	0,458				
Planning	High achieving	23	16,48	2,937	0,612	159,000	459,000	-2,507	**0,012***
	Low achieving	24	14,42	2,483	0,507				
Environmental structuring	High achieving	23	15,87	2,719	0,567	219,000	519,000	-1,220	0,222
	Low achieving	24	14,38	3,998	0,816				
Organizing and transforming	High achieving	23	19,65	2,587	0,539	92,500	392,500	-3,938	**0,000***
	Low achieving	24	15,38	3,609	0,737				
Seeking appropriate information	High achieving	23	9,826	2,3091	0,4815	209,500	509,500	-1,432	0,152
	Low achieving	24	8,917	2,0834	0,4253				
Seeking easily accessible information	High achieving	23	4,74	1,912	0,399	247,500	547,500	-0,616	0,538
	Low achieving	24	4,46	1,911	0,390				
Rehearsing and memorizing	High achieving	23	12,91	1,952	0,407	214,500	514,500	-1,329	0,184
	Low achieving	24	12,25	2,609	0,532				
Self-monitoring	High achieving	23	7,65	1,968	0,410	202,000	502,000	-1,597	0,110
	Low achieving	24	6,71	1,805	0,369				
Seeking peer, teacher, or adult assistance	High achieving	23	11,22	1,704	0,355	230,000	530,000	-0,987	0,323
	Low achieving	24	10,46	2,734	0,558				
Self-evaluation	High achieving	23	25,00	3,162	0,659	122,000	422,000	-3,289	**0,001***
	Low achieving	24	21,00	4,709	0,961				
Self-consequences after success	High achieving	23	12,83	3,881	0,809	215,500	515,500	-1,291	0,197
	Low achieving	24	10,88	5,245	1,071				
Self-consequences after failure	High achieving	23	11,43	2,826	0,589	151,500	451,500	-2,665	**0,008***
	Low achieving	24	9,25	2,848	0,581				
Self-efficacy	High achieving	23	19,09	2,875	0,599	204,500	504,500	-1,530	0,126
	Low achieving	24	17,42	3,348	0,683				
Goal orientations	High achieving	23	9,91	2,811	0,586	257,500	557,500	-0,397	0,692
	Low achieving	24	9,42	2,873	0,586				
Task value	High achieving	23	21,65	3,393	0,707	175,500	475,500	-2,151	**0,031***
	Low achieving	24	18,79	4,690	0,957				
Attributions for failure	High achieving	23	11,57	3,160	0,659	146,000	446,000	-2,785	**0,005***
	Low achieving	24	8,92	2,858	0,583				
Anxiety	High achieving	23	13,22	3,343	0,697	196,000	496,000	-1,708	0,088
	Low achieving	24	11,08	3,670	0,749				

*p<.05.

To answer the second sub-question *What are the SRL skills frequently used by ID students with different academic achievement levels?* the students' overall average score, together with sub-scales for each SRL skill and motivational factors, were compared. According to Mann-Whitney U test results (Table 3.5), student achievement levels differed significantly when comparing scores for planning, organizing and transforming, self-evaluation and self-consequences after failure. High achievers were better at planning their studies, rearranging their instructional materials, and evaluating their work and consequences after failure. High achievers had significantly higher scores for task value and attribution for failure, which means that they appreciated what they learned more than low achievers, and they attributed their failure to controllable factors such as their lack of effort.

Spearman's Rho correlation coefficient was used to answer sub-question three, *What is the correlation level between self-regulation and motivation levels?* There was a statistically significant correlation between SRL and motivation (r_s=.422, p=.003) shown in Table 3.6.

Table 3.6 : Correlation results between SRL and Motivation.

Correlations			Motivation
Spearman's Rho	SRL	Correlation Coefficient	.422**
		Sig. (2-tailed)	.003
		N	47

**Statistically significant at .01 level (2-tailed)

3.2.2 Findings from qualitative analysis

A descriptive statistic was used to describe the participants of the interviews, consisting of 6 high achievers (5 females, 1 male) and 10 low achievers (5 females, 5 males). The means of total SSRL scores were 241.3 (SS=14.61) for high achievers and 198.6 (SS=22.67) for low achievers. Another Mann-Whitney U test was run and total SSRL scores were found to be significantly higher for high achiever interviewees (mean rank = 13.50) than for low-achiever interviewees (mean rank=5.50) (U=0, z=-3.259, p< .001).

To answer the fourth sub-question, *How do high and low achieving ID students perceive their own studio course experiences?* interview data were analyzed using the CGT approach. The emerging main themes and their sub-categories are presented in

Table 3.7. This section includes key findings on students' studio experiences with representative quotations and discusses them through SRL strategies. The data obtained from the interviews were classified under three main themes: student, project, and studio. Representative quotations from the students are shown in Tables 3.8, 3.9 and 3.10.

Table 3.7 : The emerging main themes and their sub-categories of the qualitative analysis.

The main themes and their sub-categories
1. Student theme: feelings and thoughts of industrial design students
1.1. Comments on their strength and weakness
1.2. Interpretation of success in the studio
2. Project theme: expressions of industrial design students
2.1. Strategies they applied
2.2. Interpretations of the process
2.3. Comments on the outcome
3. Studio theme: external factors industrial design students are exposed to
3.1. Peer interaction
3.2. Feedback
3.3. Managing information

3.2.2.1 Student theme: feelings and thoughts of industrial design students

This student theme contained students' feelings and thoughts about themselves and their project experience. Through scrutinizing their feelings and definitions, we aimed to understand the differences in awareness in relation to achievement levels in the studio course. Under this theme, we examined (a) students' comments on their strengths and weaknesses, (b) interpretations of success in the studio, and (c) definitions of their projects. Table 3.8 provides representative quotations on this theme.

Table 3.8 : Representative quotations in Student Theme: feelings and thoughts of industrial design students.

Subthemes:	Representative quotations of low achiever design students	Representative quotations of high achiever design students
Comments on their strengths and weaknesses	*"I'm very bad at making models. I wish there were not any obligatory models for projects." (L.5)* *"I definitely cannot think abstractly. I wish [this skill] was taught to me in my first year." (L.12)*	*"I thought that presentation was my strong skill, but when I see the other works, I realized that it was not as good as I believed. So, this term, I mostly focused on developing my presentation skills as well." (H.11)*
Interpretations of success in the studio	*"I thought my project subject was not different enough. That is why I got a lower grade than others. For example, X seemed successful because she chose a very different subject and drew the attention of the instructor." (L.5)* *"I tried to find an uncommon thing that would interest instructors more." (L.3)*	*"To be successful in the studio means keeping the project subject in your mind all the time and everywhere and embracing the subject when you do not like it. Pushing yourself to like it. Not giving up." (H.14)* *"Success in the studio depends on the first impression of the instructors. Sincere interaction is important." (H.16)*

Students in both achievement groups were aware of their strengths and weaknesses, showing evidence of good metacognitive skills. However, high achieving students embraced their weaknesses and explained what they had done to strengthen them. In contrast, low achieving students expect to be taught to address their weaknesses. These attitudes indicate that low achievers need more metacognitive regulation, especially in self-evaluation and self-consequences.

Low achievers believed that finding a different project topic and developing it based on instructors' predispositions were sufficient for studio success. In contrast, high achievers had a sense of ownership in the process through participating and being able to interact with the instructor. Low achievers considered tasks as the opportunity to gain positive comments from instructors, while high achievers mentioned learning-oriented goals such as benefits for their improvement. The difference in goal orientation and task value indicated problems in low achievers' motivational regulation.

When describing their projects, high achievers used more abstract terms and words (e.g., feeling good, creating space, atmosphere, relationship), whereas low achievers

were concrete (e.g., bathroom design, object, wet area, cleaning.). The difference in the language used indicated different critical thinking skills, one of the key cognitive strategies in design studios.

3.2.2.2 Project theme: expressions of industrial design students

This project theme included students' expressions of their behaviors and discourses (e.g., homework, presentation, process experience, and learning experience). We focused on analyzing students' descriptions of what they did during their project. In this theme, (a) strategies, (b) interpretations, and (c) comments on the outcome were examined. Table 3.9 provides representative quotations.

Table 3.9 : Representative quotations in Project Theme: expressions of industrial design students.

Subthemes:	Representative quotations from low achiever design students	Representative quotations from high achiever design students
Strategies they applied	*"I could not understand which part I should focus on; product or meaning. Finally, I could not find any meaning for my product, and failed." (L.5)*	*"I thought about approaching my project in a functional way (product-oriented) or meaningful way. Then I found a way to synthesize the story (meaning) and the product (function)." (H.11)*
Interpretations in the process	*"In my critic session, the idea of an island bathroom came up – indeed, it was not my idea. After that, I lost control and got off the subject. I could not explain what I was doing and why I was doing this. Later on, I saw others' projects they were working on, such as flowers, pots, etc. I started to ask myself: Could I have these kinds of extreme [*crazy*] ideas, too? I wanted to design a product, but on the other hand, everyone was flying [*a common saying for having extreme or crazy ideas*], and I wanted to fly too, which I could not." (L.5)*	*"I think I'm good at the studio. I study, I make a great effort. I believed that I analyze the feedback very well, so I know my mistakes. I write down almost everything. That's the point that makes me strong. When an instructor says something to me which I do not agree with, I fix it [interpret it] in my own way. I always compare my work by watching others' work, and so I can understand whether I'm successful or not." (H.16)*
Comments on the outcome	*"I liked my first idea, but not the process. I felt like I got stuck and could not find anything... I wish I did something different than that [the project]. I think I started in the wrong way... I mean, if I did my research better, I could do a better project. Hopefully, I can learn how to do that maybe in my first job." (L.20)*	*"I cannot say it is over. Projects need to get a final presentation once the term finishes, but I think they never end. I liked working on it, after all. There are still things to develop, and I'm planning to develop my project to put in my portfolio." (H.10)*

The students' descriptions indicated that they found it hard to decide between realistic and conceptual projects, stated as developing either a functional product or a meaningful one. Low achieving students complained about their difficulties with a meaning-focused approach and even attributed their low grades to this. By contrast, high achievers approached their designs in a more integrated way. Low achievers were

challenged in deciding on specific task strategies, which indicates problems related to understanding the project holistically and using self-instruction.

All students demonstrated effective self-evaluation skills when they described their studies in the studio. They criticized their own behavior and works. They were highly aware of what they had been doing. However, when describing specifically their study for tasks, it was clear that high achievers developed their projects by interpreting the tasks, feedback, and experiences from other courses. This is evidence of high achievers' integrative approach. In contrast, low achieving students submitted the tasks with minimal effort without interpretation, were highly influenced by examples and likes, fixated on given ideas, and lost their motivation in the face of harsh criticism. This attitude of low interpretation reveals problems with cognitive and metacognitive regulation.

Students also commented on the outcomes differently. High achievers wanted to improve the whole process by deducing from their experiences and believed that a project never ends. They had short-term action plans with long-term goals. Low achievers were oriented towards the future. They did not enjoy the process, wanted to change it entirely, and believed that they would eventually learn how to design in their professional lives. Self-commenting on the project outcome defensively or offensively affected motivation and goals directly.

3.2.2.3 Studio theme: external factors to which industrial design students are exposed

The third category was about the external factors to which students are exposed (e.g., studio subject and description (project brief), studio space, instructors, and peers). Students were encouraged to talk about external factors to the studio such as the brief, studio environment, instructors, peers, and other factors affecting their project process. Under this theme, (a) peer interaction, (b) feedback, and (c) managing information were examined. Representative quotations are presented in Table 3.10.

Table 3.10 : Representative quotations in Studio Theme: external factors to which industrial design students are exposed.

Subthemes:	Representative quotations from low achiever design students	Representative quotations from high achiever design students
Peer interaction	*"It is very hard for me to adapt [concentrate] here [in the studio]. I prefer to study at home, alone. The studio is more like meeting friends, chatting, eating. When I try to study in the studio, I need to get up every 15 minutes, walk around, and I see others' works so I cannot focus on my ideas." (L.17)* *"When I saw X's project presentation in the midterm jury, I felt discouraged. The subject she was working on was not so fancy, but the process she performed was highly developed. After that, I decided not to look at her work at all… before submitting my work, I checked the other work submitted in the folder (online submission platform). If they are as bad as mine, I feel comfortable." (L.5)*	*"I like to study in the studio. I do not feel sleepy since everyone works, and it makes me feel more motivated." (H.11)* *"We (peers) always talk about our projects, even during our breaks in the studio. When I see or think something about my friends' projects, I tell them and we discuss it together, for example, while drinking our coffee in the break." (H.14)*
Feedback	*"In the critic sessions or juries, I feel demoralized because of the way we are criticized. I know that I should not get offended personally, but I did. I feel degraded. I don't even care about the grade at that moment. The critiques should have been given more gently and kindly." (L.3)* *"Since my project went badly, even when I came eye to eye with the instructor in the studio, I felt stressed. While having my critique, my hand was shaking. Sometimes I got the impression from the teachers that they wanted to get out of my session. I thought they did not want to listen to me at all." (L.17)*	*"In a critic session, my idea was criticized heavily. That session was my turning point. I started to think more seriously." (H.1)* *"Soft critics make me happy, but I cannot keep it in mind. But heavy criticism stays in the mind for weeks, affecting me so much more positively." (H.14)* *"Sometimes I ask other instructors in the department since they can offer a more realistic critique as an outsider." (H.10)*
Managing information	*"First, I searched on the Internet for designs of this kind of object. I saw some rope and shelters. I like these kinds of materials, so I thought there could be small modules like this… after a while, I saw that the thing in my mind was already designed, and I was very sad. I searched the designer's work deeply, and I changed my project according to myself." (L.7)* *"I searched on the Internet about the keywords in the brief, but it was not helpful for me. I wanted to see what kind of concepts I'm interested in… finally, I decided on something when I saw some projects on sports areas, I'm familiar with." (L. 20)*	*"Mostly I search on the Internet for my presentations. I think it is also important. I want to trust my visual presentation to talk about my ideas confidently." (H.11)* *"I did my research to understand the problems in public toilets. I mostly read forums or some documents about it." (H.10)*

Students' descriptions suggest that high and low performers interact with their peers differently. High achievers enjoyed studying together and commenting on other projects motivated them. They liked spending time in the studio. Low achievers preferred to study individually – mostly at home. They expressed feeling psychological pressure when studying in the studio and having low productivity due to other students' presence. They were adversely affected by others' achievements and relieved by the failures of peers. Avoiding interaction with peers indicates problems with the regulation of behaviors such as seeking help.

The descriptions about the feedback (critiques) indicated variety in the students' self-efficacy beliefs. High achievers mentioned that they stayed motivated after harsh criticism, which was more effective and helpful than being praised or gently critiqued. They mostly learned from strong criticism. Students emphasized the value of asking for extra comments from other instructors. Conversely, low achievers mentioned that they were hesitant about and avoided meeting the instructors. They became demoralized after harsh criticism and lost their confidence. High achieving students seemed to have greater self-efficacy beliefs than underperformers.

In their third year, the design studio provides students with more opportunities for self-process time, which means that students need to develop their projects by doing desktop or field research by themselves in addition to homework and feedback from the instructors. When describing their self-process time, differences in the purpose of research became clear. High achievers researched on the Internet after they had decided on their subject. In contrast, low achievers went online to decide on their subject. The difference in the purpose of gathering information indicates problems in seeking appropriate information – a sub-dimension of behavioral regulation.

3.2.3 Integrating the quantitative and qualitative findings

To respond to the fifth sub-question *To what extent do qualitative and quantitative results converge and/or diverge?* we merged the quantitative and qualitative databases using a weaving approach that makes intragroup comparisons of the results into a type of narrative integration (see Fetters et al., 2013). We considered the quantitative and qualitative data analysis together on a theme-by-theme basis and determined that the qualitative data expanded the findings of the quantitative component. This allowed us to exemplify the statistical differences in the context of studio education and illustrate

these differences with essential aspects of Zimmerman's SRL model (see Zimmerman & Moylan, 2009). Some strategies that high and low achievers used during their projects were prominent in both data sets (see Table 3.2). Organizing and transforming, self-evaluation and self-consequences after failure were significantly different for the two student groups. Specific information from interview descriptions related to these aspects. Additionally, planning, task value, and attribution for failure were statistically different with supporting descriptions from qualitative data. There were also some inconsistencies in the findings. Despite no statistical differences, our qualitative results revealed differences in seeking information, seeking assistance, self-efficacy, and goal orientation. We discuss these aspects further in the next section.

3.3 Discussion

This study aimed to explore differences in SRL strategies and motivational factors between high and low-achieving ID students in a studio course. We used a convergent mixed methods design to gain a comprehensive understanding of the students' strategy use. The integrated analysis demonstrated that there were differences between high and low-achieving students' SRL skills concerning the use of metacognitive, motivational, and behavioral strategies.

Comparing the quantitative and qualitative results illustrated that the metacognitive strategies of organizing and transforming, planning, self-evaluation, and self-consequences after failure were different for the two groups in both data sets. High achieving students interpreted the project brief, tasks, feedback, and experiences of drawing or writing; and adapted their strategies according to their own understanding. These findings align with research pointing out the adaptive inferences and SRL patterns of high achieving students (e.g., DiFrancesca et al., 2016; Nandagopal & Ericsson, 2012; Pintrich & de Groot, 1990; Powers, 2006; Zimmerman, 2008). The lack of interpretation deters low achievers from developing their autonomy which is a crucial feature for the creative endeavor in design education (Tudor, 2008). This may explain the dependency of low achievers on external factors such as being easily influenced by examples, or praise from others, especially instructors. Design students are expected to be independent, self-analytical, and critical thinkers (Tovey, 2015) and the nature of studio education generally produces this kind of learner. However, our results demonstrated that design students can have very different experiences in the

same studio, and some struggle to find their way of learning (Shreeve, 2015). These findings may caution studio educators to accept individual differences, engage metacognitive strategies, and encourage students to understand their own learning journeys.

Within metacognitive strategies, the differences in self-evaluation of the student groups were at different levels. Despite the significant difference in the quantitative analysis, students' descriptions revealed that they were all aware of their strengths and weaknesses. This qualitative result is consistent with Zimmerman and Martinez-Pons' (1986) self-evaluation finding – the only strategy unrelated to academic achievement. However, deeper conversations and observations during interviews supported the quantitative results that low-achievers were evaluating themselves while answering our question. This confirms the notion that multidimensional assessment approaches have more potential to understand human regulation (see Cleary et al., 2012; Tas & Sungur, 2012) and capture these nuances. Low achieving students complained about the problems that they encountered, attributed their weaknesses to the education system, and expected the instructors to teach them how to make self-adjustments and overcome difficulties. In their SRL model, Zimmerman and Moylan (2009) place self-evaluation and causal attribution together due to their interdependence, and our results parallel their findings. Attribution to external and uncontrollable factors discourages efforts to develop, undermines self-motivation (Schunk, 2007; Weiner, 1992; as cited in Zimmerman & Moylan, 2009), and reduces ownership which is a motivational necessity for students (Powers, 2006). Self-critique reduces dependence on others and helps to develop self-regulatory learning skills (Crolla et al., 2019; Greene, 2018). Our findings indicate that underachieving design students need to be encouraged in self-judgment during the studio process through focusing on controllable causes rather than defensive decisions.

Quantitative analysis revealed motivational factors (task value, attribution for failure, and the overall scores) as notable predictors of academic performance. Student interviews enabled us to further discover the differences in goal orientation and self-efficacy factors. Low achievers defined studio success as receiving positive critique from instructors, which demonstrated their performance-oriented goal. Their frailty in the face of harsh criticism also indicated low self-efficacy. Our integrated findings support and expand on previous studies that discuss the relationship between

motivation, SRL, and academic achievement (e.g., Araz & Sungur, 2007; Eckerlein et al., 2019; Erdogan & Senemoglu, 2016; Kryshko et al., 2020; Meece, 1994; Pintrich & Schunk, 2002; Zimmerman, 2000; Zimmerman & Moylan, 2009). The positive correlation between SRL strategies and motivational factors in the quantitative results of this study reflect the notion that self-regulation should include learning strategies and motivational factors, as many scholars have noted (e.g., McCombs, 2001; Pintrich & de Groot, 1990; Trautner & Schwinger, 2020; Zimmerman, 1990). Students need to be motivated to navigate the complexity of design education by accepting mistakes, obstacles, and risks, and developing methods for handling tasks and self-evaluating learning performances (Fadlelmula et al., 2015; Garner & Evans, 2015; Powers, 2016)

In contrast to quantitative results, qualitative data exemplified differences in behavioral strategies between the high and low-achieving groups. High achievers were more open to peer and teacher interaction. They preferred to seek the help of others, study together, and believed in learning more effectively in this way. They also sought appropriate information with a process-driven approach. Low achievers tended to access easy information in a result-oriented way and were reluctant to have comments from peers or instructors to avoid demoralization. These findings on information- and help-seeking strategies are in line with studies considering these resource management strategies as self-regulatory processes and predictors of academic achievement (e.g., Englert & Mariage, 2003; Greene et al., 2015; Karabenick & Gonida, 2018; Newman, 2008; Zimmerman & Cleary, 2009; Zimmerman & Martinez-Pons, 1990). Reluctance to seek help mostly relates to a lack of awareness of the need for help (Greene & Azevedo, 2009), lack of social competencies, or as stated in interviews, fearing criticism (Karabenick & Knapp, 1988). From this standpoint, the possibility of problematic communication between underachieving students and instructors should be considered. Critique sessions are the fundamental tools of reflective conversation in design studio education. They also improve the metacognitive skills of design students (Greene, 2018). Yet, if the critiques mostly point out weaknesses or mistakes, students may avoid attending the sessions or misinterpret the comments (Goldschmidt et al., 2010). Inaccessibility of the instructors – described as ‘mystery-mastery’ syndrome by Schön (1987) may prevent underachieving students from asking for help and decrease their self-confidence. Criticism should be given in a scaffolded manner that supports underachieving students to use external resources appropriately.

The most remarkable result emerging from the qualitative data was the dilemma faced by students. Both high and low achievers reported difficulty in deciding on a strategy for developing their projects, which they described as the dilemma of product versus meaning. High achievers were successful in integrating their ideas – exemplifying a cognitive strategy for critical thinking (Paul, 1989) – but the perception of contradiction caused underachievers to choose what seems easy. The descriptive words that students used about their projects also indicated a similar dilemma. Low achievers used concrete terms, while high achievers chose abstract phrases. These findings broadly follow research showing the correlation between SRL, critical thinking, and academic achievement (e.g., Gaythwaite, 2006; Oz, 2019; Paul & Elder, 2005; Phan, 2010; Seferoglu & Akbiyik, 2006). The cognitive strategies such as moving from abstract to concrete, analysis to synthesis, or information to interpretation are seen as skills of critical thinking (Paul & Elder, 2005), a process of innovation (Beckman & Barry, 2007), a creative production (Orlandi, 2010), a representational transformation (Casakin & Goldschmidt, 1999; Oxman, 1999), and a designer's skill (Powers, 2016; Tobón et al., 2021; Voûte et al., 2020). The ability to synthesize and interpret provides students with cognitive strength to deal with the complexity and ambiguity of design projects (Austerlitz et al., 2008; Shreeve, 2011). Fostering SRL strategies in the design studio may help underachieving design students to develop the higher-order thinking skills that are needed to cope with ill-defined problems.

Using a convergent mixed-methods approach, this study has taken steps toward describing differences in the self-regulation skills of high and low-achieving ID students in a design studio course. The interview findings expanded the self-report questionnaire results, presented new insights, and provided a detailed understanding of the statistical results. Through this study, we anticipate our contribution in two levels. First, it provides insights from design studio education for education literature, which is a creativity-focused learning environment with natural learning conditions and simulation of real-life. Second, regarding the ongoing deep changes in both educational, theoretical, and practical sides of design -which is signifying a new order of design and a new generation of designers who tend to become decision-makers- this study fills a gap within the existing body of design pedagogy and instruction in industrial design relative to self-regulated learning. It highlights the importance of students' self-awareness, strategy preferences, and purpose of learning in design studio

education. Thus, we aimed to better understand design learning and provide further insights for redesigning the studio learning experience. Design studios will not fulfill their potential to foster SRL skills through the signature pedagogy unless individual student differences are paid attention to. Studio education needs improvement to encourage students to develop their learning skills. The implication of SRL strategies regarding individual differences in design learning environments can help to improve the design performance of less accomplished students.

To further our research, we conducted an intervention in a design studio course, where the specific SRL strategies and phases were integrated into the studio process targeting underachieving students' needs. In the following chapter, this intervention study will be discussed.

4. PHASE II: SELF-REGULATION INTERVENTION IN INDUSTRIAL DESIGN STUDIO (THE SRIIDS)

This chapter depicts how the experimental study in the second phase of this thesis is designed and conducted. Student participation and self-regulated learning outcomes on design performance in the studio are examined in this study. The research questions specific to Phase Two are:

RQ.2: To what extent does SRL-intervened studio affect design learners' reported use of SRL strategies in their design learning?

RQ.3: What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?

RQ.4: How does student's self-regulation influences their design performance?

In Phase Two, a quasi-experimental research methodology was implemented, with both qualitative and quantitative data being collected. This chapter reports on the design of this intervention, the implementation of the intervention, and evaluation of thereof.

4.1 Methodology for Phase II: A Quasi-Experimental Research Design

The experiment-based phase of this thesis includes designing and testing the self-regulated intervention that is developed for industrial design studio education. The components of this phase of the research are depicted in Figure 4.1, as well as how it was informed by the previous phase. As in the exploratory phase, both quantitative and qualitative methodologies were employed in the experimental phase to test the intervention, and to explore the research questions comprehensively.

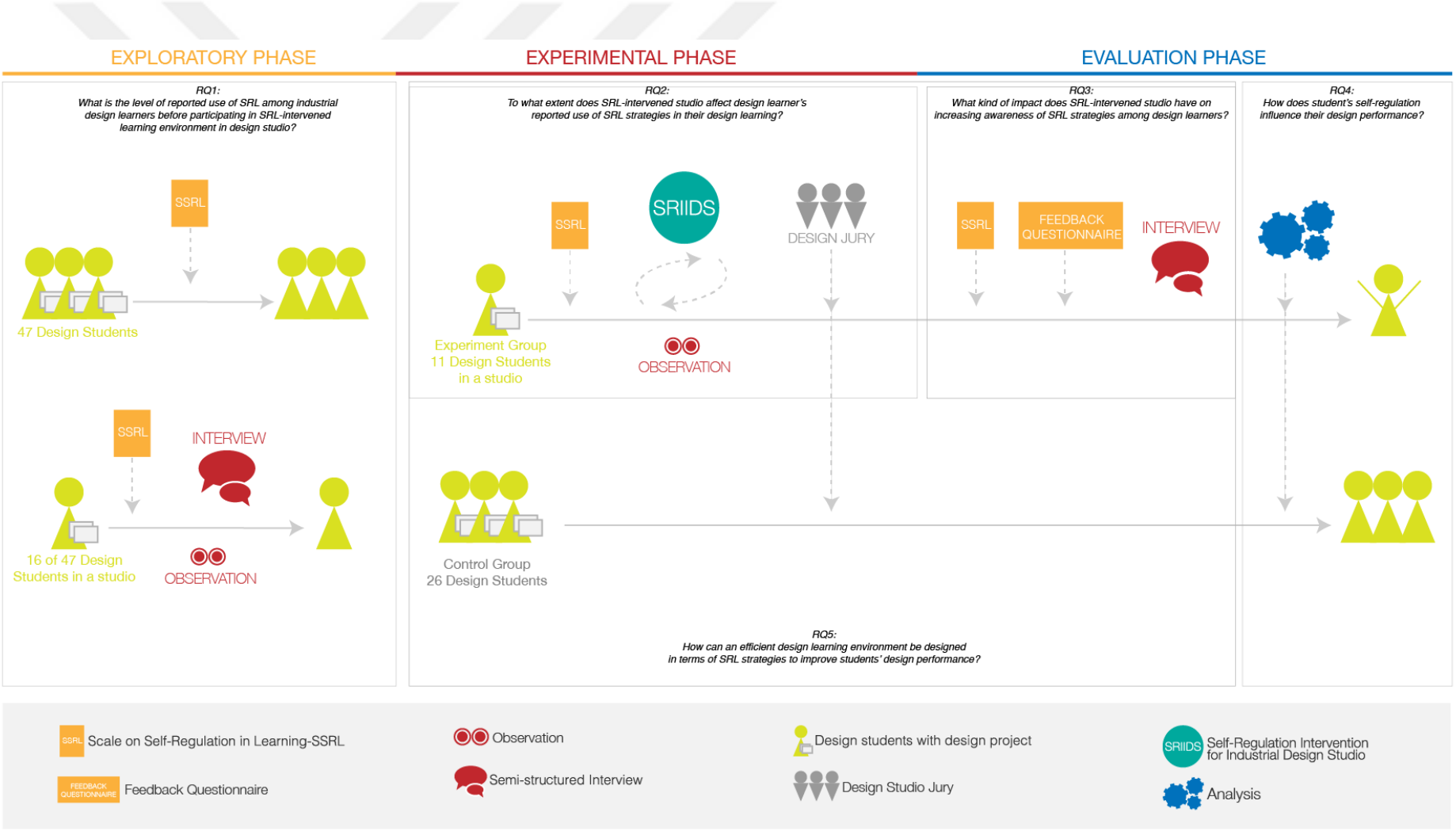

Figure 4.1 : The overview for the exploratory, experimental, and evaluation phases of research design.

Experimental research is a methodological approach in which the researcher manipulates one or more independent variables to determine their effect on one or more dependent variables (Teddlie & Tashakkori, 2009). In experimental research design, procedures vary according to the types of participant assignment (i.e., random or non-random) and the existence of a control group (see Creswell, 2014). The intervention study of this thesis was implemented with a predetermined intact group of design students, while the other students in the same studio class were attended as the control group. All the students experienced the same studio process, except that the experimental group practiced the intervention study. There was an intact group of design students available since the researcher was an research assistant in the department. The researcher did not randomly assign participants to groups. These kinds of studies are regarded as quasi-experimental designs (Campbell & Stanley, 1963). The participant students of the intervention joined the Self-regulation Intervention in Industrial Design Studio which will be explained in the following sections. The remaining students in the design studio, who acted as the control group, continued to learn under normal studio conditions.

The second and third research questions of this thesis are about the effect of the intervention study on the participant students. Within this context, Single-Group Interrupted Time Series Design as a type of quasi-experimental design was used. In this research design, the researcher records pre-and post-treatment measures for a single group (Creswell, 2014). In this study, pre-test and post-test results of the SSRL scale were compared to see the differences in the participants' reported use of SRL strategies. Furthermore, to understand the changes in the awareness of SRL strategies among participant students, they were observed and interviewed by the researcher. The fourth research question referred to the effect of the intervention study on design performance. To answer this question, Control Group Interrupted Time Series Design as another type of quasi-experimental design was used. This research design involves the observation of two groups of participants for a given period (Creswell, 2014). The researcher compared the grades of the experimental and control groups. Figure 4.2 provides an overview of the specific research design for the second phase of this thesis.

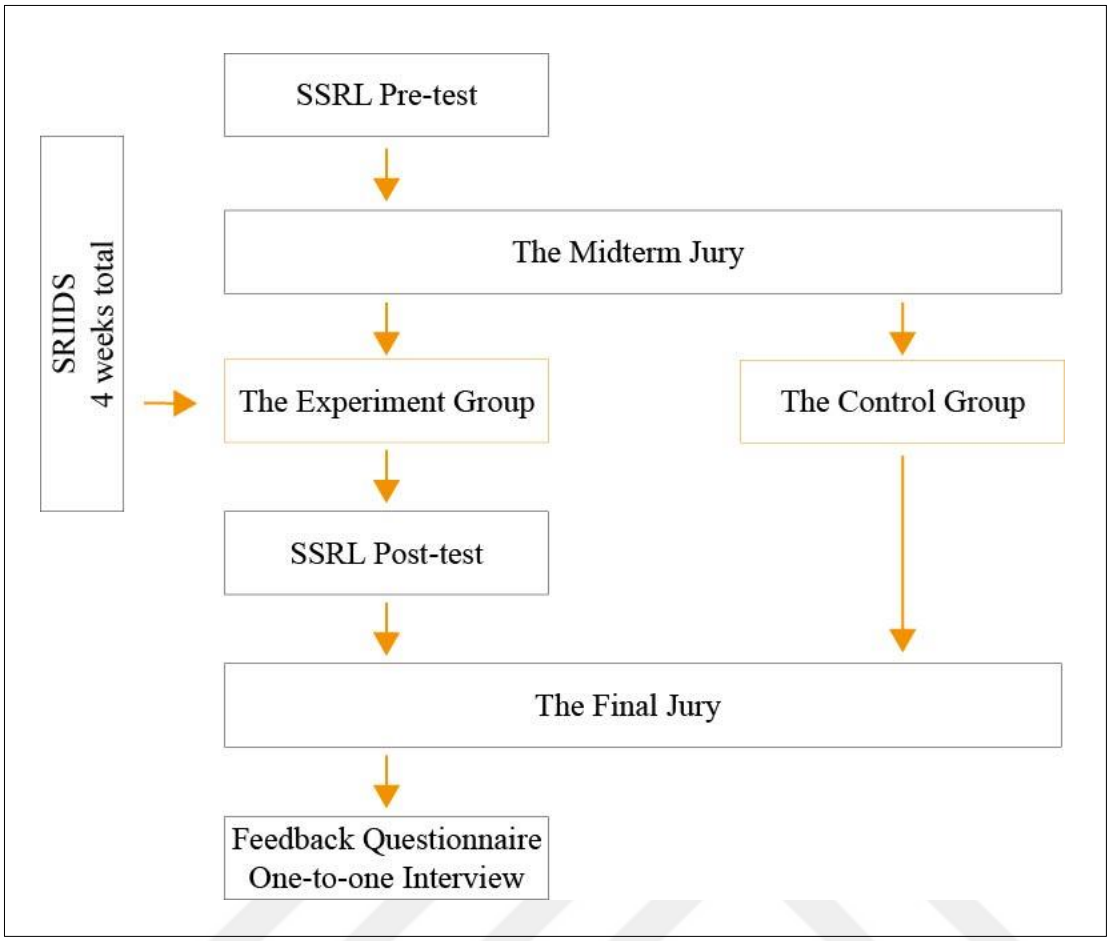

Figure 4.2 : Visual model of Phase Two research design

Although widely accepted, quasi-experiments suffer from some imperfections due to their lack of experimental controls. Campbell and Stanley (1963) claim that when it comes to the final interpretation, all experiments are imperfect. For especially quasi-experimental designs, they suggest that interpretations should be done with fully aware of the possibilities of uncontrolled factors which contribute to the outcomes. From that standpoint, the limitations of this quasi-experimental research were discussed in section 4.5.3 while interpreting the findings of the study.

4.2 Design of the Intervention

This section discusses the content development of the study that is used as an experimental research context conducted in the Department of Industrial Design at IBU. Within this framework, scaffolding in an emergency remote design studio, characteristics of the intervention, and the content of the intervention will be explained.

4.2.1 Self-regulated scaffolding in an emergency remote design studio

Learning environments in the studies that foster SRL are mostly face-to-face. In the last decade, the number of studies on online environments has started to increase since online platforms are being used more than ever. With the lockdown in March 2020, due to the Covid-19 disease, all educational activities had to move to digital platforms, which is called emergency remote learning. Teachers did not have time to prepare, and students had to get used to online learning in a very short time. This was not an online learning environment since courses were not designed to be delivered online, it was a shift to digital mediums to continue education (Winters, 2021). While using online platforms for learning, learner autonomy is required more than in face-to-face teaching since students have to connect to virtual classrooms from their living environments (Latchem, 2019). Students are expected to benefit more using SRL strategies in online environments (Latchem, 2019; Olivier, 2020; Pérez-Álvarez et al., 2016). As explained in Section 2.2, design studio is already a demanding learning context, and this causes negative pressure on some struggling students. The shift to emergency remote studio education created another demand for using online tools to keep up with the studio's educational requirements, therefore strategical demands from learners were multiplied. Scholars suggest that this is going to be our "new normal" (Lichfield, 2020). Hence, the physical distance should be turned into a positive experience by using student-centered learning activities to support the studio pedagogy.

The emergency remote studio is a virtual space where activities similar to the physical studio are conducted digitally. In the studios that this study is conducted, instructors and students meet in virtual classes using video conferencing platforms. Like the physical studio, students present their works on computer or paper, get feedback from the instructors and peers, and are expected to study during the online session which can take four or more hours. Unlike the physical studio, peers and instructors are not easily available. To give feedback one-on-one, instructors have to create breakout rooms for each student. According to the observation of the researcher of this thesis, the physical absence of the instructor creates a perception in students that time and space are flexible. Eventually, students lose their attention easily in this unfamiliar terrain. Since self-regulated learners need less teaching presence (Pool et al., 2017), supporting design students with SRL strategies can help to use this flexible time more efficiently both during and after the virtual studio.

As a result of these considerations and practical impossibilities, the intervention study of this thesis was planned and conducted as an online intervention. The content of the study was developed by getting help from both online and regular classroom intervention examples and accommodated to emergency remote studio environment regarding the findings of Phase I in this thesis.

4.2.2 Characteristics of self-regulated learning interventions

Between several successful intervention approaches, there are some didactic commonalities such as direct strategy teaching, modeling, practice, feedback, self-monitoring, self-reflection, and scaffolding (McKeachie, Pintrich, & Lin, 1985; Volet, 1991; Butler, 1998; Gargallo López, 2001; Dörrenbächer & Perels, 2016; Bellhäuser et al., 2016; as cited in Loeffler et al., 2019). It is very challenging to decide on the most suitable features since there is neither an SRL intervention study in the design studio nor a guide in other contexts that has been undertaken before. Besides, participation and achievement of students do not always correlate among SRL interventions and that may be due to differences in effectiveness (Dignath & Büttner, 2008). In a recent study, Jansen et al. (2019) conducted a meta-analysis that focuses on the differences between empirical SRL intervention studies and explored five characteristics that might potentially influence the effectiveness of SRL interventions on SRL activity and achievement. Even though they had difficulty in defining a practical design guideline for SRL interventions, the analyses prove that SRL interventions are effective in both SRL activity and achievement. They also discuss that no type of intervention is less effective than the other and there is no "wrong" intervention design. Although this assumption appears to be making the intervention design process harder for the practitioners by giving them freedom, it also provides a chance for developing interventions tailored to the specific needs of the relevant learning context. Besides most of the intervention studies were not conducted in natural learning conditions, so an application in a real-life learning condition is important to support the transfer of strategies into everyday life (Loeffler et al., 2019). To develop the very first SRL intervention for a design studio, the characteristics of interventions in the study of Jansen et al. (2019) were used as a source. The content and procedure of Jansen et al.'s intervention were accommodated to design studio conditions. The assumptions about these characteristics, findings of the meta-analysis,

and interpretations for the intervention design for the SRIIDS will be discussed in the following sections.

4.2.2.1 Cognitive strategies

To effectively self-regulate, students must possess a wide range of cognitive methods; otherwise, they will be unable to regulate their learning behavior (Hattie et al., 1996; Paris & Paris, 2001). Therefore, whether the intervention includes cognitive strategies as well as SRL is an important characteristic. The requirement for training in cognitive strategies presumably diminishes as students progress in education and internalize more cognitive strategies (Dignath & Büttner, 2008). Higher education students who have a good cognitive strategy repertoire (i.e., memorizing) may benefit from getting support for SRL activities (i.e., planning a work) (e.g., Greene et al., 2012; Nietfeld et al., 2006) In a design context, students develop some cognitive strategies intuitively since they were taught mainly by example and practice (Lawson, 2005). Hence, the intervention is designed to support their SRL activities (e.g., how to plan their project process) than cognitive strategies (e.g., thinking of the 3d visual of the project).

4.2.2.2 Format of the intervention

Knowledge about SRL and SRL activities enables students to engage in SRL successfully (Dignath & Büttner, 2008; Paris & Paris, 2001; Zimmerman, 2002). The format of the intervention is another important feature for a successful study. Undergraduates who have internalized more knowledge on SRL activities need stimulation to activate their existing metacognitive activities and reflect on their learning process (Bannert & Reimann, 2012) since they often struggle to engage in successful SRL (e.g., Azevedo & Cromley, 2004; Bol & Garner, 2011; Dunlosky & Lipko, 2007; Peverly et al., 2003; as cited in Jansen et al., 2020). They do not need instructions as they already know them, but they do not know how and when to use them. In the meta-analysis of interventions by Jansen et al. (2019), all types of intervention formats (instruction, application, and prompting) were found to be beneficial for both SRL activity as well as achievement. Regarding the undergraduate level, the format of the intervention was developed based on a scaffolding approach using basic instructions to prompt the students to use and interpret them in their project process.

4.2.2.3 Timing of the intervention

The timing of the intervention varies in studies, such as before the course (e.g., Azevedo & Cromley, 2004), during the course (e.g., Delen et al., 2014), or in the second half of the course (e.g., Nückles et al., 2009). Each timing type has some advantages. The meta-analysis showed that all possible timings of the intervention were found to be beneficial for both SRL activity as well as achievement, which means that timing is not a diversifying characteristic for SRL interventions. However, deciding on the timing according to the learning environment is still important to develop a successful intervention. In the design studio, the generation and development of design ideas is the most challenging phase, and metacognitive thinking is mostly produced in this step (Kavousi et al., 2020). In the design studio where the intervention was conducted, the individual design development phase started after the group research phase in the 4th week and continued through the end of the term. In individual projects, regulating the self-process is easier than in group projects (Powers, 2016). Therefore, it was planned to carry out the intervention with individual projects in the design development phase.

4.2.2.4 Tailoring to the learning context

Learning strategies that students employ vary depending on the learning context. Therefore, domain-specific interventions (i.e., asking students to demonstrate their understanding of a specific topic) support students' SRL behavior more effectively than general prompts (Devolder et al., 2012). Although the meta-analysis claims that tailoring the intervention to the learning context is not crucial for the effectiveness of the SRL intervention (Jansen et al., 2019), general prompts are not enough to support students to identify the most effective learning strategies in each circumstance. In the context of this study, as stated in section 2.1.3, the design studio has its domain-specific dynamics. To support the design students through these dynamics, the interventions were conducted in parallel with the studio process. The weekly tasks that the studio coordinator defined were used as the materials of the SRL intervention to make the students interpret and apply the activities on them. Specifically, the midterm jury was used as a milestone so that students could see their performance and reevaluate their process.

4.2.2.5 The type of SRL activity

Within the framework of student achievement, some SRL activities correlate to success in a stronger way than others (e.g., Broadbent & Poon, 2015; Sitzmann & Ely, 2011). The debate yet remains whether SRL interventions should direct their efforts on one specific subset of SRL activities (i.e., those that are extremely connected to achievement), or instead whether they should be used to aid students in having an overall skill in SRL. To explore if there are differences in effects of SRL interventions according to their focus of aspects, Jansen et al. (2019) included all SRL activities (i.e., metacognitive & resource management) that are used in interventions as a moderator in their meta-analyses. General SRL interventions were expected to be more effective for achievement than interventions that focused on specific metacognition or resource management activities, yet the meta-analyses indicated no difference in effectiveness depending on the activities. In other words, all kinds of SRL activities promoted achievement regarding SRL behavior. Since there is no study on SRL intervention in a design studio prior to this thesis, as a first step, a general SRL intervention which is suggested in Jansen et al.'s meta-analysis was planned. The content for the general SRL intervention was developed by accommodately fostering all the components of Zimmerman's SRL model, which was the most promising model and that manifested in improved performance in students (Nückles et al., 2009).

4.2.3 Content development for a self-regulation intervention in industrial design studio

In this section, the content of the SRL intervention study for an emergency remote industrial design studio will be presented. The intervention study was named as Self-regulation Intervention in Industrial Design Studio (hereinafter the SRIIDS). The content was informed by the findings of the first phase of this thesis (see section 3.2) and the process model of SRL developed by Zimmerman (2000) (see section 2.1.2). The characteristics of the intervention stated by Jansen et al. (2019) were used for procedural decisions. Following this, the SRIIDS was planned as 4 sessions within the design studio course. 3 of the sessions were developed based on the 3 phases of the SRL model, and the last session was conducted as a reminder about the loop of the process. The content of the sessions will be illustrated in the following sections.

4.2.3.1 The first session of the SRIIDS: goal setting and planning

As described in section 2.1.2, Zimmerman and Moylan's revised SRL model is a cyclical process consisting of three phases: forethought, performance, and self-evaluation. Although these phases are related to each other in a cyclical process respectively, it has been found that there is a high correlation between the sub-processes of the phases (Zimmerman & Kitsantas, 1999; Zimmerman, 2002). Therefore, in this study, the SRIIDS sessions were named after the strategies which were mainly focused on in that phase (i.e., goal setting & planning), but they were also supported during the other sessions through questions and discussions.

As a preparatory step, in the forethought phase students are expected to analyze the learning tasks, set specific goals, and make plans to complete these tasks. As a distinctive feature from other models, motivation is considered as a part of SRL in Zimmerman's model and included in the forethought phase. This phase precedes efforts to learn, influences students' readiness and desire to self-regulate their learning (Zimmerman & Moylan, 2009). Goals are required to start the SRL loop since they promote students to shape their design actions, and increase motivation to participate in learning (Powers, 2017). Boekaerts and Cascallar (2006) see goals as "knowledge structures" that lead to behavior (as cited in Panadero, 2017). Students tend to be emotionally triggered according to their perception of task difficulty, and goals allow them to use strategies for protecting their ego and moving through their plan (Panadero, 2017).

In the design studio, emotional triggers are much stronger due to the critical approach of the instructors, thus design students need to be allowed to select or modify their projects through their personal goals. Powers (2017) defines this approach as "self-regulated design learning" and identifies three important factors of SRL, which are pro-active engagement, choice, and goals. All these determinants indicate the importance of agency, autonomy, and awareness for a design student to build up a self-regulated process in the design studio. Powers (2006) also indicates that prior knowledge and background of the students should be used to personalize the projects for each student. Although studio instructors have a process-oriented approach, time pressure and/or the purpose of being appreciated by the partner company can make the critics be more interested in how a good project should be. In such an environment, it is very difficult to realize the individual weaknesses of the student and to devise

learning-oriented plans for each student. Instructors rarely give students the opportunity to define their learning goal, choose tasks or evaluate their own work on their own. On the other hand, students require their teacher's leadership and approval especially in the early stages of their studies since they feel very insecure about their project (Goldschmidt et al., 2010). A supporting conclusion was reached in the first research phase of this thesis (see section 3.2.3). The dependency of design students on their studio instructors and other external factors has a negative correlation with their achievements. Therefore, the first session of the SRIIDS was planned as a breaking point where dependency on others started to transform into self-realization.

Based on this starting point, the content of the first session of the SRIIDS is designed to encourage the students to ask questions about their learning experience in the studio and to specify their own goals. Since the SRIIDS was designed as a direct and explicit intervention study (see section 2.1.5.1), the content of the first session included information about SRL and its support for achievement. Students were presented explicitly with self-regulation strategies, learning tools, SRL phases, and implementation in the studio. They were then encouraged to think and write down their ideas on their design process. As a task analysis, the project brief was reread, and learning outcomes and evaluation criteria were discussed. Later, they defined their goals and plans according to their priorities through a questionnaire form (see Appendix D). Table 4.1 shows the subjects in the content and process with dates of the the SRIIDS study.

Table 4.1 : Content and Process of Self-regulation Intervention in Industrial Design Studio.

Date	Process	Content
20-Oct-20	Ethical permissions	
23-Oct-20	SSRL Questionnaire	Conducting SSRL self-report questionnaire to all 3rd-grade industrial design students
27-Oct-20	Research Jury	
30-Oct-20	the SRIIDS announcement	E-mailing invitation poster and initial information about the process
2-Nov-20	the SRIIDS working group	Arranging working groups Announcement of the first session
3-Nov-20	1st session of the SRIIDS	**Goal setting and planning in the studio (as part of the forethought phase of SRL):** Students' introduction of themselves Introduction to "learning" How does learning take place in the studio? Thinking and writing about the project process in the studio What are SRL and SRL loop? When and how is SRL used? What is the effect of motivation? How to implement SRL in the studio. <u>Task analysis:</u> Re-reading the brief of the project Discussing the learning outcomes and evaluation criteria Goal setting and planning practice: Questionnaire 1.
10-Nov-20	2nd session of the SRIIDS	**Self-observation in the studio (as part of the performance phase of SRL):** Discussion of the answers for Questionnaire 1 Discussion of individual differences in learning Reflection on the individual learning process: How do I learn? <u>Metacognitive monitoring: Self-observation</u> My belief in myself in this project (avg. 3.2/5) In which subject do I feel successful, strong, lucky? At what point do I feel unsuccessful, powerless, unlucky? Developing the weakest point: Questionnaire 2
17-Nov-20	Midterm Jury	
24-Nov-20	3rd session of the SRIIDS	**Self-evaluation in the studio (as part of reflection phase of SRL):** Watching self-presentation and commentary records of midterm jury Answering the questions: -How do I feel after the jury? -Commenting on presentation and comments -The strongest part of my project -The weakest part of my project Self-evaluation of the midterm jury: Questionnaire 3-a Re-planning after midterm jury: Questionnaire 3-b One-to-one process tracking: My design process
1-Dec-20	4th session of the SRIIDS	**The loop of SRL** Practice thinking on the project process: What did the studio want from me? What was my purpose? Where am I in my project, what am I doing? What subjects am I bad at, what can I do better? What will I do now? Activities on Miro application: Collective activity: what do you need to be successful in the project? Individual activity: Process follow-up "My design process" 5-day & 5-week plan.

4.2.3.2 The second session of the SRIIDS: self-observation & self-efficacy

According to Zimmerman & Moylan (2009), the learning processes which affect engagement and achievement are included in the performance phase. It is the most active phase regarding implementing, monitoring, and regulating the learning strategies, and using resources most efficiently (Jansen et al, 2019). In this phase, self-regulator students control themselves by using behavioral strategies such as managing the time, structuring the environment, and seeking help (Zimmerman & Moylan, 2009). These self-control techniques help them to follow their goals and plans and improve their motivation (Wolters, 2003). To develop persistence, one of the important characteristics in SRL, strategies should be adapted according to students' goals, which indicates the importance of self-observation. Metacognitive monitoring, as a form of self-observation, is a method of tracking one's own active learning performance and outcomes (Zimmerman & Moylan, 2009). Self-monitoring helps students to see their strong and weak activities so that they can develop a strategy on them. By doing this, self-efficacy, which according to Zimmerman (2000) influences persistence, increases, too. It is important to note that, in this phase, students who already have high self-efficacy have more active and productive progress (Arpat, 2020). This also confirms that motivation is needed in every phase of SRL.

In a design studio, motivation is another factor that is constantly tested. Particularly public comments that are unjustifiably harsh can cause students to lose confidence in their abilities to do specific design-related tasks and behaviors (Powers, 2006). In the first phase of this thesis, findings showed a similar pattern (see section 3.2.3). Low-achieving design students defined success in the studio as having positive critique, and they were so fragile in the face of harsh criticism. Students' persistence for studying was diminished. Besides, low achievers were reluctant to seek help from others to avoid demoralization and aimed at easy result-oriented ways.

The second session of the SRIIDS was developed targeting these deficiencies (see Table 4.1). First, participants discussed their goals and plans which they defined in the first session together. This discussion aimed at developing peer interaction, which also helps to improve self-efficacy since students share similar problems or weaknesses and exchange their prior experiences. Another direct and explicit SRL subject was shared, which was about individual differences. Students were encouraged to persist in their own way of learning to develop their trust in themselves. Later, as a metacognitive

monitoring activity, strengths and weaknesses against the studio's assessment criteria were discussed. Finally, they were asked to answer Questionnaire 2 (see Appendix D) which was focused on writing a response to the question "How to get an A in the design studio?". This question is a suggested SRL activity by Nilson (2013) who claims that underperformers must take an honest look at why and where their performance has been weak and attempt to correct or strengthen their approaches. Since making a connection between success and effort is defined as an instructional approach that promotes SRL (Paris & Paris, 2001; Sungur & Gungoren, 2009), this question was directly used to make the design students think about the criteria of success and compare their performance against these criteria.

4.2.3.3 The third session of the SRIIDS: self-evaluation

The self-reflection phase, which is the third phase of Zimmerman and Moylan's SRL model (2009) includes self-judgments and reactions to these judgements. Zimmerman and Moylan point out two critical factors in this phase: determining the standard for evaluation and attributing for success or failure. To make a self-evaluation, which is the key form of self-judgment, learners must compare their performance with a standard. If that standard is at an unrealistic level, students' motivation will diminish. Using prior levels of performance as a reference prevents students from competing with peers who have an advantage (Zimmerman and Moylan, 2009). This also encourages the students to focus on controllable causes rather than defensive decisions. Findings from the meta-analytical review of Panadero, Jonsson and Botella (2017) show that self-evaluation interventions have a positive effect on students' self-regulated learning strategies and self-efficacy. Students evaluating their learning can discern which methods were useful and what changes could be made for future learning (Pintrich, 2000).

Design studio education demands that students study by themselves during the studio and between the studio sessions. In these self-study times, design students are expected to criticize their own work and make progress. Hence, self-criticism is one of the important progressive tools in the design process. We can construe Schön's (1982) description of "back-talk" of the situation as self-criticism. Students must respond to that back-talk to develop their ideas. However, this can be difficult for underachievers since they tend to depend on the instructor's talk. The first exploratory research phase of this thesis produced similar findings. Low-achieving design students attributed their

failure to external sources (i.e., education system and instructors). In the end, this reduced their ownership of design project which is a motivational necessity for students (Powers, 2006). Self-criticism is an important independent design learning tool to reduce dependency on others (Crolla et al., 2019), which design students need to be encouraged to do.

Besides self-critiquing during the studio, students can also reflect on their design processes via their jury presentations. In jury presentations, they express in words on the summary of their design process while answering how and why questions and showing their visual representations. The verbal presentation has a complementary role to visual media and is as critical as visuals to understand a design project (Ferreira, 2018). According to Cross (1996), words that connect the ideas and visualizations of the design also contribute to the design process together with the drawing activity. Juries are the milestones for deciding on the direction of the projects. However, students get nervous during their presentations, forget to mention some parts of their projects, and mostly miss or do not remember the critics made by jury members. Zimmerman and Moylan (2009) indicate that when a person's mental capacity is exceeded by the amount of information required to execute hard academic tasks, tracking one's performance becomes challenging. Recording helps students to reduce their dependence on memory and to better track performance over time (Zimmerman & Kitsantas, 1999). According to the findings of the exploratory phase in this thesis, while achieving design students preferred to use recordings such as written or voice-notes, underachievers were reluctant and ineffectual about this because of either their lack of confidence in writing-drawing skills or their unwillingness to rework on the recordings. Therefore, underperformers need to be guided to self-critique themselves for which recordings can be helpful.

In pre-teacher education literature, there is a technique called “microteaching” which uses video recording of a scaled-down lesson conducted by a pre-teacher as an evaluation tool. Pre-service teachers watch their video-recorded microlessons with their peers and instructors to analyze, reflect on and finally improve the lesson (Ostrosky et al., 2013). This enhances the learning experience by allowing pre-teachers to receive more detailed feedback on their performance (Brent et al., 1996). Besides, watching self-performance provides pre-teachers with advantages such as determining strengths and weaknesses, realizing their own mistakes, and the opportunity to watch

and analyze the record many times (Marulcu, 2014). In the studio education context, such an approach can be used for midterm juries since they are rehearsals for final juries.

The content of the third session of the SRIIDS was developed by considering how to encourage the design students to make self-criticism. Due to the emergency remote learning conditions, the studio meetings and juries were already recorded on Zoom, which is the cloud-based video conferencing platform used during pandemic. First, participants watched the video-record of their midterm jury presentation on Zoom by themselves. A question list prepared by the researcher was shared with the student to answer while watching their performance (see Table 4.1.). After the individual video watching session, the records were watched and critics and feedback were analyzed together with researcher. It was important to encourage the peers to comment on the records. Requirements of the midterm jury were used as evaluation criteria, but also prior presentation experiences of the presenter student were discussed. Finally, students were asked to fill out the questionnaires which were designed to focus on self-evaluation and re-planning (see Appendix D).

4.2.3.4 The fourth session of the SRIIDS: the loop of SRL

According to the social cognitive model of self-regulation, feedback loops for students are cyclical, which means that the self-regulatory cycle is completed when self-reflections inspire forethought about future learning activities, and each student has different lengths of self-regulatory cycles, depending on the frequency and timing of feedback (Zimmerman and Moylan, 2009). While students move through each phase, they may choose to use different activities to help regulate their learning (Jansen et al., 2019). Individuality is an important characteristic of the SRL process. Students should understand that each learning activity belongs to them, and they should identify, try, evaluate, change and eventually improve the activity according to themselves.

The fourth session of the SRIIDS was developed to make sure that students understand the loop of SRL and that they can operate and individuate it in practice. They were asked to use MIRO, an online collaborative whiteboard platform while thinking about the project process. First, they created individual boards consisting of their ideas on the requirements for success project. Then, we created a general board named *success in the studio* (SIS), in which they could participate in real-time and share their opinions

on it. Finally, they were asked to use individual boards created by the researcher to plan their following 5-day and 5-week goals, which each student discussed it with the researcher individually. Figure 4.3 depicts the visuals of individual and general boards created during the activity. In this way, students were directed to start another SRL loop by defining goals and plans based on their reflections on the previous one.

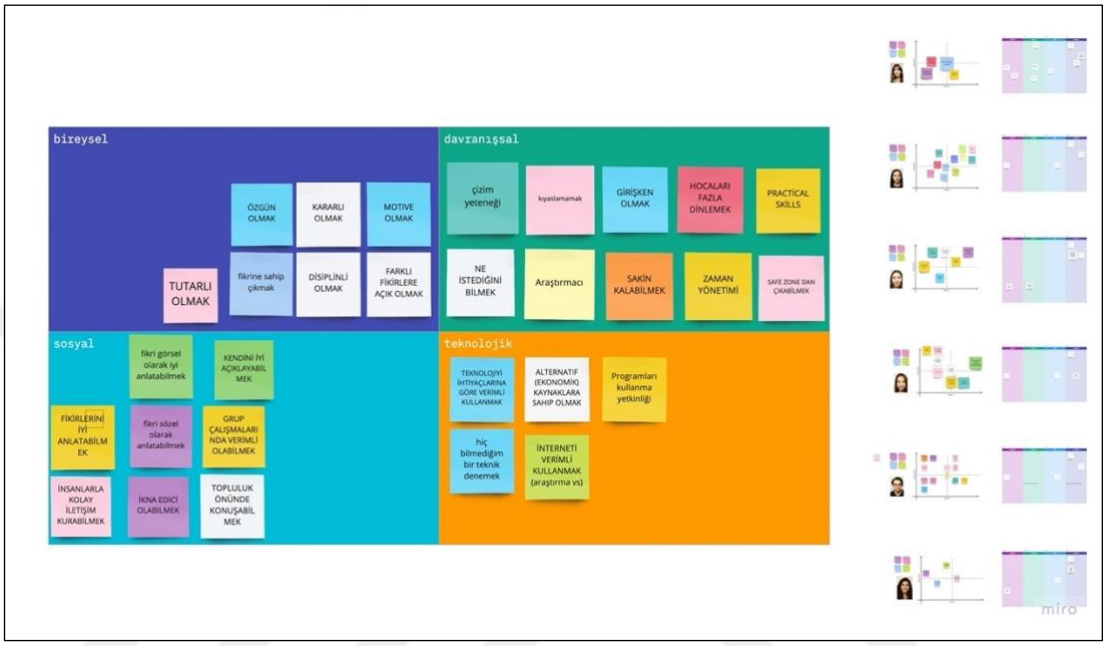

Figure 4.3 : Visuals from the MIRO activity.

4.3 Implementation of the Intervention

This section presents the process of the the SRIIDS, which was conducted as an intervention study in the Department of Industrial Design at IBU during the Industrial Design Studio III course. In the following, the participants of the study, their backgrounds, settings of the intervention, and the procedure of the study will be explained.

4.3.1 The settings

As explained in section 3.1.1.1, SRL studies of the first exploratory research phase of this thesis were conducted in the third-year studio in the fall semester of the 2018-2019 academic year. As a follow-up experiment, the SRIIDS intervention study was implemented with the students who are at the same academic level in the same university in 2020-2021.

In the fall semester of 2020-2021 academic year, Industrial Design Studio III consisted of 40 students (35 F, 15 M), 4 instructors, and 1 assistant (the researcher of this thesis) in the Department of Industrial Design at IBU. The similarities between the research (i.e., Phase 1) and intervention (i.e., Phase 2) environments are listed in Table 4.2. Due to these similarities at the education level, context, and content of the studios, this studio was selected as the environment for the intervention study.

Table 4.2 : Similarities between the settings of research phases.

The studio environment of Phase 1: research	**The studio environment of Phase 2: the SRIIDS**
consisted of 20 third-year undergraduate students	consisted of 40 third-year undergraduate students
was designed for only junior (3rd year) students	was designed for only junior (3rd year) students
was coordinated by a full-time design academician and a design professional with a bachelor's degree in industrial design	was coordinated by a full-time design academician, 2 design professionals with bachelor's degrees in industrial design, and 1 engineer with MSc in industrial design
was a client project for a big design and production company in Turkey that preferred not to interfere in the studio process but to evaluate the design solutions	was a client project for a global design and production company that preferred not to interfere in the studio process but to evaluate the design solutions
the project definition of this studio had focused on realistic design solutions while enabling abstractions and a creative research process.	the project definition of this studio had focused on realistic design solutions while enabling abstractions and a creative research process.

The important difference between the study settings was the delivery method of the studios. The first research was conducted face-to-face in a physical studio environment. However, the intervention study had to be conducted in online environments due to the Covid-19 restrictions. As explained in Section 4.2.1, the need for SRL strategies has been deepened in online environments. This emergency remote learning environment did not limit the intervention's potential. Since the conducting method of intervention was the same with the delivery method of studios, students can use what they learn in the intervention on their studio process easily.

The project content of ID301 Industrial Design Studio III was written in the project brief document as follows:

> This is a design studio that focuses on product design suitable for mass production. The Studio focuses on functional product designs that can be

produced in large numbers with different production methods and materials. In the product design and development process, it is essential to conduct research to determine user needs. The main purpose of this studio is to provide an experience of product design and development process similar to that experienced in the industry.

According to this content, the project was developed as a collaboration project with a home appliance producing company, focusing on two product groups (i.e., refrigerator and dryer). The studies started with user research. Students were divided into 7 groups for the research session. This was followed by idea generation sessions through scenario and concept developments were conducted individually. There were three jury sessions during the term, which the company's design team, research team, and engineering team joined. In the 4th week, in the research jury, students presented their user and literature (desk) research findings in groups. The midterm jury consisted of 4 different idea and scenario proposals for each student in the 7th week. At the end of the term, the final jury was conducted with detailed final product design presentations. The percentages of evaluation criteria were 20% for the research jury, 30% for the midterm jury, 35% for the final jury, and 15% for participation during the term. Class attendance was mandatory.

The intervention sessions were conducted in the Zoom platform (see Figure 4.4). For each session, participator students and the researcher met in the same Zoom link. Students were encouraged to turn on their cameras to create a collaborating environment. They participated with questions and comments during the sessions.

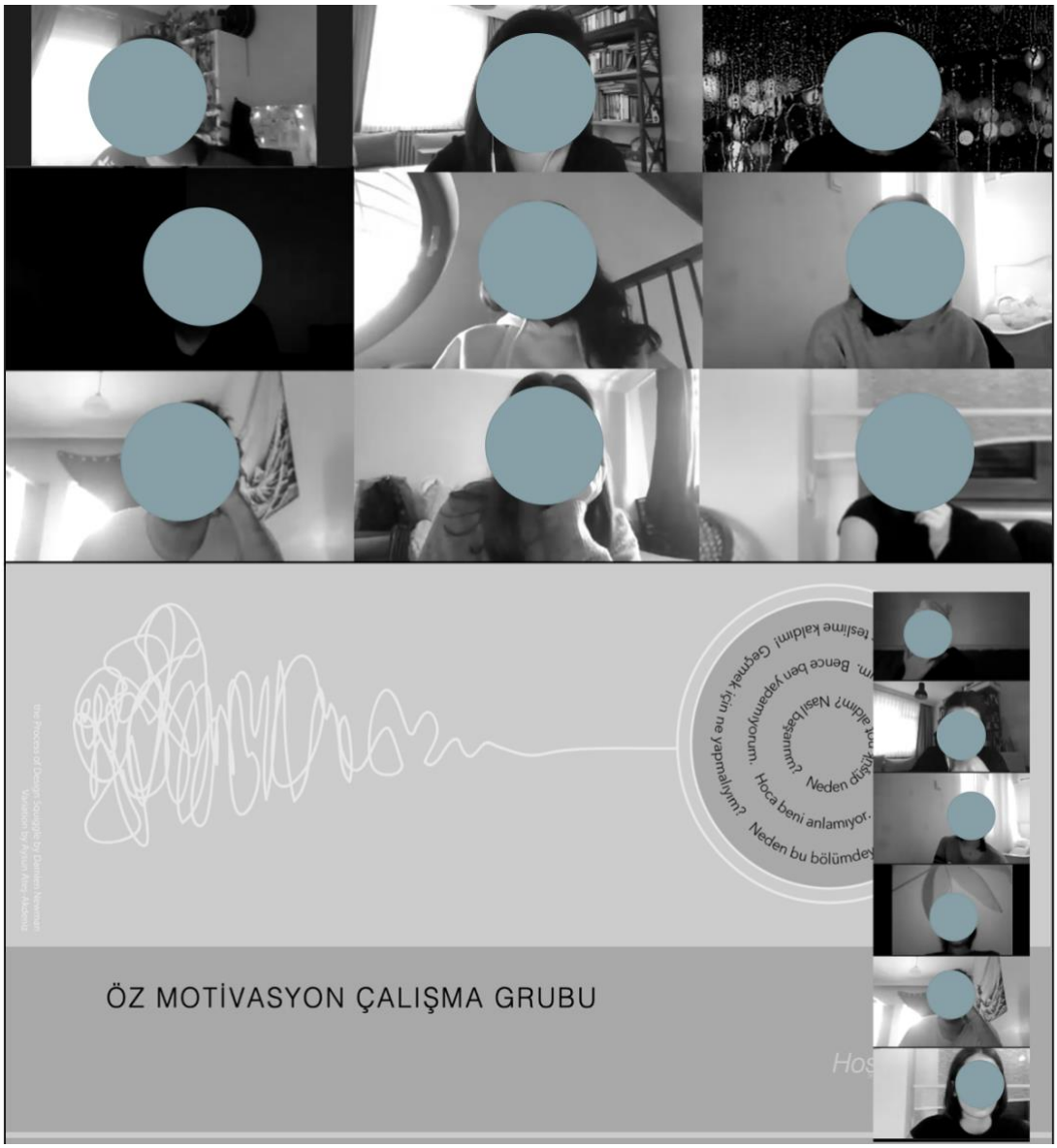

Figure 4.4 : Screenshots from Zoom meetings for the SRIIDS sessions.

4.3.2 The participants

In 2020-2021 fall term, there were 40 students who took in the third-year studio class at Industrial Design Department. 11 of them participated in the intervention voluntarily. Some background information will be provided on the IBU Industrial Design Department's admissions process for the year 2017 in which the participator students had entered the central exam (LYS) and enrolled at the university. The total quota of the department was 42 for that year (URL-3). Since IBU is a private university, the scholarship quotas depend on the LYS success. The quota was 4 for full scholarship, 7 for 25% scholarship, 23 for 50% scholarship, and 8 for no scholarship (URL-3). In 2017, the success order of the students with the lowest score for the

department was 270.000 for no scholarship quota, 219.000 for 25% scholarship, 157.000 for 50% scholarship, and 47.100 full scholarship among 1.846.880 students (URL-3). These success rankings placed the IBU ID department within the first six ID departments in Turkey among 32 university.

A detailed information on the eleven students of the SRIIDS presented in Table 4.3. Three of the participants had full scholarship, 4 of them had half scholarship and 1 of them had 25% scholarships. They were on average 20.9 years old (SD = 1.2) and all of them were in their fifth semester. According to the grade average of the last two studios, 3 of them were categorized as high-achievers and 8 of them were accepted as low-achievers, which will be further explained in the following section 4.3.3. All of them were native speakers of Turkish; thus, the the SRIIDS study was conducted in this language. The study was conducted in accordance with the ethical principles for research involving human subjects and ethical approval was provided by the University Ethical Committee (see Appendix E).

Table 4.3 : Information about participant students of the SRIIDS.

Participant Codes	Scholarship	Age	GPA in 2020	The average of the last two studio grades
P1	Regular	21	2,51	71
P2	OSYM (100%)	22	3,46	80
P3	OSYM (100%)	20	3,32	76,5
P4	OSYM (50%)	20	3,04	75
P5	OSYM (50%)	19	3,20	88,5
P6	Regular	20	2,81	76,5
P7	OSYM (100%)	21	3,67	87
P8	OSYM (25%)	23	2,30	75
P9	OSYM (50%)	22	2,53	75
P10	OSYM (50%)	22	2,69	74
P11	Regular	21	2,50	71,5

4.3.3 Procedure

The the SRIIDS study was planned to be carried out in the middle of the term. The sessions needed to be carried out during the individual project development phase, since SRL focuses on individual learning development. Another important factor for the decision on timing was that the midterm jury should be included during the sessions since it would be used as a self-evaluation tool. Therefore, the study was conducted between the 5^{th} and 9^{th} weeks of the term, which consisted of 14 weeks. Specifically,

the study was scheduled to take place from 2 weeks before until 2 weeks after the midterm jury in the morning session of studio days (see Figure 4.5).

2020-2021 Fall Term ID301 Industrial Design Studio																											
Weeks	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	11	12	12	13			
Hours	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*7*	*4*	*4*	
Dates	6 Oct	9 Oct	13 Oct	16 Oct	20 Oct	23 Oct	27 Oct	30 Oct	3 Nov	6 Nov	10 Nov	13 Nov	17-20 Nov	24 Nov	27 Nov	1 Dec	4 Dec	8 Dec	11 Dec	15 Dec	18 Dec	22 Dec	25 Dec	29 Dec	11 Jan	12 Jan	
Studio Process	Introduction	Research Crit - Group	Research Crit - Group	Research Crit - Group	Research Crit - Group	Research Crit - Group	USER & LITERATURE RESEARCH JURY	Idea generation - Individual	Idea generation - Individual	Idea generation - Individual	Idea generation - Individual	Idea generation - Individual	MIDTERM JURY - Scenario & Concept Proposals	Design Development -Individual	Design Development -Individual	Design Development -Individual	Design Development -Individual	Design Development -Individual	Design Freeze -Individual	Detail Design -Individual	Detail Design -Individual	Detail Design -Individual	Detail Design -Individual	Detail Design -Individual	Final Jury	Final Jury	25-29 January
Observation																											
SSRL									pre															post			
SRIIDS									1		2				3		4										
FEEDBACK																											
INTERVIEW																											

Figure 4.5 : ID 301 Studio content schedule

The studio content was full of various meetings with the project managers from the company. Besides, high number of students in the studio caused delays in the schedule. The instructors of the studio considered that the project process was not suitable to make this intervention study obligatory. Thus, the SRIIDS was planned as a voluntary working group. All students in the studio were asked if they wanted to join this working group via an email poster (see Figure 4.6). In this email, students were provided with written information on the study, were assured of confidentiality, and asked if they wanted to participate. Five students volunteered to join the study by replying to the first invitation mail. The researcher reviewd these students' grades to see whether they could be classified as high or low achievers. As in the first phase of this thesis, the average of the last two official studio grades was used as an achievement indicator for design students (see Section 3.1.2.1). The average of the last two official grades of all students in the studio was M=77.9 (SD= 6.08), hence students whose grade average were over 77.9 were accepted as high-achieving students. Three of the first 5 participant grades were higher than 77.9, therefore these students were

considered as high achievers. Since the focus of the the SRIIDS study is developing SRL skills of especially underachieving design students, the researcher had to identify low achievers in the studio and encourage them to participate. Twenty-three students with an average of the last two official studio grades lower than 77.9 were identified. Besides, none of them had received an A letter grade in their last two studios. These students were informed about the study via an encouraging and reminder email. Nine of them replied and volunteered to participate. One of these participants was a transfer student who was in a different university for the first and second years, thus she was excluded in the evaluation phase since she does not have the same background as the other students. Two of the low-achieving participants joined only two meetings, so they were excluded from the evaluation, too. Eventually, 11 participants filled in pre- and post- SSRL questionnaire, participated in all the SRIIDS meetings, followed the instructions and completed the tasks, filled in the feedback questionnaire, and participated in interviews. Hence, these 11 students were all included in the evaluation phase. The remaining 26 students who did not participate in the study in the same studio were assigned as the control group. After the the SRIIDS sessions, at the end of the semester, a feedback questionnaire form was sent to the participants, and interview meetings were arranged. All the SRIIDS participants filled in the questionnaire and participated in the interviews as well. The collected data were stored pseudonymized using multidigit codes.

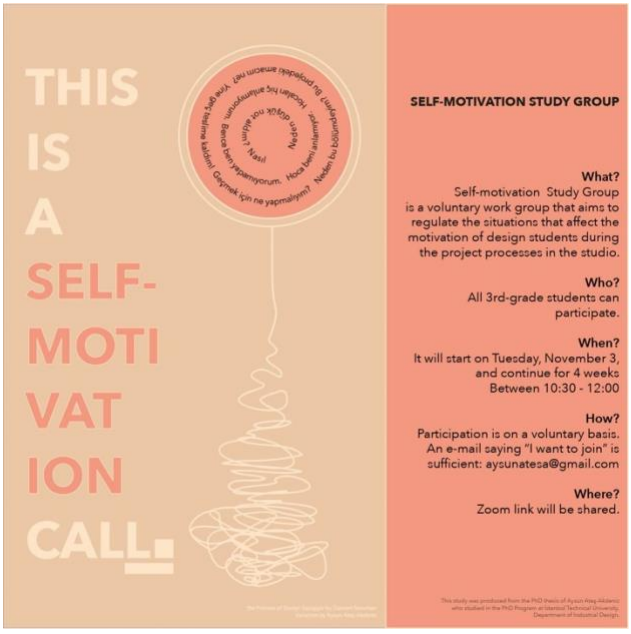

Figure 4.6 : Poster design for the intervention call (Translated in English) (The visual of "The Process of Design Squiggle" designed by Damien Newman was used).

4.4 Evaluation of the Intervention

The intervention study was conducted based on the theoretical framework in the previous sections. This section presents the data collection, the measures, and the data analysis techniques employed during this study.

4.4.1 Data collection

As discussed in Section 2.1.5, although there are studies conducted by many authors, assessing and developing SRL skills is still insufficiently explored. Even though researchers have shown the efficacy of self-report instruments such as questionnaires and interviews in monitoring SRL strategies to be dependable and helpful (Roth et al., 2016), utilizing a single measure has been criticized since it does not allow the researcher to assess a wide range of learning strategies (Perry, 2002). Employing multiple methods of approaches to investigate SRL provides researchers to build theory inductively (Butler, 2002). The first phase of this dissertation also illustrated that, survey evaluations and students' narratives can be inconsistent, and this provides the researcher with an expanded field of discussion.

The second research phase of this thesis had a pre- and post-test quasi-experimental research design. To answer research question 2 "To what extent does SRL-intervened studio affect design learner's reported use of SRL strategies in their design learning?", the SSRL self-report questionnaire scale was used before and after the intervention study. Besides, to answer research question 4 "How does student's self-regulation influences their design performance?", the student's grades from juries conducted before and after the intervention were tracked and compared. Additionally, to answer research question 3 "What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?", feedback questionnaire and interviews were conducted after the intervention. As in the first phase, the data of the intervention study was collected through both quantitative and qualitative methods.

4.4.1.1 Quantitative measures: SSRL self-report questionnaire, grades and feedback questionnaire

SSRL self-report questionnaire

As in the first research phase of this thesis, "Scale on Self-Regulation in Learning (SSRL)", a self-report questionnaire developed by Erdogan (2012) was used to determine the self-regulation level of students in the SRIIDS study. Detailed information about the scale is available in section 3.1.1.2. Since the study environment was a design studio, the adapted terminologies were used again (see Appendix B). To see the effects of SRL intervention on the experimental group, pre-test and post-test scores were compared.

Grades

Since the effect of SRL interventions on student achievement cannot be attributed primarily to students' involvement in SRL activities, it is vital to report the correlation between SRL activity and achievement (Jansen et al., 2019). Even though learning success is defined as the achievement of subjective learning goals, many SRL studies measure learning success by task performance or exam grades (Loeffler et all., 2019). The juries in the studio can stand for exams of classroom contexts. Since the process cannot be separated from the design performance, the evaluation criteria set which was used in jury evaluations were factored in the analysis. There are several reasons for this assumption which will be explained below.

Primarily, it is important to state that the researcher was not involved in any evaluation process, despite being a research assistant in the studio. All grade evaluations were proceeded by 4 instructors of the studio. They met in Zoom meetings after every jury, discussed the projects together, and decided on all the grades by common consent. While grading, instructors used the evaluation criteria that they had already decided on while preparing the project brief at the beginning of the term. Table 4.4 summarizes the evaluation criteria and percentages of the criterias in the final mark. During the studio process, 3 jury evaluations, 3 process gradings, and 1 participation grading were conducted. The first jury evaluation was for the user research phase in which students studied in groups and presented their research findings to the jury together. Therefore, the groups were graded together for both the user research process and jury performances. Since this study aims at developing individual learning performance, group performances in the user research jury and process were not factored in the

analysis. During concept development and design development phases, students studied individually and presented their ideas to the jury. The midterm and final juries were conducted in the middle and end of the term. Both juries were graded under the same 3 subheadings: visual presentation, verbal presentation, and design proposal. While grading the processes, the instructors focused on the performance in the studio critic sessions. Each instructor met with the students individually in critic sessions and evaluated the process of each student separately. They did not use set criteria for these sessions, but they used a shared excel document to write down their comments and grades for the work of each student in every critic session. Eventually, each student was graded for both the design process and the design outcome. This study focuses on interpreting and improving students' design performance in relation to self-regulated strategies. Design performance cannot be described without its process. As Findeli (2001) states, designing does not mean only creating an object, it also involves a process that transforms the designer, which is the dimension of learning and should be included as a project component. Therefore, in this study, students' grades on concept development process, design development process, participation, midterm and final juries, and term grades were factored in comparison tests to understand if there is a significant change in design performance before and after the the SRIIDS study within and between the groups.

Table 4.4 : Juries and evaluation criteria in ID301 studio.

ID 301 - Evaluation Criteria	**Visual presentation** **Product Present.:** Renders, details, Interface, Technical Drawings, etc. **Scenario**: User scenario explaining the benefit of the concept **Page Layout**: Font selection, Alignments, White space usage, etc.	**Verbal Presentation** **Fluency**: Relevance of the information, accuracy, time control, preparedness **Clear explanation of the project:** Target group, the problem/need, reference to the research, scenario, etc. **Command**: Responding to the questions, Terminology	**Design Proposal** **Contextual relevance**: Brief, Brand, User Functionality, **Usability**: Ease of use, Benefits for the user, Safety **Details**: Level of finish, Level of Detail, Holistic approach **Aesthetics**: Brand relevance, aesthetics, period **Uniqueness**: Originality, Competitiveness, Marketability	**Percentage in Total**
User Research Process	-	-	-	10%
User Research Jury	1%	3%	6%	10%
Concept Development Process	-	-	-	15%
Midterm Jury	**3%**	**3%**	**9%**	**15%**
Design Development Process	-	-	-	15%
Final Jury	**7%**	**3%**	**10%**	**20%**
Participation	-	-	-	15%

Feedback Questionnaire

A feedback questionnaire was used to measure the impact of the intervention study on increasing awareness of SRL strategies among design students. The questionnaire included 18 items that were conducted at the end of the SRIIDS study. Both qualitative and quantitative data were collected through both open-ended and closed-ended questions (see Appendix F). In 16 closed-ended items, the efficacy of activities conducted in the SRIIDS sessions, general satisfaction about the study, and future planning were scored on a five-point Likert scale ranging from “Disagree (1)” to

"Agree (5)" by the participants. A quantitative analysis was conducted on these answers. Two open-ended items allowed the participants to comment on the study in their own words. This data was associated with the interview transcriptions for the qualitative process and analyzed using the content analysis method.

4.4.1.2 Qualitative measure: interview

It is a challenging task to collect and analyze data about SRL. In the industrial design studio context, since self-regulation has not been studied before, researchers need to have a wide and deep comprehension. As explained in section 3.1.1.3, the qualitative approach is a required and effective tool to understand the relations between words and behavior. Therefore, in the second phase of this thesis, the intervention study was tested with quasi-experiments, and data was collected through both quantitative and qualitative approaches. In this study, utilizing both qualitative and quantitative approaches, researcher chose to follow a mixed-method approach again. It allowed to leverage the findings of one method and explain those from the other method, hence magnify the quality of the data interpretation (Onwuegbuzie & Teddlie, 2003).

The interviews aimed to collect qualitative data on student engagement with the intervention study. A semi-structured interview protocol was used to guide the interview sessions (see Appendix G). The questions were developed to encourage the participants to comment in more detail on the activities regarding the intervention's efficacy in regulating their learning. The semi-structured interview protocol enabled the researcher to prompt the responses for more elaboration.

4.4.2 Data analysis and findings

The quantitative and qualitative analyses of the data were conducted sequentially. The results of the feedback questionnaire were combined with interview analysis. And finally, results and findings were discussed in an integrative way.

In this study, the statistical tests mentioned above were performed by using IBM SPSS Statistics 25.0 and presented in the tables with appropriate analyses.

4.4.2.1 Quantitative analysis and findings

SSRL self-report questionnaire

To answer research question 2 “To what extent does SRL-intervened studio affect design learner’s reported use of SRL strategies in their design learning?”, the pre and post-test scores of the Scale of Self-regulated Learning (SSRL) self-report questionnaire was compared through statistical analyses. For pre-tests, Cronbach’s alpha coefficient was calculated as 0.88 for the whole scale, 0.87 for Self-regulated Learning Skills, and 0.88 for Motivation. For post-tests Cronbach’s alpha coefficient was calculated as 0.85 for the whole scale, 0.82 for Self-regulated Learning Skills, and 0.86 for Motivation.

Descriptive statistics were used to describe the sample population. Table 4.5 shows the descriptive statistics of all variables (N=11). The SSRL total scores were found to be 224.55 (SS= 20.7) for pre-tests, 246.45 (SS=15.9) for post-tests scores. The mean of SRL scores was calculated as 151.64±15.8 for the pre-test scale and 176.73±13.4 for the post-test scale. The mean of Motivation for learning scores was calculated as 72.91±9.87 for the pre-test scale and 78.73±9.79 for the post-test scale.

Table 4.5 : Descriptive statistics of pre-and post-test scale results of students who participated in the SRIIDS.

SSRL Dimensions	Tests	N	Number of items	Mean	Std. Deviation	Minimum	Maximum
SSRL Total	**Pre-test**	**11**	**67**	**224.55**	**20.729**	**205**	**258**
	Post-test	**11**	**67**	**246.45**	**15.977**	**222**	**274**
SRL Total	**Pre-test**	**11**	**45**	**151.64**	**15.870**	**126**	**175**
	Post-test	**11**	**45**	**167.73**	**13.417**	**150**	**188**
Motivation Total	**Pre-test**	**11**	**22**	**72.91**	**9.874**	**56**	**92**
	Post-test	**11**	**22**	**78.73**	**9.799**	**68**	**96**
Before Study	**Pre-test**	**11**	**13**	**44.64**	**5.085**	**36**	**51**
	Post-test	**11**	**13**	**49.00**	**4.796**	**41**	**55**
During Study	**Pre-test**	**11**	**19**	**60.09**	**7.752**	**50**	**72**
	Post-test	**11**	**19**	**68.18**	**7.360**	**58**	**78**
After Study	**Pre-test**	**11**	**13**	**47.64**	**6.217**	**35**	**56**
	Post-test	**11**	**13**	**51.36**	**7.159**	**33**	**61**
Arrangement of study time	Pre-test	11	4	12.55	2.162	9	16
	Post-test	11	4	12.91	2.119	9	15
Planning	Pre-test	11	5	15.91	2.212	12	19
	Post-test	11	5	18.09	3.419	13	22
Environmental structuring	Pre-test	11	4	16.18	2.601	13	20
	Post-test	11	4	18.00	1.789	16	20
Organizing and transforming	Pre-test	11	5	17.09	4.847	11	24
	Post-test	11	5	19.00	4.000	14	24
Seeking appropriate information	Pre-test	11	3	9.18	1.991	6	13
	Post-test	11	3	11.45	1.635	9	14
Seeking easily accessible information	Pre-test	11	2	3.82	1.722	2	7
	Post-test	11	2	4.00	1.897	2	7
Rehearsing and memorizing	Pre-test	11	4	12.55	2.162	8	16
	Post-test	11	4	13.55	2.544	10	18
Self-monitoring	Pre-test	11	2	5.91	3.015	2	9
	Post-test	11	2	8.09	1.640	5	10
Seeking peer. teacher or adult assistance	Pre-test	11	3	11.55	2.252	6	13
	Post-test	11	3	12.09	1.973	8	15
Self-evaluation	Pre-test	11	6	24.36	3.295	20	30
	Post-test	11	6	25.55	4.591	16	30
Self-consequences after success	Pre-test	11	4	11.00	4.313	4	17
	Post-test	11	4	13.45	2.945	8	17
Self-consequences after failure	Pre-test	11	3	10.55	3.475	5	15
	Post-test	11	3	11.55	2.115	9	15
Self-efficacy	Pre-test	11	5	18.27	3.524	14	23
	Post-test	11	5	21.09	1.758	18	23
Goal orientations	Pre-test	11	3	10.27	2.102	7	14
	Post-test	11	3	10.18	3.430	4	15
Task value	Pre-test	11	5	19.73	4.077	14	25
	Post-test	11	5	21.27	3.663	14	25
Attributions for failure	Pre-test	11	4	10.82	3.281	7	17
	Post-test	11	4	10.73	3.690	8	18
Anxiety	Pre-test	11	5	13.82	3.341	9	20
	Post-test	11	5	15.45	3.908	11	22

To decide on the type of comparison tests, the normal distribution of the data was examined. The Shapiro-Wilk test concluded that the significance value was higher than 0.05 in all sub-dimensions; however, Kurtosis and Skewness values were not within the ±1.5 range for all variables (Tabachnick & Fidell, 2013). Besides, since the sample size of each group was less than 30, it was decided to use non-parametric tests. A Wilcoxon signed-rank test was performed to determine if there is a statistically significant difference between pre-and post-test scale scores. The results presented in Table 4.6 show the differences between pre-and post-test scores of students who participated in the SRIIDS intervention study. The Wilcoxon signed-rank test revealed that total SSRL scale scores were found to be statistically significantly higher in post-tests (*Mdn* = 248) than in pre-tests (*Mdn* = 218), $T = .00$, $z = -2.940$, $p < .003$. Besides, the SRL Total scores of the students were found to be statistically significantly higher for post-test scale (*Mdn* = 166) than the pre-test scale *(Mdn* = 149), $T = .00$, $z = -2.937$, $p < .003$. Furthermore, Motivation Total scores of the students were found to be statistically significantly higher for post-test scale (*Mdn* = 67) than the pre-test scale *(Mdn* = 59), $T = 1$, $z = -2.501$, $p < .012$. In addition, pre-and post-test scores of some sub-dimensions such as planning, seeking appropriate information, self-monitoring, self-evaluation, self-consequences after success, and self-efficacy were found statistically significant on behalf of post-test scores.

Table 4.6 : Wilcoxon test results of scale scores of pre-and post-tests.

	Negative Ranks			Positive Ranks			Test Statistics	
SSRL Dimensions	*n*	Mean Rank	Sum of Ranks	*n*	Mean Rank	Sum of Ranks	Ties	Z	Asymp. Sig. (2-tailed)
SSRL Total	11	6.00	66.00	0	0.00	0.00	0	-2.940[b]	**0.003***
SRL Total	11	6.00	66.00	0	0.00	0.00	0	-2.937[b]	**0.003***
Motivation Total	8	6.50	52.00	2	1.50	3.00	1	-2.501[b]	**0.012***
Before Study	9	5.83	52.50	1	2.50	2.50	1	-2.555[b]	**0.011***
During Study	11	6.00	66.00	0	0.00	0.00	0	-2.947[b]	**0.003***
After Study	9	5.72	51.50	1	3.50	3.50	1	-2.469[b]	**0.014***
Arrangement of study time	3	3.33	10.00	2	2.50	5.00	6	-.677[b]	0.498
Planning	7	5.71	40.00	2	2.50	5.00	2	-2.101[b]	**0.036***
Environmental structuring	7	4.00	28.00	0	0.00	0.00	4	-2.388[b]	0.317
Organizing and transforming	6	6.25	37.50	3	2.50	7.50	2	-1.799[b]	0.072
Seeking appropriate information	9	5.00	45.00	0	0.00	0.00	2	-2.701[b]	**0.007***
Seeking easily accessible information	2	1.50	3.00	0	0.00	0.00	9	-1.414[b]	0.157
Rehearsing and memorizing	6	7.75	46.50	5	3.90	19.50	0	-1.209[b]	0.227
Self-monitoring	8	4.50	36.00	0	0.00	0.00	3	-2.539[b]	**0.011***
Seeking peer. Teacher or adult assistance	5	4.60	23.00	2	2.50	5.00	4	-1.561[b]	0.119
Self-evaluation	5	3.90	19.50	3	5.50	16.50	3	-.213[b]	**0.031***
Self-consequences after success	6	5.50	33.00	2	1.50	3.00	3	-2.108[b]	**0.035***
Self-consequences after failure	5	4.20	21.00	2	3.50	7.00	4	-1.190[b]	0.234
Self-efficacy	7	4.00	28.00	0	0.00	0.00	4	-2.375[b]	**0.018***
Goal orientations	4	5.25	21.00	5	4.80	24.00	2	-.178[c]	0.858
Task value	6	5.17	31.00	2	2.50	5.00	3	-1.845[b]	0.065
Attributions for failure	4	5.25	21.00	5	4.80	24.00	2	-.181[c]	0.856
Anxiety	8	4.88	39.00	1	6.00	6.00	2	-1.970[b]	0.049

p<.05

Grade comparison

To answer research question 4 “How does students’ self-regulation influence their design performance?”, the change in the grades of the students in the studio were evaluated. The grade comparison was conducted both within the experimental group and with the control group. First, the grades of the groups including concept development process, midterm jury, design development process, final jury, participation, and total term grades were analyzed to compare between the groups. Descriptive statistics were used to describe the sample population. Table 4.7 shows the descriptive statistics of mean grades of student groups (N=37).

Table 4.7 : Descriptive statistics of grade means of student groups.

Grades	Groups	N	Mean	Std. Deviation
Concept Development Process	experimental group	11	10.9	1.9
	control group	26	9.3	2.4
Midterm Jury	experimental group	11	10.8	2.0
	control group	26	9.2	1.7
Design Development Process	experimental group	11	8.9	2.2
	control group	26	8.3	2.0
Final Jury	experimental group	11	14.5	1.5
	control group	26	12.8	3.0
Participation	experimental group	11	8.6	0.8
	control group	26	7.6	1.8
Term Grade	experimental group	11	78.3	6.7
	control group	26	70.2	11.2

Although the normal distribution of the data was examined and confirmed by the Shapiro-Wilk test, which concluded that the significance value of each grade was higher than 0.05; by Kurtosis and Skewness values which were within the ±1 range for all variables, and by the histogram chart which showed the data had a normal distribution; since the sample size for each group was less than 30 it was decided to use non-parametric tests. To determine if there were significant differences in grades between these groups, the Mann-Whitney U test was run. As shown in Table 4.8, the test revealed that, the experimental group's final jury grades (mean rank=24.05, U=87.5, z= -1.488, p<.035), participation grades (mean rank=23.41, U=94.5, z= -1.651, p<.042) and term grades (mean rank=22.18, U=108.0, z= -1.166, p<.024) were found to be statistically significantly higher than control group. It is worth noting that the SRIIDS study was completed after the midterm jury, which took place during the design development process. Significant differences were found in the grades which were given after the intervention was completed. Alternatively, it could simply mean that the SRIIDS intervention affected the participant students' design process positively. These findings support the notion that SRL interventions help students to gain academic achievement, and this is valid in the design studio as well. However, it remains unclear to which degree the increase in the grades can be attributed to the SRL intervention. Therefore, to better understand whether the assumptions are acceptable in this context or not, more data analysis was needed.

Table 4.8 : Mann-Whitney U Test Results of grades of student groups.

Grades	Groups	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Concept Dev. Process	experimental	11	23.41	257.5	94.5	445.500	-1.613	0.107
	control	26	17.13	445.5				
Midterm Jury	experimental	11	17.91	197.00	131.000	197.000	-0.402	0.688
	control	26	19.46	506.00				
Design Dev. Process	experimental	11	19.73	217.00	135.000	486.000	-0.266	0.790
	control	26	18.69	486.00				
Final Jury	experimental	11	24.05	264.50	87.500	438.500	-1.488	**0.035***
	control	26	16.87	438.50				
Participation	experimental	11	23.41	257.50	94.500	445.500	-1.651	**0.042***
	control	26	17.13	445.50				
Term Grade	experimental	11	22.18	244.00	108.000	459.000	-1.166	**0.024***
	control	26	17.65	459.00				

Another Wilcoxon signed-rank test was run to understand if there is a significant change in students' grades in the experimental group before and after the the SRIIDS study. The midterm jury and final jury grades were used since they were evaluated based on similar criteria. The time when the juries were conducted was also suitable for pre-and post-comparison. As shown in Table 4.9, the difference in the midterm jury grades (*Mdn*=60.0) and final jury grades (*Mdn*=72.6) of the SRIIDS students are statistically significant $T = .00$, $z = -1.689$, $p < .04$. This means that, participant students statistically significantly increased their jury grades from midterm jury to final jury. On the other hand, as we can see in Table 4.8, comparing with the jury grades of the control group showed that the mean rank of their final jury grades (mean rank=16.87) is lower than the mean rank of their midterm jury grades (mean rank=19.46). In other words, while jury grades of students in the experimental group increased before and after the intervention, jury grades of students in the control group decreased.

Table 4.9 : Wilcoxon signed-rank test results of pre-and post-tests jury grades of student groups.

	Negative Ranks			Positive Ranks			Test Statistics		
Juries	***n***	**Mean Rank**	**Sum of Ranks**	***n***	**Mean Rank**	**Sum of Ranks**	**Ties**	**Z**	**Asymp. Sig. (2-tailed)**
Pre-tests (Midterm Jury) – Post-tests (Final Jury)	3	4.67	14.00	8	6.50	52.00	0	-1.689	**0.04***

Spearman Rho correlation coefficient was used to assess the relationship between the changes in scale scores and grades of the experimental group. As shown in Table 4.10, there was not a statistically significant correlation between change in scale scores and grades r_s=.198, p=.056.

Table 4.10 : Correlation results between the changes in SSRL scale and grades of student groups.

Correlations			Grades
Spearman's rho	Scale Scores	Correlation Coefficient	.198
		Sig. (2-tailed)	.056
		N	11

Feedback questionnaire

The feedback questionnaire was conducted to answer research question 3 “What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?”. It consisted of 16 Likert-type questions evaluating the the SRIIDS activities, general satisfaction level, and future planning. The Cronbach’s alpha coefficient was calculated as 0.84 for the whole questionnaire. Since assigning numbers to Likert-type items indicates a "greater than" relationship, while it is unclear how much greater, Likert-type items can be classified as ordinal measurements for which descriptive statistics are recommended with mode or median for central tendency, and frequencies for variation (Boone & Boone, 2012). Therefore, in this analysis, the medians were used as statistical tools. As presented in Table 4.11, the descriptive statistics of results show that all variables of the feedback questionnaire were found to be higher than 4,0 points over 5. These findings hint that the activities in the study was efficient, the whole intervention was satisfying and promising for the students.

Table 4.11 : Descriptive statistics of feedback questionnaire analysis.

Variables	Mean	Median	Mode	SD
Efficacy of activity: *Goal setting and planning*	4.0	4.0	4.0	0.59848
Efficacy of activity: *Analyzing project & watching the Midterm jury*	4.3	4.2	4.0	0.33575
Efficacy of activity: *My design process in Miro*	4.2	4.5	5.0	0.80419
Satisfaction of the SRIIDS	4.3	4.4	4.5	0.21448
Future planning about the SRIIDS	4.2	4.3	4.3	0.51962

4.4.2.2 Qualitative analysis and findings

To answer research question 3 "What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?", one-to-one semi-structured interviews were conducted after the SRIIDS study. The quantitative approach in the feedback questionnaire was integrated with the qualitative approach in interviews aiming to understand the effect of the SRIIDS study on participant students. The interviews with 11 the SRIIDS participants lasted between 40 and 60 minutes depending on the follow-up questions and probes. The data were recorded using a digital audio recorder. In total 279 minutes of recording were collected, saved, and then transcribed verbatim on Microsoft Excel.

The analysis of the data was conducted through the Content Analysis method which is a method of analyzing and classifying data without any theoretical assumptions (Elo & Kyngäs, 2008; Schilling, 2006). In content analysis, both quantitative and qualitative analysis can be used (Elo & Kyngäs, 2008; Krippendorff, 1980). Therefore, content analysis is particularly beneficial when it is used to evaluate data from mixed methods. More information about the content analysis process will be detailed below.

Content Analysis

In content analysis, the main purpose is to filter meanings into content-related categories. Making inferences from the data provides new practical knowledge to act (Krippendorff, 1980). It is useful for identifying critical processes (Lederman, 1991),

such as learning. The process can be managed inductively or deductively. In the absence of prior knowledge about the phenomenon, it is advised to use an inductive approach (Lauri & Kyngas, 2005). In this thesis, since the SRL approach has not been studied in industrial design studio education before, it was decided to conduct an inductive approach. According to Elo and Kyngas (2008), notwithstanding being inductive or deductive, the analysis process has three phases: preparation, organizing, and reporting. In the analysis phase of this study, this flow of phases was followed. Figure 4.7 presents the phases of content analysis defined by Elo and Kyngas (2008), which will be explained in detail below.

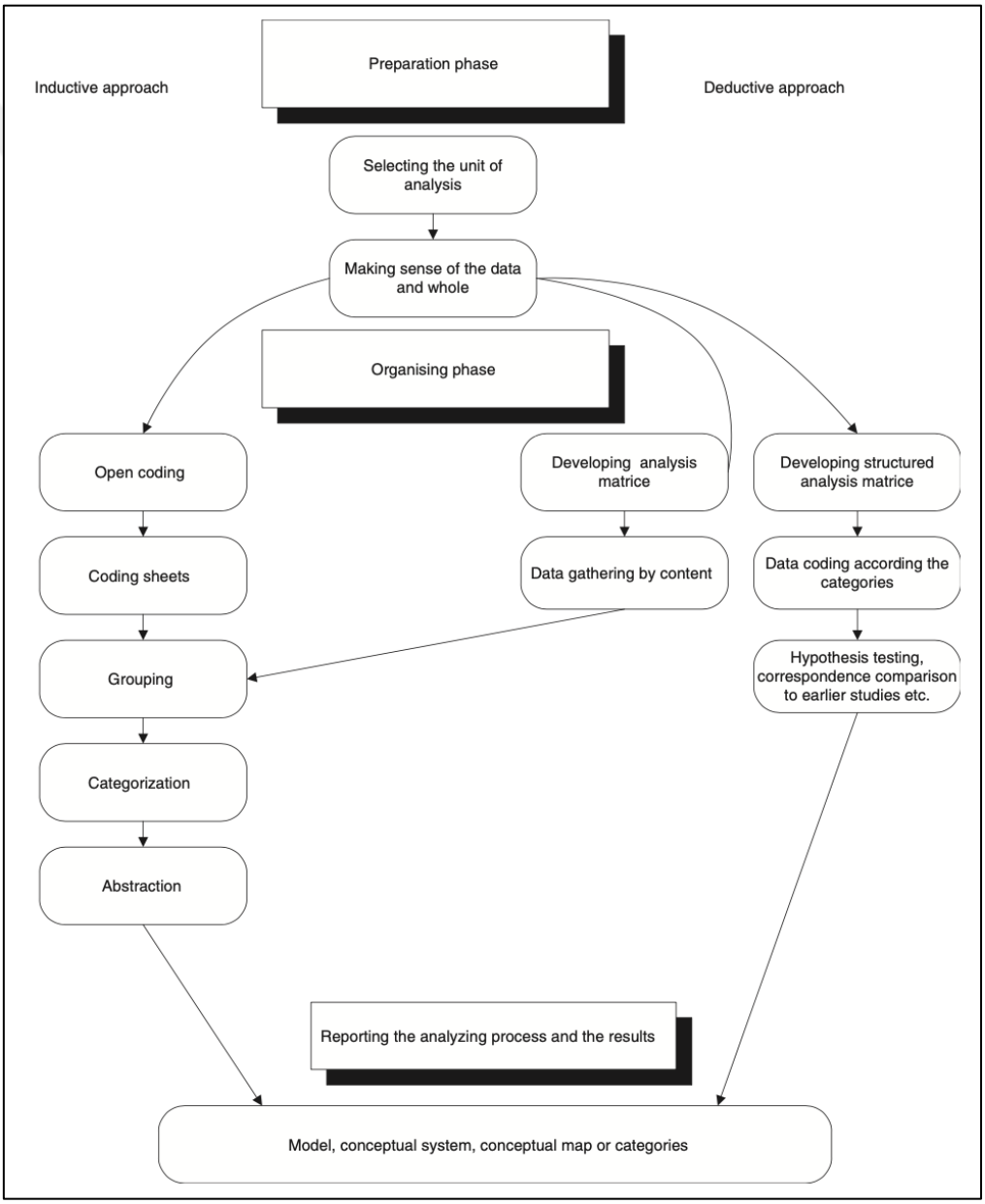

Figure 4.7 : Preparation, organizing, and resulting phases in the content analysis process (Elo and Kyngas, 2007, p.110).

In the preparation phase, depending on the research question, the unit of analysis which can be a letter, word, sentence, portion, the number of participants, or the time used for discussion (Robson 1993, Polit & Beck 2004), should be decided on by the researcher. The important point is that it should be large enough to make a meaning and small enough to remember as a context (Graneheim & Lundman, 2004). In this study, it was decided to use sentences that share emotions since it was planned to evaluate the students' engagements to the intervention study. Before deciding on the type of approach, the researcher should have a comprehensive understanding of the data. In the inductive approach, which is the approach used in this study, the organizing phase starts with open coding, in which written notes and headings are read and augmented again and again until enough headings were reached. Based on these headings, categories are generated to clarify and expand understanding of the phenomenon (Cavanagh, 1997). Finally, a formulation of the research topic is created through abstraction. The categories are re-grouped in reference to their similarities to create main categories (Dey, 1993; Robson, 1993). It is important to point out that this process in content analysis is not sequential, the phases can be re-visited and iterated according to need. Also, findings differ baesd on the researcher's analytical and critical thinking skills (Hoskins & Mariano, 2004), which shows the uniqueness of each inquiry.

In this study, answers given by the 11 interviewees to the questions were analyzed and coded. In the preparation phase, questions about the intervention study were converted into headings. Through open coding, the codes were derived from the students' answers. The primary categories included *students' expectations and needs, general views on the SRIIDS, general views on activities, and students' self-comments.* Second-level analysis was conducted on these codes and through re-reading, the data in the categories in the coding scheme in Table 4.12 was developed. MAXQDA'20 Qualitative Data Analysis Program software was used in coding the raw data from the interviews (see Figure 4.8). In the reporting phase, the frequencies of use of these categories in the interview data and direct quotations from students representing these categories were included.

Table 4.12 : The coding scheme of content analysis relevant to the topic of students' engagement with the SRIIDS.

1.0 Students' expectations and needs before the SRIIDS
1.1 Learning method awareness (high school)
1.2 The need for strategy change (transition from high school to university)
1.3 Blankness / inability to make sense (transition from high school to university)
1.4 Self-efficacy / motivational need
1.5 Communication need (Online education)
1.6 Experienced peer need
2.0 General Views of Students on the SRIIDS
2.1 A useful activity
2.2 Time to analyze yourself
2.3 Good timing in the studio process
2.4 "I was not alone"
2.5 Comfortable environment
2.6 Earlier need in university life
3.0 General Views of Students on the Activities Practiced in the SRIIDS
3.1 Setting and achieving goals
3.2 Project analysis / Rereading the brief
3.3 Project analysis / Replaying Midterm records
3.4 Most useful activity: Miro
4.0 Students' comments on themselves after the SRIIDS
4.1 Strategy development
4.2 Increase in self-confidence
4.3 Influenced by the sample / peer
4.4 Continuity
4.5 Learning experience

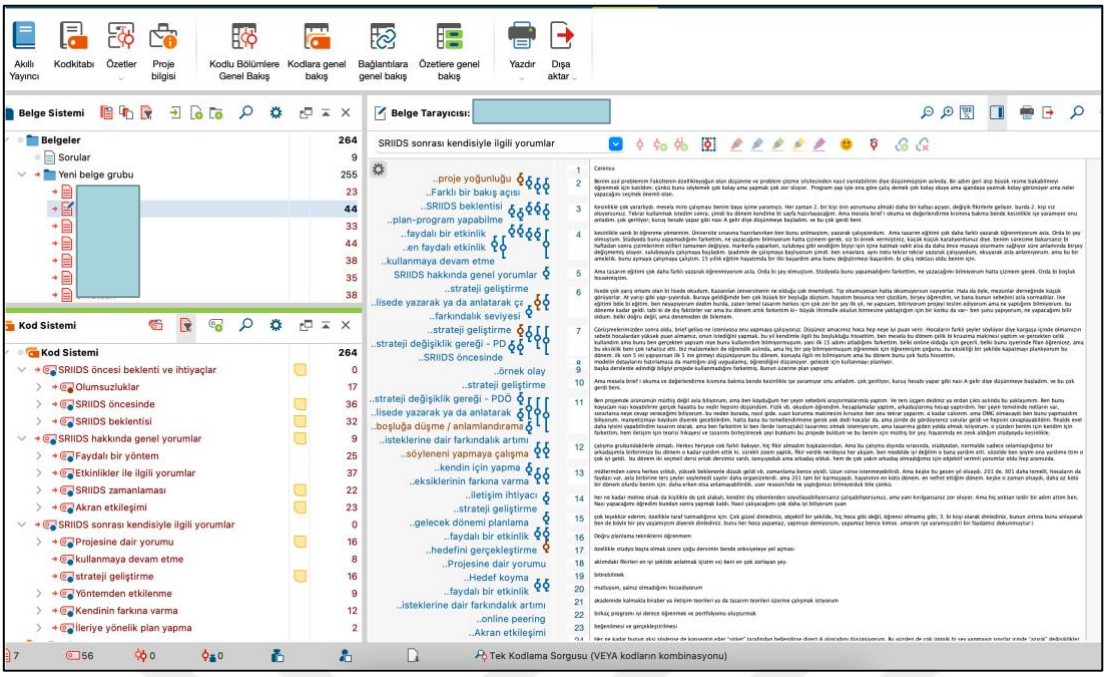

Figure 4.8 : A screenshot from the coding process (MAXQDA'20 Qualitative Data Analysis Program).

Reliability in qualitative research is defined as the consistency between data code groups that have been derived by multiple researchers (Creswell, 2014). Therefore, in this content analysis process, the researcher studied with another scholar. The researcher and the expert determined that several codes were not compatible with each other, so they were either grouped with other categories or eliminated. They agreed on the reliability of coders to create themes. Inter-coder reliability is defined as the ratio of the sum of agreements to all agreements and disagreements amongst coders (Miles & Huberman, 1994). The comparison of the researcher's and the expert's themes and codes showed 83% inter-coder reliability. It was also necessary to use direct statements from the participants to get a clear picture of their opinions. The findings and comments will be discussed in the following section.

Findings from content analysis

All 11 participants of the SRIIDS study were interviewed by the researcher of this thesis. The answers of the students to open-ended questions of the feedback questionnaire were also included in the analysis of interview data. This section includes key findings on the students' engagement in the SRIIDS study. The outcomes of content analysis were classified under four main themes: students' expectations and needs before the SRIIDS, general views of students on the SRIIDS, views of students

on the activities practiced in the SRIIDS, and students' comments on themselves after the SRIIDS. In Tables 4.13 through 4.17, the letters and numbers in parentheses (such as P1, P2, ...) indicate the students whose statements in the interviews were directly quoted.

Students' expectations and needs before the SRIIDS

Students were asked about their expectations before participating in the SRIIDS study and their needs were aimed to understand by the researcher. As shown in Table 4.13, the students' statements were grouped under 6 main categories.

Table 4.13 : Students' expectations and needs before the SRIIDS.

Categories	*f*	Student Expressions
Learning method awareness (high school)	10	"I had a way of learning. While I was preparing for the university exam, I understood this, I was working by writing." (P2) "Yes, I thought about it before. Something I used to do while preparing for the exam: I was memorizing by writing and explaining. It stayed in my mind." (P4) "Since there are more verbal lessons, I would write down examples and study [them]." (P10)
The need for strategy change (transition from high school to university)	9	"I never learn by writing in design education, it is much different. I realized that I couldn't do this (writing to learn) in the studio, I don't know what to write, I even have to draw." (P2) "There were so many things I don't know. I was learning everything for the first time. I thought that I knew things related to drawing, technique, sketch rendering, etc." (P4) "Coming straight from high school, I felt like I stepped into a world I didn't know. It was different from social or mathematics. It was about creativity. I didn't understand the words being said. Teachers were saying something; everyone was in a rush." (P6)
Blankness / inability to make sense (transition from high school to university)	8	"In the first year, I thought about quitting (from the department) for a long time because I didn't understand [anything], I couldn't understand it was bad." (P1) "I took tests all my life, I learned something, and they never asked me why. High school education is this kind of education. In the first year, I said 'What am I doing here?'. Basic design was a very difficult thing for everyone. I was finishing the project, but I didn't know what I was doing and what I was going to do. It was the same until this term." (P2) "Basic design shocked me, I was doing something, and I was like 'How can you not like these?!' It shocked me. I realized in the faculty that, everything I was good at in high school was in fact in average level. I didn't know how to do what to do." (P11)
Self-efficacy / motivational need	8	"When I think there is someone doing better than me, I always pull myself back." (P4). "After a few tries if it doesn't work out, I feel hopeless and back off by saying I'm not going to be able to do it, I strained too much." (P9) "I often question my own skills and the grades I received. I immediately despair at the slightest negativity." (P5) "I want to analyze myself better. It feels like I'm hindering what I can do." (P7)
Communication need (Online education)	6	"Thank you very much for not taking a side in this study. You listened and guided as a third person. I wish our professors could use this approach in their critiques as well. I think we can [then] express ourselves more easily." (P8) "Distanced education made everything difficult, especially communication." (P3) "Because of being online, we [students] had a low level of communication and there was a lack of communication in critics. Everyone was coming, it was so quiet, no one said anything since we didn't bring anything [drawings, any kind of works]." (P5) "I feel that online education started to destroy the sense of commitment and respect I feel for the school. Our access to teachers also seems to be decreasing." (P7)
Experienced peer need	4	"In the first year, I needed a person, I went to the upper floors [where upper-class students work] and looked at what they were doing." (P4) "When I have a problem with the lesson, it is usually solved when I consult the upper classes." (P8)

It was observed that students mostly studied by writing or rehearsing to their friends during the high school period - as required by the education system. However, the transition from high school to the Architecture Faculty necessitated a change in their working strategies. Students stated that they had difficulty with coping with this transitional change in the educational environment, they could not understand and make sense of the new system, therefore they did not know what to do. Their awareness and designation about the situation were valid, yet they still need appropriate strategies for their transition problems.

It was observed from their statements that, students' self-efficacy (i.e., belief in themselves and what they could do) was quite low during the project process. Especially during the online studio process, they stated that they had problems in reaching and communicating with instructors. Even though instructors were open to online communication tools such as e-mail and Zoom, students were reluctant to reach out to them since they found this kind of communication very difficult than face-to-face communication. They also complained about the quietness in the critic sessions, they all felt withdrawn, and this affected one another. This can be interpreted to be a result of low self-efficacy. Four of the students who were in the underachiever group stated that they tend to find answers to their questions by communicating with their upper-class peers. Experienced peer support can be proposed as a learning experience transfer tool for underachiever design students.

General views of students on the SRIIDS

Before asking about the activities in detail, students were asked about their general opinion on the SRIIDS intervention study. As shown in Table 4.14, their answers were grouped under 6 main categories.

Table 4.14 : General opinions of students about the SRIIDS.

Categories	*f*	Student Expressions
A useful activity	11	"I don't see it from the point of view of the grade. It was useful, I started to think about something about myself, about what I want, about the future. For example, I am planning to spend more time on coding." (P1)
		"It was very useful for me, I felt that I improved myself and my goals." (P3)
		"The practices we did make me realize things I knew but did not pay much attention to." (P8)
Time to analyze yourself	9	I became aware of myself, that is, I feed off what they (other students in the group) said and what we did together." (P4)
		"After the study, I looked back at myself to see how I could work and express myself better." (P10)
		"I found the opportunity to analyse myself better." (P7)
Good timing in the studio process	9	"I think the timing was very good. After the midterm, everyone was devastated, some of the friends who expected high grades got low grades. This study helped us to recover ourselves after the midterm." (P2)
		"It was very good timing. Since it was on Tuesday mornings, it was really motivating me before the studio hours. Even if I had only one hour until the studio started, it made me want to do something [study for the project]. So, I was sitting and doing something for my project, saying 'What do I have to lose?'." (P10)
"I am not alone"	8	"When everyone talked about themselves, I realized that we are all alike." (P11)
		"I noticed people in the same situation as me. I felt that I was not alone." (P4)
		"It was nice to have the environment of those who experienced the same situation. I wasn't alone. It felt good to know that there are people who can tell and understand what I went through." (P9)
Comfortable environment	7	"At first, I wasn't sure if I would attend, but when you said that there are motivational techniques and that I could learn them, the event caught my attention. Also, since we could share our thoughts, it was like a therapy session." (P3)
		"The working environment was a more comfortable and freer environment, unlike our studios. That's why I was able to express myself." (P7)
Earlier need in university life	7	"I wish this study was in the previous year. The second year of my university was a complete mess. The worst period of my life. My most hated period. If only it was then, it would have been a less bad semester for me." (P2)
		"It might be even better for freshmen. After making a few mistakes, they can reflect on themselves and say 'Where have I made the mistake?'. The sooner the better." (P9)

All participating students found the study beneficial. They stated that the intensity of the project always comes before their wishes and feelings. Nevertheless, when they were allowed to look at themselves, they were able to move forward by being more focused on their goals. They called the study "self-analyzing time", and suggested that the feeling of "I'm not alone" made them feel more comfortable while self-evaluating. The sharing of people who had similar processes and problems created a friendly and understanding environment so that they could express themselves and develop self-oriented aims. They compared the study with their studio experience and indicated that, unlike the studio, they could express themselves more freely. It has been observed that the students need communication at this level during studio hours, too.

Students also asked about the timing of the study. Their interpretations indicate that the timing of the week and the termination process were successful since it was right after the midterm jury and right before the studio hours. Students put forth that these times were stressful moments and they felt uncertain and unmotivated about their processes. On the other hand, they wished that they participated in this study earlier in their university life. It was understood that such a study was needed in the first or second year of the university because of the sudden change in the learning environment at the university and increase in the intensity of the uncertain processes in the studio.

General views of students on the activities practiced in the SRIIDS

Students were asked about their opinions on the activities of the SRIIDS in detail. As shown in Table 4.15, their answers were grouped under 4 main categories, which shows the views of the students on the most effective activities according to them.

Table 4.15 : Views of students on the activities practiced in the SRIIDS.

Categories	*f*	Student Expressions
Setting and achieving goals	11	"I wanted to learn software-related coding. I watched tutorials on Udemy. Because the project was bad anyway, I planned to focus on my other goals. I thought I could improve myself in the field I want." (P1) "I know that my product (design) is not super great in my project, but I researched everything I put in my project. I decided on this approach after the goal planning activity where you made us set goals. I planned as my goal that I will think in detail about every decision and move I make. I'm going to put something in my project, how can I put it, what is this in real life, and so on. I felt so good knowing that if you break a dryer, I can fix it again. I've been working on it a lot. But I know I wouldn't have done this without the SRIIDS study." (P2) "I was away from the rhino [computer-aided 3d drawing software] at the beginning. Then I set to study on rhino as a goal for my project, and when I did it, I liked it, I remembered, I continued, I even tried different renders, etc. In that sense, I felt that I improved myself a little more, rather than designing for a company or a studio. I started to trust my project more. I realized that I could speak more freely. I was able to present more comfortably in this term." (P4) "I set a goal to find out how the heating and turning functions work together. This gave me the determination to solve. In my previous projects, I did not set my own goal as much as this one." (P6)
Most useful activity: Miro	9	"The most useful part is the one with the chart in Miro. I used it to phase my project process in steps. I have used it on my personal plans, too. I'm still using it." (P3) "The applications in the Miro definitely worked a lot. The parts we commented on together at the same time were very useful. I realized that the difficulties I was challenged with were not special to me." (P4) "Especially the post-it works in Miro stuck in my mind. Sometimes I was thinking about how much I had done. After the final jury, I thought how many of my goals in the post-its I have completed." (P7)
Project analysis / Replaying Midterm records	8	"It was the most helpful activity. It was good to understand what I should concentrate on. Listening to the comments again was good feedback for me." (P6) "We had never done this before. This was the first time. When the midterm jury finished, we forgot everything about it. We celebrated that we somehow progressed, another big assignment is finished, as if we passed the exam. I didn't care about the critics I got. But in this study, it was very useful to watch it again. Later, I watched it 2-3 times more." (P7)
Project analysis / Rereading the brief	6	"Before, I never reread the briefs. Now I am reading the briefs." (P11) "I read it at first, but I did not read it again. Actually, it was helpful to understand the expectations of the course." (P5) "It was extremely useful for me. I never read the brief. I don't even look at what I do first. I always look ahead. I like to watch movies a lot, and I knew that in my second watch I perceive something different before then. I did not realize that I did not apply this approach outside of the cinema. I didn't apply it to the brief reading. In this study, I realized that in the second read of the brief I can perceive something else. Now, I'm trying to interpret the brief differently in every read." (P10)

In the goal-setting activity, students were asked to set specific individual goals for their project process. In the interviews, all students made positive comments about the goal planning activity. All of them stated that they achieved the goals that they set for their project. It was observed that the goal planning activity led students from grade-oriented goals to learning-oriented goals, and increased their self-efficacy since they focused on the strategies that they want to do and can do. This also increased their motivation.

To identify the challenges that students faced in their project and to develop plans for them, collective and sequential individual activities were held at Miro. Students stated that they observed in the collective activity that everyone had similar difficulties. This provided them with comfort during self-evaluating activities. They remarked that seeing their goals on post-its was helpful to remember and check their goals. Furthermore, students indicated that the Miro activity was the most effective one in the whole study. The reasons for this can be that the visual interface was easy to use, the students were familiar with it, they could use it more interactively and they could open separate private pages to look at their work again.

For the project analysis activities, students commented on mostly re-reading the brief and watching midterm jury recordingss. Most of the students had not read the brief again. They had not even opened the project brief document again after the first day. It was observed that they found it very useful to re-analyze the brief. They stated that they could deduce different meanings when they read it later. However, students were embarrassed and did not want to watch their presentations in midterm jury recordings at first. They said that they do not like to watch themselves. After encouraging them to focus on not visuals but the content, they were willing to do the activity. Separate Zoom breakout rooms were created to make them watch on their own. When they returned to the main Zoom room, they realized that:

- they had not been able to convey what they wanted to say,
- they had said things that would cause the jury to misinterpret,
- they had not told the most important detail of their projects.

When they were asked about the experience of watching the recording, they were satisfied with their realizing of their weaknesses.

Students' comments on themselves after the SRIIDS

Students were asked about their comments on themselves after the SRIIDS study. As shown in Table 4.16, their answers were grouped under 5 main categories, which shows the views of the students on their own progress after the study.

Table 4.16 : Students' comments on themselves after the SRIIDS.

Categories	*f*	Student Expressions
Strategy development	9	"I started to work with watercolor. I'm planning to start to work with my iPad now. I was studying by writing the same notes over and over for exams, I never understand by reading. But I understood that it was too much work. I've tried to get over this, and finally this semester I achieved a first in my 15 years of education life. I managed to change my way of studying. It was a starting point for me." (P2) "I focused on my process in the project, and I think it was not a bad decision. I tried to have something to show every week because I think the process was given more importance. Most of the percentage of evaluation included the process, the rate was almost the same as a jury." (P3) "I realized that I like to take notes and write with nice pens. I realized that when I write with beautiful pens, I am more encouraged to do it. That's why I'm trying to work with paper now." (P5) "I never thought before that [SRIIDS] what I should do for the better. But what we did in the study affected me, [showing] that instead of trying to learn something without liking it, I will try to make it interesting." (P7)
Increase in self-confidence	8	"During this period, I realized that I know what to do. This study gave me the first step to try." (P11) "I became aware of myself. I can dare and trust my project. This study showed me that I need to be confident in myself. To be honest, I used to study to get good grades. This year, I approached [my work] boldly. I persisted on what I was doing. In the past, when I thought I couldn't do it and that people were doing better than me, I always pulled away. But now I start to think that I do things better than some other people." (P4) "I think if I can continue what we tried during the study, I will increase my self-confidence even more. Because normally, I would pull away from myself with the smallest negativity. But this semester, I felt self-confident, I think that I did what I really wanted to do in my project." (P6) "My project was the best project of the entire studio. I'm satisfied with everything I did. What I received (grade) was not satisfying, but I stand behind my product. I generally don't feel comfortable with my projects, I always find something to criticize. But I feel very satisfied with this project." (P10)
Learning orientation	8	"Before, when the brief arrived, we tried to do whatever is requested. Our aim was always to satisfy the teacher to get good grades. When they commented on our works in different ways, we got lost. The reason for that was being focused on what the teachers wanted to get high grades. This year, after our sessions, I felt this emptiness about myself, I realized how nice it is to do projects for myself, not for them. I also found what I want to do in my graduation project. It was definitely the studio I enjoyed the most in my life." (P2) "In fact, I got a better grade than my previous projects, but I had aimed for a much better grade this term, but I couldn't [get that]. But I am happy with my process because I had a very productive process for myself. I think that what I learned is more than my grade." (P8) "I ask myself whether I did something I felt good about or not. I liked the last product I designed for my project very much. Maybe I didn't get a good response as a grade, but it made me make some decisions about myself." (P6)
Influenced by the sample / peer	6	"In one of our sessions, you [the researcher of this thesis] gave an example about your experience with finding your drawing style. If you look at my process, the styles of my drawing changed completely after that week. Even though it took more time, including watercolor while using markers for drawing helped me to start studying beforehand. From now on, I want to develop it [further]." (P9) "From the moment you explained that this [your own learning method and strategies] can be learned, the event caught my attention." (P3) "You told us about your experience of finding your drawing style in a session. After that, I criticized myself to see how I could work and express myself better. I realized that I stopped taking notes which were one of my favorite things, colored pencils, writing with images, etc. After that speech, I bought a new notebook for the project and spent the semester with it." (P4)
Continuity	5	Then I used our page on Miro again. Now this semester, I will prepare a page for myself. With the help of this study [the SRIIDS], I learned how to do it [planning to study]. I know how to study much better now." (P2) "Watching midterm jury records were very useful. I watched it 2-3 more times after that. I will record and watch or listen to my presentations again from now on." (P7)

Students were encouraged to develop applicable strategies in line with the goals that they set within the scope of the study. It was observed from the statements that these incentives worked, students sought different ways of expressing themselves, and developed and implemented both process and result-oriented strategies. According to students' statements, they also seemed to be focused on themselves more rather than on getting grades. Their comments provide evidence that their goals became more future-oriented, process-oriented, and learning-oriented. Their statements showed that by getting to know about their abilities and wishes, their self-efficacy also increased. They used the word of *self-confident* in their expressions and also declared that they were satisfied with their gains in *finding themselves.* These outcomes were deemed to be a result of learning-focused strategy development and application.

During the the SRIIDS sessions, some examples of personal strategy development experiences were shared with the students. It was observed that these examples were quite effective on the students. In their feedback, 6 students referred to the example given by the researcher, which was about the researcher's own experience of finding her drawing style as a strategy. The students stated that they were motivated and took action to find their strategies after that example. This shared experience affected the students who struggling in the form of peer support.

Some students mentioned their plans for the next semester. They were willing to use some of the activities of the SRIIDS study. This was an important indicator of the SRL skills since the persistence in performing a task is an outcome of self-efficacy and self-regulation (Schraw, 2006; Zimmerman et al., 1992).

5. FINDINGS AND DISCUSSION

In the second phase of this dissertation, the SRIIDS intervention study provided design students with activities that involve self-regulated strategies that have been developed relevant to the design studio context. Data collection and analysis of this phase aimed to explore the effect of the intervention study in the design studio course. Several interrelated research questions guided this phase. We conducted a mixed-method research design to collect and analyze the data after the intervention study. The integrated analysis and some quantitative analysis (i.e., grade comparisons) demonstrated that the SRIIDS study has a developmental effect on students' engagements with some SRL strategies and on their design performance.

In this section, the integration process and major findings of the study will be described and discussed under the related research questions together with the content of the SRIIDS study and the findings of the first phase of this dissertation.

5.1 Integrating the Quantitative and Qualitative Findings on Self-Regulated Learning Strategies

As stated in the beginning of section 4, this experimental phase attempted to answer the second, third and fourth research questions which focus on evaluating the impact of the SRL intervention in the design studio on student performance. To answer research question 2 "To what extent does SRL-intervened studio affect design learners' reported use of SRL strategies in their design learning?", the self-report questionnaire scale was used, and the quantitative data were analyzed. To answer research question 3 "What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?", a feedback questionnaire and interviews were conducted, both quantitative and qualitative data were collected and analyzed. Finally, to answer research question 4 "How does student's self-regulation influences their design performance?", the students' grades

from juries were tracked and compared through quantitative analysis. Although the analyses appear to answer different research questions, the second and third questions are related to each other, and they both focus on evaluating the effect of the intervention study on gaining SRL skills of the students. Therefore, like in the first phase, the convergent mixed-method approach (see section 3.1) was used in the second phase, too, to have a deeper understanding of the effect of the developed intervention study on SRL strategies. The data were gathered at the simutaneously and independently, so they did not inform each other. While analyzing, the data were combined at the end of the data collection process for interpretation and drawing conclusions. As stated in section 3.1.2.5, Creswell and Plano Clark (2018) and O'Cathain (2010) suggest using a comparison matrix to assess both data sets and determine the levels of agreement between them. Therefore, as shown in Table 5.1, a joint comparison matrix was used to investigate the coherence of findings. Some SRL strategies were prominent in both data sets. Planning, seeking appropriate information, self-monitoring, self-evaluation, and self-efficacy in students statistically significantly increased after the intervention. There were exact descriptions related to these strategies in qualitative data. Some inconsistencies were also discovered in the findings. The qualitative findings revealed some advances in seeking assistance, goal orientation, and task value, even though there was no statistically significant increase in these strategies in the qualitative data. This allowed us to understand and expand unanticipated results from quantitative data through qualitative data. The results and findings will be discussed by revisiting the research questions in the following section.

Table 5.1 : Comparison of quantitative and qualitative findings in Phase II.

SRL strategies & Motivational factors	Quantitative (SSRL pre-post test results)	Qualitative (Content analysis of interview)	Agreement, partial agreement, dissonance/expansion, no match,
Arrangement of study time	-		No match
Planning	++	++	Agreement
Environmental structuring	-		No match
Organizing and transforming	-		No match
Seeking appropriate information	++	++	Agreement
Seeking easily accessible information	-		No match
Rehearsing and memorizing	-		No match
Self-monitoring	++	++	Agreement
Seeking peer, teacher, or adult assistance	-	+	Dissonance / Expansion
Self-evaluation	++	++	Agreement
Self-consequences after success	++		No match
Self-consequences after failure	-		No match
Self-efficacy	++	++	Agreement
Goal orientations	-	+	Dissonance / Expansion
Task value	-	+	Dissonance / Expansion
Attributions for failure	-		No match
Anxiety	-		No match

++: exact information related to a finding

+: supporting/related information related to a finding

-: contrasting information related to a finding

No symbol: no information

5.2 Key Findings in the Change in Self-Regulated Learning Strategies

The second and the third research questions of this dissertation have a proximal aim of questioning the impact of the intervention study by tracing the changes in students' engagement with SRL strategies. The difference between these questions is in their approach since the second one queries the reported use of SRL strategies quantitatively, and the third one inquires the level of awareness of SRL strategies qualitatively. To answer research question 2 "To what extent does SRL-intervened studio affect design learner's reported use of SRL strategies in their design learning?", the self-report questionnaire scale was used, and the quantitative data were analyzed. To answer research question 3 "What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?", a feedback questionnaire and interviews were conducted, both quantitative and qualitative data

were collected and analyzed. The integrative analysis provided us with a holistic view to answer these questions. Three key findings emerged from this analysis:

- Design students who engaged with an intervention that is aimed at supporting SRL strategies demonstrate increases in metacognitive strategies (i.e., goal planning, self-monitoring, and self-evaluation)

- Design students who engaged with an intervention that is aimed at supporting SRL strategies demonstrate increased motivation levels (i.e., self-efficacy, goal orientation, and task value).

- Design students who engaged with an intervention that is aimed at supporting SRL strategies demonstrate increases in behavioral strategies (i.e., seeking information and seeking help).

These major findings will be explained and discussed in the following section by revisiting the findings from the first phase and the content of the intervention study.

5.2.1 The change in metacognitive strategies

Goal setting and planning

In the first phase of this dissertation, the comparative analysis between high and low achiever design students' strategy use highlighted that high achievers have more adaptive inferences about their designing and learning processes. They reported using metacognitive strategies (i.e., goal planning, self-evaluating, organizing, and transforming) more than the others. On the other hand, because of lack of interpretation attitude and metacognitive strategy use, underachievers were more dependent on external factors such as the instructor's critics or examples. Metacognitive strategies help students to monitor themselves from outside of the activities. These strategies lead the students to plan their aims, activate their prior knowledge, and organize and prepare the existing materials according to their own method of learning (Pintrich, 1999). Especially in collaborative learning environments (e.g., design studio), metacognition has a central role in supporting the regulations at both individual and group levels (Järvelä et al., 2021). Goal setting as a planning process is one of the fundamental metacognitive features of self-regulation (Boekaerts & Niemivirta,

2000). Zimmerman, Greenberg, and Weinstein (1994) define this strategy as a first step to start the SRL phases despite its cyclical process.

In the design studio, students who do not have personally developed goals experience struggle more during their projects. They tend to be dependent on what is fed back in the critic sessions, which is very complicated situation since it causes fluctuation in the developmental process. To engage design students with more metacognitive processes, goal setting and planning activities were conducted in the first session of the SRIIDS study. SRL strategies and their effects on their achievement and learning processes were explicitly presented to the participant students. They were encouraged to define their personal goals about their project and plan on them. This approach was planned to make them think about their own learning processes and develop their own strategies. Integrated analysis of the data which was developed through participant interviews and pre-and post-test SSRL scores, showed that goal-setting activities supported the development of SRL skills. Participating students conducted, followed, and compared their goals with their previous experiences. They managed to set future-, process- and learning-oriented goals. One of the participant students mentioned the willingness to continue to set goals for his other courses and his life as well. Another student mentioned her specific goals for that project in the final jury, and that she successfully achieved these goals, of which she was proud. Another student set some personal off-project goals (i.e., doing sport regularly) in her goal-setting form, and in the interview session, she stated that she still follows that plan. This study supports the notion that planning goals and monitoring them during learning are effective strategies to be more efficient in learning (van den Hurk, 2006). As stated in section 4.3.2.1, design students are exposed to various emotional triggers since as Goldschmidt et all. (2010) stated, they need approval and comment to continue their idea development, which is a sensitive process with emotional inclinations. Sometimes, some students can get fascinated by the instructor's negative or positive comments too much. Some study to satisfy the instructor's expectations, which affect learning badly (Kavousi et al., 2020). Goals are like safety jackets for students to hold and breathe against external factors. They need a starting point to compare and interpret the critics with their own ideas and aims. Goals can be used as a tool to decrease the full dependency on the outside and syncretize comments with personal goals.

It is important to distinguish the goals of the project and those of the students. Project statements which are defined by the students upon request by instructors can be seen as a goal planning activity. However, in project statements, students mostly focus on the project's requirements and the instructor's comments. The goal-setting and planning activity that are suggested in this dissertation are about focusing on students' needs and expectations in their learning process. This requires another level of communication in the design studio. While criticizing the development of the design project, it is not always possible to consider the students' aims. Additional activities should be conducted during the studio to support the learning process for design students.

Self-monitoring

Self-monitoring refers to the systematic monitoring of students' performance and provides information to students about how well they are progressing against their own goals (Oz, 2019). It is a covert form of self-observation (Powers, 2006). According to the integrated findings of the first phase of this thesis, there were no difference between high and low achiever students in the use of self-monitoring strategy. However some high performers mentioned that they voice-recorded the critic sessions and listened to them while preparing for the next critic session. In the second phase, after the the SRIIDS study, the integrated findings indicated an increase in usage of the self-monitoring strategy. Participant students mentioned that they started to use new notebooks and/or pens to take notes about their design process. Besides, the self-watching of the recordings of jury presentations which was introduced as a self-evaluation strategy in the second session of the SRIIDS was also an example of a self-monitoring method for the students. Students pointed out that they will use video or voice recording strategy in their next studio experiences. According to some research, teaching self-monitoring skills provides students with benefits (e.g., Schunk 1983; Delclos & Harrington 1991; Maag et al. 1992; Malone & Mastropieri 1992; as cited in Chang, 2007). However, although self-monitoring is necessary for self-regulation, it is not enough to sustain the learning regulation (Schunk, 1995). Zimmerman (1989a) states that self-monitoring is affected by individual processes such as self-efficacy, goal setting and planning, and also behavioral factors. Self-trial and self-recording as sub-strategies of self-monitoring require systematic and frequent tracings (Bandura, 1986). The design process already necessitates this kind of tracing method since it

consists of complicated and long cognitive processes (e.g., developing multiple ideas). In this long period, the most frequent problem is forgetting the ideas and/or comments. Self-monitoring strategies would help the design students to track their process, so that they can reflect on their ideas and comments more easily. It is also important to note that, self-monitoring provides the necessary materials to make self-evaluations on. Schunk (1995) highlights the relation between self-monitoring and self-evaluation and argues that students' achievement outcomes are improved by explicit self-monitoring of skill acquisition through self-evaluation of capabilities. To have a productive learning environment in a design studio, these two skills of self-regulation should be improved by linking them with the goals of design students.

Self-evaluation

To define their goals, students first need to evaluate themselves. Self-evaluation, a metacognitive strategy, is about defining the level of previous works, existing situations, and quality of works (Zimmerman & Martinez-Pons, 1986). In the exploratory phase of this dissertation, as mentioned in section 3.3, the findings of the differences in self-evaluation and causal attributions of students indicated similar results similar to those of Zimmerman and Moylan's (2009) study. Both high and low achievers could evaluate themselves, however, while high-achievement students could adjust their difficulties and weaknesses; underachievers tended to attribute their weaknesses to external uncontrollable factors such as the education system and instructors, among others. They expected the instructor to fix their problem, not themselves. These findings drove us to think about how design students could be prevented from making defensive and accusing decisions and led to an accurate self-judgment attitude. To create an environment for the student to make their evaluations, a micro-teaching method from education literature was used in the third SRIIDS session (see section 4.2.3.3). Students watched the recording of their midterm jury presentations. They were encouraged to make evaluations of their projects and presentations according to jury requirements shared by the instructors previously. The integrated analysis of this study indicated a change in the goal orientation of the students. Before the activity, when they were expected to observe themselves and define weaknesses and strengths, they reported some issues about themselves hypothetically. However, when they watched themselves literally, they stated that they realized their weaknesses, necessities, and mistakes more clearly. Thus, they could

plan their goals in a more future-oriented way, since they were more aware of their future necessities. They mentioned planning to develop their inadequate knowledge (i.e., historical or technical knowledge). They could focus on the process since the midterm jury was not the final stage of their education. They were glad to hear and see themselves from the outside and to have time to improve. With the help of discussion on individual differences during the the SRIIDS session, they could embrace their weaknesses and strengths. They became more learning-oriented by developing strategies over their differences. These findings tie in well with the notion that watching self-performance enables one to monitor SRL behaviors; and realize and analyze self-learning processes in a real dynamic social setting (Kohen & Kramarski, 2012). As proposed by Gray et al. (2020), having a critical instructional perspective for design education provides us with the environment for rich externalization and discussion of learner experience, by which students will develop their design expertise involving value improvement with design identity. Since the designing process cannot be described without the designer's self-processes, design education should not be instructed without the learner's agency. In the design studio, the main evaluation tool is the critics of instructors, and there is not enough space and time for learners' comments. In their study about analyzing self-efficacy and anxiety of industrial design students, Chien et al. (2021) claim that ID students' self-efficacy is positively affected by their self-evaluation. In line with previous studies, in our study, self-criticizing through the microteaching method functioned as a self-evaluation tool. It helped students to understand their values and develop their own identity of learning. Finally, this self-evaluation behavior of the design students provided an increase in their self-efficacy supporting the theory that motivation is an essential component of the SRL cycle, and thus allowing metacognition to be used (Zimmerman, 2000). The motivational changes will be discussed in the following section.

Self-consequences are another metacognitive strategy in SRL processes. Using this strategy, students reward or punish themselves based on the result they receive in comparison it with their definition of success and failure. According to Nota, Soresi & Zimmerman (2004), this strategy should be an indication that students continue their learning efforts since thinking about possible rewards and possible punishment increases student motivation for additional study. In the first phase of this dissertation, findings indicated that high achiever design students tended to punish themselves after

failure more than underachievers did. The statistical results of the second phase indicated an improvement in the strategy of self-consequences after success, however, we could not find supporting information related to this strategy development in qualitative analysis. It remains unclear to which degree the statistically significant advance can be attributed to the effect of the intervention study. We must note that statistical change only is not a satisfactory indicator of SRL improvement, in the absence of performing proper qualitative procedures. Because of this potential limitation, we prefer to treat this result as supplementary data and not to use it to reach conclusions by itself.

In the first phase of this dissertation, the findings indicated a difference in organization and transformation strategy use of high and low achievement students. Zimmerman and Martinez-Pons (1989) define this cognitive and metacognitive strategy as students' performance of organizing information in different forms. Using this strategy, students reconstruct the newly encountered information in a way that makes it more meaningful by using their previous knowledge (Oz, 2019). High achiever design students were more interpretive of the given tasks and critics. They had a project notebook to synthesize and reconstruct ideas and comments by writing and drawing. They adjusted their works according to their intentions and related requirements while underachievers were stuck to the requirement list without question. However, in the second phase of this dissertation, there was not any direct indicator of improvement about this strategy neither in quantitative nor qualitative analysis. We speculate that this might be due to the limitations of our observational technique which could not manage to capture the cognitive process under this strategy. On the other hand, in the third session of the SRIIDS, we introduced a mapping activity which is proposed as a helpful organization tool by Zimmerman and Schunk (2003), however, we did not conduct it as an activity. Because of this potential limitation, we treat organization and transformation strategy as an important issue for future research to explore.

5.2.2 The change in motivational strategies

Self-efficacy

In the first phase of this dissertation, as stated in section 3.3, the comparative analysis of students' strategy use indicated that academic achievement is influenced by

motivational variables such as self-efficacy, goal orientation, and task value. Low achievers indicated low self-efficacy against harsh critics. Their definition of success was dependent on the instructor's positive judgments, which revealed performance-oriented goals. Their comment about the contribution of the studio to themselves, which was generalized and far future-oriented (i.e., "will help in my professional life"), indicated the value they attribute to the studio. On the other hand, high achievers were more confident about their process although they had harsh critics, too. They were focused on studio courses for self-development and for having successful projects to prepare a good portfolio. They used their previous studio experiences directly on their subsequent studio courses, which means that their comments on the value of the studio were short-term oriented. In SRL literature, cognitive and metacognitive learning strategies draw more attention to study, however, some students struggle to reach their goals despite using the proper learning strategies, and these difficulties might be derived from motivational factors (Senemoğlu, 2007). Motivational deficiency may cause a decline in joy while applying a strategy or in task valuation of the students (Rabinowitz, Freeman, & Cohen, 1992; as cited in Zimmerman and Moylan, 2009). In the second session of the SRIIDS, the participant students were encouraged to compare the criteria of success and their performance in the design studio, so that they could define their weaknesses and strengths. As a metacognitive monitoring strategy, this provided students with higher self-efficacy by influencing their persistence (Zimmerman, 2000) especially against harsh critics in the design studio. Ochsner (2000), who studied the interaction in design studio from a psychoanalytic perspective, indicates the importance of belief in self and its difficulty in the design studio:

> Many students are motivated to apply to architecture school by an idealism about the environment and a wish to contribute to human betterment. Some are also clearly motivated by the kind of experience they will find in design studio—they are seeking a place where they can draw on ways of being and thinking that they sense are possible, but they have not found widely understood or recognized. They may not be able to articulate this consciously, but many are seeking to recover aspects of the transitional space of creative play lost since childhood. To do this requires a suspension of disbelief and an acceptance of the process before the results can be assured. For students this

> can be exhilarating, but the uncertainties and ambiguities can also be frightening (p.203).

As seen from this quotation, design students need to form self-beliefs during their design process to capture and use their creative sides, however for some of them, this can be frustrating because of the complexity of design studios. Even if design students know how to design, their sense of low self-efficacy may cause them to underperform (Powers, 2006). In this equation with multiple unknowns, the role of design instructors should also cover the developing self-efficacy of the students with relevant strategies. Self-efficacy beliefs are shaped mostly by earlier self-experiences, but they can also be influenced by experiences of others, verbal convincing, and physiological reactions (Bandura, 1986; Bong & Skaalvik, 2003; Pajares & Valiante, 2002, as cited in DiFrancesca et al. 2016). Another finding of this study, which is about experience sharing, led us to consider this experience sharing approach as a strategy development tool. This was not intentionally defined or developed before the the SRIIDS study. During the sessions, especially while discussing individual differences, the researcher shared some experiences of how she became aware of her design strategies, and this also encouraged the students to share their own earlier experiences about realizing their differences. Ayyıldız-Potur (2007) points out unique qualities of design students with that make them different from others; such as experience, personality traits, level of interest and willingness, values, ability, and creativity. According to the findings in the second phase of this thesis, students stressed that they were influenced by the real experience sharing talks, and they felt that they were not alone. This approach, as mentioned in a few studies of teacher training literature, would be a potential SRL training method (e.g., Dermitzaki & Kriekouki, 2017; Liu, 2016) for design students. Powers (2006) states that, for low achiever landscape design students, goals are less likely to be used as a guide for connecting with peers, therefore they deliberate less on their studio performance with their peers. With experience sharing strategy, students would be encouraged to connect with peers and share their good or bad experiences. This helps them to develop their learning commitment in the studio. Hence, they could overcome their frustrations with regards to ideas of inability through reflecting on similar stories of others.

Goal orientation and task value

Even though self-efficacy is seen as the most significant factor of motivation (Zimmerman, 1990), other factors (i.e., goal orientation and task value) should be considered together since they have a strong relation to each other (Erdogan, 2012). As we stated in the previous paragraphs, according to the first phase of our study, motivational variables affected the design students according to their achievement levels. Students' statements indicated that high achievers' goal orientation was more learning-oriented, while low achievers were performance-oriented. Additionally, while high achievers expected short-term gains from the tasks and the studio (e.g.., developing their portfolio), low achievers estimated extended gains from studio education (e.g., helping future occupational life). In the SRIIDS study, unlike self-efficacy, goal orientation and task value factors were not the preliminary aim to develop. However, we observed that these variables were developed indirectly via activities. According to Dweck (1986), if students believe that their qualifications are improvable, they tend to develop them. After direct explanations of SRL strategies and the effects of motivational factors, students were likely to orient their goals to self-improvement. One of the participant students explicitly stated that her ideas of studying for the studio completely changed after the direct explanation of strategies that can help us to develop our way of studying. This implies that the SRIIDS study makes her believe that her abilities can be further developed. Additionally, as Pintrich (1999) states, students who see the tasks as interesting, important, or beneficial for them use more self-regulated learning skills. After the the SRIIDS study, even though they mentioned that they did not like the subject of the project, some students found a way to like their project via blending the subject with a subject which they were already keen on. These imply that the existence of the SRIIDS study in a studio course itself could be considered as a motivational strategy. Nevertheless, the developments in these factors were derived only from qualitative analysis, therefore they were defined as expansion findings in integrated analysis (see Table 5.1). To have a deeper understanding about changes in these motivational variables, more specific research needs to be conducted.

5.2.3 The change in behavioral strategies

Seeking information

The behavior of seeking information is a process of identifying and selecting the most suitable information among the possible sources (Uçak, 1997). Due to the rapidly developing and changing technology, the ability to make necessary arrangements to access information in the shortest time and in the most effective way has become one of the requirements of the contemporary era (Oz, 2019). The self-regulated learner is expected to make an effort to access appropriate information and organize it. In the first study of this dissertation, the indicators of behavioral difference between the student in high and low achievement levels were about seeking information and help strategies. Low achievers tended to have easy and applicable information about the project subject in a grade-oriented way mostly via the internet. On the contrary high achievers conducted a learning-driven approach while seeking information for their project. They mentioned that they preferred to record the voice of the instructors during critic sessions and listen to them afterwards. These results were in line with the results of Chiu's (2010) study on design-learning resources preferred by junior and senior industrial design students, where while juniors listed the internet as one of the top four knowledge sources (i.e., books, studio mates, and schoolmates), seniors added auditing desk crits to that list. In the second phase, while re-analyzing the project brief, students were encouraged to think about appropriate information sources about their own project goals. Looking for information not to imitate but to inspire was specifically mentioned. The findings of the second phase about seeking information strategy showed that when the students advanced more on learning-oriented goals, they tended to seek learning-oriented information, too. After the the SRIIDS activities, findings indicated an increase in seeking appropriate information behavior of the students in both qualitative and quantitative legs of the research. Students were willing to research their subject in detail and synthesize the information they asccessed with their goals and project requirements. As stated before, the goal planning activity helps them to increase their self-efficacy and decrease their high dependency on the instructor's comments. In a design studio, research is an essential starting point, and mostly the students are expected to develop their ideas with their ongoing research. Such a start can be challenging for an underachiever with a fewer or negative experiences regarding project development. Rittel and Webber (1984) discuss two difficulties that

less-sufficient students encounter while collecting knowledge to solve ill-defined design problems; which are not knowing where to start, and not having an ultimate formulation of an ill-defined problem. Powers (2006) points out that low achievers prefer the trial-and-error method using primary internet information because of their reduced ownership of their project and focus on their performance on the perspective of the instructor. Chen (2016) compares resource usage of design students regarding their class levels and finds that while seniors try to use an object (e.g., internet, books, magazines, products), method (e.g., brainstorming, discussion, observation, interview, and survey, practice, computer-aided) and environment (e.g., library, workshop, processing factory, department store) resources to solve learning problems, juniors depend on human resource (e.g., instructors, peers, technicians, experts, family, friend) more. Leading low performer students to understand the importance of the goals and develop their self-efficacy supports them to find the appropriate ways to engage with the external resources. In other words, instructors should take in a scaffolding approach where they should use the information as a tool, not as a goal.

Seeking help

Seeking help strategy is the ability to use peers, teachers, or other adults as a resource to cope with the uncertainty and difficulties encountered in the learning process (Newman, 2008). Although self-regulated strategies involve mostly individual processes, help-seeking requires social interaction dissimilar to other strategies. Therefore, it can be classified as a form of social information seeking (Zimmerman & Martinez-Pons, 1986), and social motives influence the use of help-seeking strategy (Ryan & Pintrich, 1998). According to the findings of the first phase of this dissertation, in line with the studies on help-seeking strategy (e.g., Karabenick & Gonida, 2018; Newman, 1994; Sungur & Yerdelen, 2011; Zimmerman & Cleary, 2009; Zimmerman & Martinez-Pons, 1990), low achievers were reluctant to have a conversation with peers or instructors to not demoralize themselves. On the contrary, high achievers preferred to receive feedback from other people such as peers, upper-class peers, or instructors out of the studio in addition to their instructros. In the second phase, during the SRIIDS study, one of the main subjects which were indicated and discussed with the participant students was being open to criticisms, sharing comments, synthesizing them with individual preferences, and orienting every move of the project to learning goals. It was deduced from the statements of the participant

students that, they were aware of their need for help, and they preferred consulting senior peers. This finding was in line with the ideas of Karabenick and Knapp (1988); the students might feel too embarrassed to ask their questions during the studio because of emotional pressure, and they might want to receive comments from their peers out of the studio rather than from their peers in the studio. Both reasons indicated that students needed more focused and flexible communication in the studio. Chen (2016) points out that design students rely mostly on the human resource to solve the problems encountered in the studio, but they also experience difficulties with interacting and communicating with their instructors and peers. As discussed in section 3.3, the "mystery-mastery" syndrome which was defined as inaccessibility of the instructors in the studio by Schön (1987) may cause low achievers to feel out of place and may prevent them from asking for help. It is noteworthy that in design studio which is expected to be open to collaboration, underachievers displace themselves refusing the communication.

In their study which is focused on the SRL strategy differences of Turkish high school students, Sungur and Yerdelen (2011) partly explain the low usage of help-seeking strategies by underperformer students with the exam-oriented Turkish educational system. Turkish students' competitive behavior starts to develop beginning from middle school since they must enter national prescriptive exams to get into better high schools and universities (Sungur and Yerdelen, 2011). Our findings support the notion that when design students who came from such competitive learning environments encountered a studio that consists of both individual and collective processes, they needed a change in their learning strategies. Schön (1985) states that the goal of the design studio is built on teaching a new language which is defined as the language of design and designing. However, students could not make sense of this new language since it could not be explained or transferred directly because of its complex instructional structure. In a learning situation where there is no single right or solution, students do not know what to do at first (Erdogan, 2012). They need a restructuring of their ways of learning including metacognitive, motivational, and behavioral factors. If especially poor performers cannot receive enough explanation with decent communication from their studio instructors, they feel the need to ask for help from their peers. Because of its implications of inadequacy, help-seeking can be stigmatizing and result in personal consequences like feeling obliged to compensate

the helper (Karabenick & Gonida, 2018). Therefore, they can be reluctant to ask for further assistance. This impeding condition for help-seeking should be amended by applying appropriate communicational strategies in the studio education. During the the SRIIDS study, students mentioned their feeling of loneliness while struggling with the difficulties in the studio. After they had a chance to talk about these difficulties with their peers in the SRIIDS sessions, they stated that they did not feel alone anymore, and that they felt like they could express their ideas on their processes more easily. This finding ties in well with the highlights of Bilgin and Akkapulu (2007) who suggest that peer attachment prevents adolescents from feeling alone and increases the level of social self-efficacy. Social self-efficacy is defined by Sherer et al. (1982) as one dimension of self-efficacy and representation of a person's confidence in self-social skills. The design studio requires high social skills since it has critic sessions and juries in which students present their studies to the instructors, guests, or peers. In their study, Dunbar et al. (2018) indicate that collaborative learning environments correlate with higher social self-efficacy, and high social self-efficacy correlates with higher academic performance. Peer interaction in the design studio contributes to the collaborative learning structure so that students become proactive, self-regulating learners (Crolla et al., 2019). Design studio as a collaborative learning environment (Wang, 2010) might be expected to develop self-efficacy through encouraging peer attachment, especially for underperforming students.

5.3 Major Findings in the Change in Design Performance

To answer research question 4 "How does student's self-regulation influences their design performance?", the students' grades from juries were tracked and compared through quantitative analysis. The key findings that emerged from this analysis are as follows:

- Design students who engaged with an intervention aimed at supporting SRL strategies demonstrate increased jury grades compared to the students who did not engage with the intervention in the same studio class.

In the first phase of this dissertation, design students were grouped according to their average of their last two official studio grades. The reason for including two studio

grades is that as stated by Soderstrom and Bjork (2015) assessing learning requires long-term understanding, which is not easy to evaluate in a classroom. Two studio grades both of which consisted of process evaluations can be an indicator of consistent achievement for design performance. Students' SRL strategy use was analyzed through both quantitative and qualitative data, and the differences related to achievement levels were identified for the design studio. High achiever design students reported and were observed to use some of the metacognitive, motivational, and behavioral strategies more than the underperformer design students. In the second phase of this dissertation, to support the underachiever students' design performance with the help of SRL strategies, the SRIIDS intervention study was built around the findings of the first phase and conducted in another 3rd-year design studio course. The intervention started in the 5th week and finished in the 9th week. The midterm jury was in the 7th week, and the final jury was in the 14th week. To see the differences in the grades received by the experimental and control groups before and after the intervention study, mid and final jury grades were analyzed. According to the results of the statistical tests explained in section 4.4.2.1, while the control groups' jury grades decreased, the experimental group's grades increased significantly from mid to final jury (see Table 4.8 and Table 4.9). Besides, to see the differences in each evaluation factor between the groups, all evaluation criteria (i.e., concept development process, midterm jury, design development process, final jury, participation, and total term grades) were used for analysis. According to this analysis, the experimental group's final jury grades, participation grades, and term grades were found to be statistically significantly higher than the control group (see Table 4.9). This displays that before the intervention, there was no statistical difference between the student groups' grades, yet after the intervention, the experimental group had higher grades than the control group.

The increase in the grades of the SRIIDS participants provides evidence for the positive correlation between SRL strategies and academic achievement (e.g., Araz & Sungur, 2007; DiFrancesca et al., 2016; Erdogan & Senemoglu, 2016; Loeffler et al., 2019; Zimmerman, 1990). Additionally, according to Ergen and Kanadli's (2017) study which aimed to investigate the effect of self-regulated learning strategies on academic achievement through a meta-analysis of studies conducted in Turkey between 2005-2014, it was determined that self-regulated learning strategies had a

"big" effect (d = 0.859) on academic achievement. Our study had findings that supported these studies.

In his study discussing creative processes within the SRL framework, Rubenstein et al. (2018) discuss the difficulty in assessing the creative processes because of the effects of its psychological and social patterns, and intentional actions. They further indicate that SRL measurement methods may help to assess students' creative processes. There are other studies (e.g., Greene et al., 2019; Hargrove, 2007; Sawyer, 2017) which prove the intimate relationship between SRL strategies (especially cognitive and metacognitive) and creative performance (i.e., higher-order or critical thinking) in art and design education. However, it must be pointed out that, in this thesis, researcher did not focus on the creative performance of the students or the creativity of the final projects solely. What we focus on in this study was the academic design performance, which includes creative performance as one of the grading criteria. In academic design performance, instructors evaluate not only the creativity of the final project but also the continuity, timing, and improvement of the ideas during the design learning progress. According to Cowdroy and de Graaff (2005), creativity is frequently assigned a 'higher order' ability status in higher education, and evaluation normally mirrors that in the practice arena focusing on the result and the 'craft skills' of implementation. It is important to distinguish that academic design performance has different assessment factors than creative (i.e., professional) design practice. In his study discussing the relationship between design education and practice, Buchanan (1998) describes design education as a separate discipline that does not copy from but equally works with the professional practice. Therefore, the aim of assessment in design studio cannot be the creative results only, and the learning process underlying that creative performance should be included, too. We believe our study which focused on the learning process in design studio provides a vital starting point for discussion and further research about also creativity with SRL strategies in industrial design studios.

6. CONCLUSIONS AND RECOMMENDATIONS

This explanatory and experimental study aimed to provide design educators, students, and researchers with a foundation to understand the self-regulated learning strategies in the industrial design studio. Instead of providing instructions with generalizable conclusions, the findings of this thesis must be read in the light of the research context by considering design learning in studio.

In this chapter, research topics and findings are summarized, the implications resulting from the findings are recommended and limitations of the study are discussed for future studies. Suggestions for design educators and learners are shared regarding several facets of teaching, learning, and searching in industrial design education.

6.1 Summary of the Study Findings

This thesis consisted of two phases that investigate self-regulated learning strategies in the industrial design studio. The first phase has an exploratory research design to describe the differences in the use of self-regulated learning strategies by high- and low-achieving ID students in a design studio. The second phase has an experimental research design that is developed based on the findings from the first phase and conducted to understand the impact of SRL intervention on students' design learning processes in a design studio. In both phases, a mixed-method approach was adopted, and data were collected both quantitatively (i.e., through a self-report questionnaire) and qualitatively (i.e., through interviews). To the best of our knowledge, this thesis is known to be the first to examine SRL strategies quantitatively and qualitatively through SRL intervention in an industrial design studio. In this sense, it contributes novel insights that attempt to fill this gap in design studio education literature. The findings from both phases are summarized in Table 6.1. and will be explained subsequently.

Table 6.1 : Summary of study findings.

Dimensions of SRL Strategies		***Findings from exploratory research phase***		***Findings from experimental research phase***
		High achiever industrial design students;	**Low achiever industrial design students;**	**After participating in the SRIIDS, the design students;**
Metacognitive strategies	**Goal planning**	have high interpretation skills of the briefs and tasks	have high dependency on decision-makers other than oneself	conducted, followed, and compared their goals with their previous experiences, setted future-, process- and learning-oriented goals, decreased the dependency on the outside and syncretize comments with personal goals
	Self-monitoring	are aware of weaknesses	attribute their weakness to external factors (i.e., education system, faculty, instructor)	bought new notebooks, pens to take notes about design process used self-recording and watching activity as a monitoring tool
	Self-evaluation	prefer self-adjustments of difficulties	have high expectations from others (i.e., faculty, instructors)	watched the recording of midterm jury presentation, realized and embraced weaknesses, necessities, and mistakes, internalized learning-orientedness through individual differences
		able to change the learning strategy	have lack of interpretation and synthesizing skills	
	Transformation and organization	have high level of abstract thinking: defining project with abstract words	have high level of concrete thinking: defining project with concrete words	*There was not enough information related to this strategy in the integrated analysis.*
		able to synthesize information as a cognitive strategy	have low level of critical thinking as a cognitive strategy	
Motivational strategies	**Self-efficacy**	have high self-efficacy	have low self-efficacy especially against harsh critics	compared the criteria of success and their performance, shared their positive or negative experiences with peers, changed their lonely moods and increased their self-efficacy, increased their SSRL pre and post-test scores of self-efficacy
	Attributions for failure	attribute their failure to controllable factors	make defensive decisions after a failure	embraced their weaknesses, failures and worked on them
	Goal orientations	have learning-oriented goals	have performance-oriented goals	setted future-focused and learning-oriented goals, blended their project with a subject they like
Behavioral strategies	**Seeking help**	are open to interaction with others	are reluctant to interact with and get help from teachers and peers	started to be open to criticisms, shared comments, synthesized comments with their individual preferences, oriented every move of the project to learning goals
		seek help from teachers and peers		
	Seeking information	seek information for learning	have tendency to rely on easily applicable information	worked with appropriate info sources about their own project goals, looked for information not to imitate but to inspire

Different learning strategies for different levels of design performance

The first phase of this thesis investigated the differentiation of SRL variables between high and low-achieving design students in a studio. Research question 1 that guided this phase with its sub-questions was: "What is the level of reported use of SRL among industrial design learners before participating in an SRL-intervened learning environment in a design studio?" (see chapter 3). To answer this overarching question, five sub-questions were developed. They were: Are there meaningful differences between the SRL skills and motivation of ID students with different academic achievement levels?; What are the SRL skills frequently used by ID students with different academic achievement levels?; What is the correlation level between self-regulation and motivation levels?; How do high and low-achieving ID students perceive their own studio course experiences?; To what extent do qualitative and quantitative results converge and/or diverge?. The findings from the first phase help to answer these questions. Shortly, there are significant differences in design students' utilization of SRL strategies in design studio in relation to their achievement levels.

The achievement levels were determined according to their last two studio grades; therefore, their achievement levels can also be considered as their design performance levels. The first research question with its sub-questions guided this phase. The 3rd year design studio was chosen because at this level students are highly expected to have developed their learning strategies already. Focusing on this level provided us to exclude students' adaptation problems to a new learning environment. Despite the similarity in expectations, low and high achievers in the same studio reported different levels of self-regulated learning strategies. High achiever design students reported more frequent use of metacognitive strategies (e.g., high interpretation skills of the briefs and tasks, being aware of weaknesses, self-adjustments of their difficulties, ability to change the learning strategy, high level of abstract thinking, and synthesizing ability as a cognitive strategy), motivational strategies (e.g., high self-efficacy, attribution to controllable factors, having learning-oriented goals), and behavioral strategies (e.g., being open to interaction with others, seeking help from teachers and peers, seeking information for learning). On the other hand, underachievers showed evidence of a lack of metacognitive skills (e.g., high dependency on decision-makers other than oneself, attributing weakness to external factors, high expectations from others, lack of interpretation and synthesizing skills, high level of concrete thinking,

and as a result, low level of critical thinking as a cognitive strategy), motivational skills (e.g., low self-efficacy especially against harsh critics, making defensive decisions after a failure, having performance-oriented goals), and behavioral skills (e.g., reluctancy to interact with others, tendency to rely on easily applicable information).

The findings from the first phase were supportive of other research which has investigated the relationship between SRL and academic achievement (e.g., Araz & Sungur, 2007; DiFrancesca et al., 2016; Eckerlein et al., 2019; Erdogan & Senemoglu, 2016; Kryshko et al., 2020; Nandagopal & Ericsson, 2012; Pintrich & Schunk, 2002; Powers, 2006; Zimmerman, 2000; Zimmerman & Moylan, 2009). Across all these research studies, a recurring major theme emerged: the need for underperformers to develop a learning strategy. These findings allowed us to obtain a better understanding of the learning challenges and necessities of design students in the design studio context and motivated us to move on to the experimental phase of this thesis to investigate how design learners could be assisted more effectively by way of self-regulation.

Supporting self-regulated learning strategies in the industrial design studio

This thesis was founded on a social-cognitivist theory of self-regulated learning. This theory defines self-regulated learning as a process that is driven by interactive relationships between personal, behavioral, and environmental aspects (Bandura, 1986; Zimmerman, 1989a, 2000). Therefore, it is not a permanent characteristic (Schunk, 2001), the strategies of SRL can be taught (Panadero & Alonso-Tapia, 2014) through supportive processes. This point of view influenced the development of activities to help design learners experience and improve self-regulated learning strategies during their design process in the studio.

For the second phase, a self-regulated intervention study in an industrial design studio (i.e., the SRIIDS) was developed based on the findings from the first phase (see section 3.2 in chapter 3), examples in the literature, and the process model of SRL developed by Zimmerman (2000) (see section 2.1.2). This phase was guided by the second and third research questions which were: “To what extent does SRL-intervened studio affect design learners’ reported use of SRL strategies in their design learning?” and “What kind of impact does SRL-intervened studio have on increasing awareness of SRL strategies among design learners?” The answers to these questions can be found

in the findings from both quantitative and qualitative analyses. Briefly, SRL strategy awareness and usage by design students can be developed through activities in the design studio.

The characteristics of the intervention stated by Jansen et al. (2019) were used for procedural decisions. In line with this, the SRIIDS was planned as 4 sessions within the design studio course. The content of the first three sessions was developed based on the 3 phases of the SRL model. In these sessions, participators were encouraged to set learning-focused goals, monitor their process, evaluate themselves, and adapt their goals and strategies according to the reflections from themselves. They were informed on self-regulated learning theory and its effect on learning process as well. Additionally, learners experienced watching their jury presentation video recordings as a learning strategy (known as the microteaching method in education literature). The last session was conducted as a reminder about the loop of the process so that students could plan to use this cyclical process in their design process later.

Through a quasi-experimental research design, the intervention was evaluated using both quantitative and qualitative methods. To evaluate the effect of the intervention on the use of SRL strategies, an integrated analysis was conducted, and the findings were compared and discussed. The findings specific to SRL strategy developments are summarized in the following paragraphs.

First, design students who engaged with the intervention which aimed at supporting SRL strategies in design studio demonstrated increases in metacognitive strategies. The analysis of the qualitative data revealed that design students were more likely to employ effective learning strategies, set goals, and customize them for their preferences; track their process and evaluate themselves through the tools suggested when they were actively involved in the activities. The participants demonstrated an increase in their SSRL pre- and post-test scores of metacognitive strategies (i.e., goal planning, self-monitoring, and self-evaluation). Such improvements in the findings from both data sets show that students' use of metacognitive strategies has changed positively.

Second, design students who engaged with the intervention which aimed at supporting SRL strategies demonstrated increased motivation levels. The analysis of the qualitative data revealed that design students were more likely to share their positive

or negative experiences with peers when an appropriate environment was provided in the activities. This helped them to change their lonely moods and increase their self-efficacy. They also indicated an increase in their SSRL pre and post-test scores of self-efficacies as a motivational strategy. The development of self-efficacy in both data sets provides evidence of strengthening of students' motivation levels.

Finally, design students who engaged with the intervention which aimed at supporting SRL strategies demonstrated increases in behavioral strategies. The analysis of the qualitative data revealed that these students were more likely to research learning-oriented information (not to imitate but to inspire) for their projects and synthesize it with their personal learning goals and project requirements when they were actively involved in SRL activities. They reported not feeling alone anymore after they shared their experiences and difficulties with the participants of the intervention study. They also showed an increase in their SSRL pre- and post-test scores of seeking appropriate information as a behavioral strategy. This improvement in their behavior regarding seeking information and assistance presented evidence of development of students' behavioral strategy.

This thesis progressed through two phases in each of which different research questions were addressed whilst elucidating an overall question. The findings of this thesis illustrated that activities for supporting self-regulated learning in design studios can assist design students to improve their design learning experience in the studio.

Self-regulated learning and design performance

During the experimental phase, the grades of the students both in the experimental and control groups were tracked by the researcher of this thesis. Research question four "How does student's self-regulation influences their design performance?" guided this phase. The changes in the jury grades before and after the intervention study were compared within the experimental group. The grades in each evaluation criteria of the studio course were compared between the two groups. According to quantitative analysis, design students who engaged with the intervention aimed at supporting SRL strategies demonstrated an increase in their jury grades after the intervention, while the control groups' jury grades decreased. The statistical analysis for each evaluation criterion of the jury indicated that the experimental group had higher grades than the control group after the intervention, while before the intervention there was not a

statistical difference between the two groups. The increase in the grades of the SRIIDS participants demonstrated that there is a positive relationship between SRL strategies and design achievement. The findings of this thesis lead to implications for education and research, which will be discussed below.

6.2 Study Implications

This thesis supports the idea that self-regulated learning strategies help students to achieve higher grades. As part of this thesis, conducting a self-regulation intervention in an industrial design studio allowed us to see the instructional possibilities in the design studio. The feedback from the participant students functioned as a useful guide regarding the implications to studio education. Addressing research question five, "How can an efficient design learning environment be designed in terms of the SRL strategies to improve students' design performance?" this section attempts to propose some applicable considerations that might be helpful to design educators and learners.

6.2.1 A proposal for self-regulated learning in the industrial design studio

As discussed in section 2.1, the social-cognitivist theory on which this thesis is founded defines self-regulation as a triadic reciprocal process entailing person, behavior, and environment factors (Bandura, 1989). This complex social interactive process involves not only metacognitive skills but also social, motivational, and behavioral components (Zimmerman, 1995). In the self-regulated learning process, Zimmerman (2000) emphasizes the cyclical adaptation of self-generated actions and behaviors; and covert processes (i.e., feelings and thoughts) to attain the goals. In other words, self-regulated learners experience both overt and covert processes sequentially and cyclically, and these processes feed each other to develop the learning experience.

In this thesis, as discussed in section 2.3.2, the actors of design studio education were considered from the point of view of the social-cognitivist self-regulation theory. The triadic process including person, behavior, and environment was adapted for the design studio learning environment as the student, project, and studio. As stated in section 3.2.2, qualitative findings in the first phase reflected on this view, and strategies were analyzed through this approach. With the guidance of the experimental phase's findings, a proposal for a self-regulated learning process regarding the relationship

between and within these three design studio actors is presented in Figure 6.1. In this figure, the relationships between and within the actors and SRL strategies were depicted through arrows indicating communicational directions in the dynamic learning environment. This model proposes that the communication between the actors of the design studio can be regulated through SRL strategies. If the students have direct explanations about the value of metacognitive strategies in individual processes (i.e., goal planning, self-monitoring, and self-evaluation), behavioral strategies in the collective processes (i.e., seeking appropriate information and seeking help from peers and instructors), and motivational factors during the entire process in the studio, they could be more enthusiastic to use these strategies. Due to the cyclical nature of the SRL process, the strategies which are used to communicate with the actors provide students with feedback so that they can use the results of the strategies as the elements of the other stages.

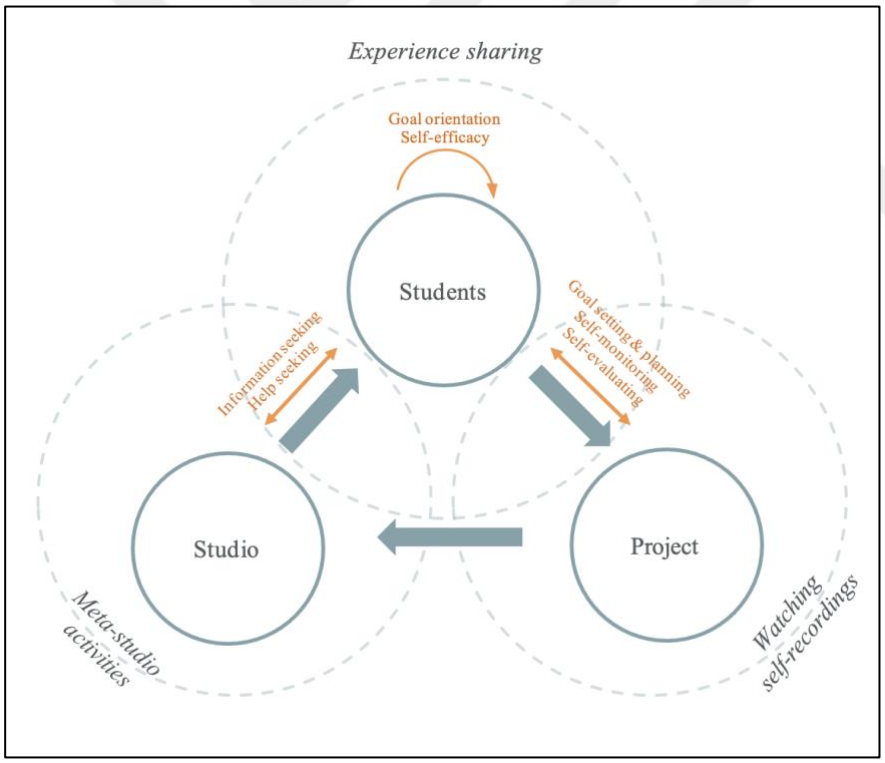

Figure 6.1 : A proposal for self-regulated strategies in design learning developed on "Triadic forms of self-regulation" by Zimmerman (1995).

The proposed model that is depicted in Figure 6.1 indicates the actors in a design studio. It centralizes the student in the learning environment with three communication spaces which are promoted through SRL strategies: self-communication, communication with the project, communication with the studio.

Self-communication

In the model depicted in Figure 6.1, the student as a design studio actor represents design students' feelings and thoughts. Design learning requires self-study times in which design learners are expected to reflect on their works and ideas. This is one of the ways to experience professional designer attitude (i.e., thinking and behaving) for the students (Shreeve, 2015). However, this is as well the most unled phase of design studio education. Ledewitz (1985) defines this phase as a "leap in the dark" which students must take to move from analysis to synthesis. They are expected to use the information they accumulate in the analytical phases of the studio and synthesize it to develop creative ideas intuitively. In this stage, instructional deficiency causes ambiguity for some students; thus, they cannot use the self-study time effectively causing a decrease the motivation. In our model, self-communication includes the motivational factors of the self-designing process. As known from the literature, goal orientation is an important predictor for academic achievement (e.g., Pintrich & Schunk, 2002; Steele-Johnson et al., 2000; Sungur & Yerdelen, 2011). The findings of this thesis indicated that, in the design studio, the personal aims of the students differ with regards to their appreciation of their projects, which directly affects their study activities. Furthermore, it is observed that students without learning goals have a low level of self-efficacy and high dependency on external factors. Developing a project for their portfolio, which means working not for the grade but learning, encourages them to interpret the process according to their personal goals. Defining a personal goal that is different from the goals of the project brief can direct their activities to purpose of learning. Finally, their self-efficacy can be developed so that they do not depend on external factors. There are several ways to increase self-efficacy, and this model emphasizes two of them. First, the internal conversation, which is a crucial activity while designing, should be a preliminary task for the students. If they have a direct explanation of the effect of the motivational factors on their design process, they can develop positive inner conversations. Second, creating a social bonding and the help-seeking strategy have a positive effect on self-efficacy. Leading students to seek help via direct instruction is not possible. Our model emphasizes experience sharing as a motivational strategy that establishes a basis for peer and instructor attachment through conversations on common difficulties and weaknesses. When the students feel that they are in an environment consisting of shared feelings and thoughts, they can be

more open to trusting their own approach. Therefore, experience sharing should be included in the studio process to provide social support for students' self-efficacy.

Communication with the project

The design project as a design studio actor represents behaviors and expressions of design students in this model. In the design studio process, as an outcome of self-study times, students are expected to present their works to get feedback and criticism. Mostly visual representations are used as conversation mediums between the instructor and the student. Some students who have insufficient visualization skills or doubt their skills have problems in the critic sessions since they do not know how to work on or cannot present their actions effectually. Explaining the design actions, choices and decisions require a certain level of awareness and communication ability (McDonnell, 2016). To become more aware of the mental process students need to reflect on their thinking, which is another uninstructed process in design studio education (Azevedo & Hadwin, 2005; Christensen & Ball, 2016). While criticizing the work of the students, design instructors should use scaffolding techniques to open metacognitive spaces where students can interact with their project (Gray, 2014). In our model illustrated in Figure 6.1, metacognitive strategies of self-regulation are proposed to encourage students to communicate with their own projects. According to our findings, underperformers avoid evaluating their design actions in the studio since they are not aware of the strategies that they can use, or they value the instructors' comments more. This dependency on external factors also indicates a low level of self-efficacy. If students are provided with an explicit setting to reflect on their works and scaffolded through conversations, the awareness and the agency of the students can be developed. In this manner, our model proposes self-recording of students as a metacognitive strategy. Watching the recordings of themselves while presenting their project provides students with realizing unthought and untold weaknesses of their designing process. Video recordings can be utilized in both physical and digital studio environments since education is becoming more blended after the emergency remote education. Screening sessions can be conducted alone, or as a group, so that peers (audiences) can comment on it. Recording helps students reduce their dependence on memory and better track performance over time (Zimmerman & Kitsantas, 1999). This retrospective monitoring activity provides students with a tool to evaluate themselves.

In this way, they can regulate their goals according to the outcomes of the self-evaluation on recordings.

Communication with the studio

The studio as a design studio actor represents the external factors affecting the design process such as interaction with instructors, peers and the information gathered. While developing their design project, students encounter a range of interaction and communication problems, and they mostly rely on human resources for solutions (Chen, 2016). Also, our study indicated that especially low performer design students tend to rely on instructors' comments and try to fit the project to their view only. The communication between the student and instructor is mostly based on verbal conversation and the level of interaction depends on the individuals. Besides, in their study on a semantic analysis of the conversations in design studio, Casakin and Georgiev (2021) indicate that the verbalization of the instructors and students differ based on their knowledge, skills, and level of expertise; while instructors mostly use expressions associated with creativity (i.e., feasibility and usability), the articulation of students is more related to the conceptual features of the task. These differences in the content of the conversations cause difficulties in understanding each other. The accordance on the next step becomes vague, especially for the students. To prevent such communication problems more collaborative practices are needed. Vyas et al. (2013) categorize three generic themes of collaborative practices which create communication channels to develop creativity in the design studio: artifacts, space, and practices. Our study focuses on the needs and problems of students until they reach these three mediums. Therefore, in addition to using artifacts, fields, and practices to develop communication in the studio, practices that explain why these practices are done should be constructed. In our model, meta-studio activities refer to a set of activities that involve discussions on the aims of the studio tasks, difficulties and problems that students encounter in the process, and their behaviors in response to these problems. Creating a medium for students to share their positive or negative studio experiences with instructors and peers strengthen the feeling that they were not alone and increases their motivation by improving their confidence in their abilities. Besides, the accessibility of the instructor can be enhanced through these activities. Self-regulated learning stresses the importance of socializing agents such as peers, parents, and instructors (Zimmerman, 2000). SRL strategies of seeking help and

appropriate information help students to develop their learning experience behaviorally. Such meta-thinking studies through experience sharing with the individual actors of the design studio should be incorporated in the studio pedagogy to provide a more accessible studio environment where students can use people and information as external resources.

The social-cognitive view of self-regulated learning allowed us to propose this introductory-level model for self-regulated learning in the design studio which was introduced in this section. The exploratory and experimental research phases of this thesis provided information to develop this domain-specific proposal, which opens new communication channels in design studio conversations. More empirical studies are required to verify and develop this proposal in the context of design education, which will be discussed below.

6.3 Recommendations for Design Studio Education

This thesis contributes to the existing literature on two levels. First, it provides insights for education literature from design studio education which is a creativity-focused learning environment with natural learning conditions and simulation of real-life. Second, regarding the ongoing deep changes in both educational, theoretical and practical sides of design -which is signifying a new order of design and a new generation of designers who tend to become decision-makers- this thesis fills a gap within the existing body of design pedagogy and instruction in industrial design in relation to self-regulated learning. It highlights the importance of students' self-awareness, learning strategy preferences, and motivational aspects in design studio education. Design studios will not fulfill their potential to foster SRL skills through the signature pedagogy unless individual student differences are paid attention to. Studio education needs improvement to encourage students to develop their learning skills. The implication of SRL strategies regarding individual differences in design learning environments can help to improve the design performance of less accomplished students.

With this thesis, we aimed to better understand design learning and provide further insights for redesigning the studio learning experience. Both theoretical and practical implications can be drawn from the study's findings. Educators can reflect critically on their teaching and learning practices. The the SRIIDS intervention applied in the

second phase of the study will be useful to studio instructors allowing them to develop new applications.

This section summarizes some pedagogical insights for design education derived from this thesis. The findings of two research studies with third-year design students and the researcher's seven years of third and fourth-year design studio teaching experience gave the motivation to make recommendations to both design instructors and learners. These recommendations focus on including the underperformer students in the design learning process in the studio effectively.

Recommendations for pedagogy in the design studio

1. **Flourishing personal goals**: Design instructors should be aware of individual differences of students during the studio process. As mentioned in the article of Buchanan et al. (2013), the internal characteristics of the design student (e.g., their judgment, perception, appreciation, empathy, courage, imagination) should be addressed, too. Metacognitive activities provide proper content for students' individualistic features to discuss with them. The aims of the project and the goals of the students should be differentiated and then syncretized together through the conversations in the studio. By doing this, students can comprehend the importance of their own goal plans and orient them towards learning. Personal taste and attitudes of the students can flourish through such an approach which also helps to increase their self-efficacy.

2. **Watching self-recordings:** Due to its complex longitudinal process, the most frequent problem of designing is forgetting or misunderstanding the ideas and/or comments on one's design. Design learners need methods and tools to trace their designing process. Design instructors should encourage students to record their own process via either digital (video, audio recording) or physical (note-taking, drawing) tools. Since the student's emotional experience is higher while presenting or explaining their work, this recording activity should include especially critic sessions and jury presentations. For underperforming students, note-taking can be frustrating since they do not count on their abilities enough. Therefore, especially these students should be presented with easy recording methods such as audio or video records. However, recording is not a satisfactory learning strategy without reviewing. Specific time allocations should be included in the studio process for evaluating these records. These

sessions can be conducted within student groups or individually. However in both, the instructor should be included in the process to lead the students in self-evaluation. Having a metacognitive view encourages low performer design students to regulate their learning strategies, develop self-belief, and explore their ways of designing which is the main purpose of studio education.

3. **Questioning the studio:** In self-regulation outcomes of the learning activities feed the other strategic learning steps. While metacognitive strategies such as planning goals, monitoring, and evaluating help to increase the self-efficacy and motivation of the learners, they also give students a point of view to regulate their behavioral strategies. Help-seeking as a behavioral strategy is the only strategy that requires social interaction in SRL. Design students may have problems reaching the studio instructors for asking for help when they are insecure about their process. They are mostly afraid of being criticized and consequently demoralized or feel too embarrassed to ask questions. The educational system that they were previously part of was based on a competitive approach, so they need to adapt to the features of the collaborative learning environment. In some cases, reflective conversations with the instructors are not enough to make students understand the learning process. They need more explicit and flexible communication in the studio. Questioning the studio at a meta-level can be helpful to develop more sincere dialogues between instructors and students, which also helps to create a more collaborative environment. In these meta-studio activities, students should be encouraged to compare the criteria of success and their performance in the design studio explicitly, so that they can define their weaknesses and strengths. This activity also allows students to question the decision-makers of the studio and decrease their high dependency on them. Critical thinking requires questioning minds so that all kinds of information can be synthesized. The design studio should allow students to challenge the status quo so that they can explore their abilities to “leap into the dark”. The fewer the number of external factors that students depend on, the more agency and awareness they can develop.

4. **Sharing experiences:** In the design studio, knowledge is constructed mostly through reflective conversations between the instructor and the student. These

conversations vary according to the works and activities of the students. In the case of no development in the project or no activity during the week, the effectiveness of the critic session decreases. Most design instructors do not have time or vision to look for the reasons for these situations, and they might simply assume that students are not investing enough time in their studies. Instead, instructors should pay attention to the motivational factors which have a big effect on the learning process. Even though students try to apply learning strategies, motivational deficiency can cause them to underperform. Besides, harsh critics on a negative design process can be demotivating for especially low performers in the studio. Failures should be criticized in a way that they can be turned into fruitful feedbacks for the struggling students. Design instructors should share their experiences of learning and designing to encourage students to share their difficulties and problems with their peers as well. This creates another level of communication for these students and increases social self-efficacy by empowering them via making them feel less alone in this journey. Higher self-efficacy helps the students to trust their abilities and regulate their learning strategies accordingly. Experience sharing is a motivational strategy that can be promoted through group tasks or activities in the studio process.

Recommendations for learning in the design studio

1. **Being open to strategies:** According to the findings of this thesis, students who use SRL strategies on purpose have higher academic achievement. Besides, students who joined SRL studies during the studio increased their jury grades and consequently design performance. Design students should always remember that as Portugali (2006) contends, the meanings of the interactions depend on the receiver, not just the system. The design studio is a learning environment with ambiguity and uncertainty for the students. However, the meaning in the design studio is also constructed through the interactions, and design students as the central actor should have the awareness of their expectations and problems. SRL provides them with awareness of their inner voice, their actions, and the external factors that affect their processes. SRL strategies help them to control these to achieve the learning goals. Therefore, design students should become more familiar with self-regulated activities.

The earlier they get acquainted with SRL, the faster they can adapt to the design studio environment.

Recommendations for design education

1. **Introducing SRL to students:** The findings of this thesis indicated that design students coming from an individual and exam-oriented learning environment need explicit explanations about the aspects of studio learning environment; which has a more collaborative, student-oriented, and constructive approach. The transition can be difficult especially for some of the first-year design students since their existing learning strategies may not be useful in the new context (Thomas, 2013). These students are required to adapt their strategies or develop new ones to participate in the studio process effectively (Schunk, 2001). Although there are various implications for students, SRL is still notably missing from educational norms and curricula (Greene, 2021). The instructional structure of the first-year curriculum should include introductive SRL courses, activities, and/or meetings to help the student during this transitional period. Introducing design students with self-regulation in the early years helps them to develop an individual, environmental and behavioral awareness sooner, so that they can adapt to the design studio by improving strategies metacognitively, motivationally, and behaviorally.

2. **Introducing SRL to instructors:** The lack of SRL applications in design studios affects how design instructors engage with students, which result in inadequate SRL support. To promote the integration of SRL in design curricula, a more extensive knowledge on how instructors can facilitate metacognition and SRL is required. It is recommended that institutions initiate instructional awareness for self-regulation for the instructors, which Kramarski (2018) calls “self-regulated teaching” (SRT). Especially part-time instructors with relatively less experience in teaching design studio courses should be introduced to SRL to improve their ability to communicate with students through their projects. Besides, they can look into their own learning processed retrospectively with a view of self-regulation and use this experience in the design studio to create a deeper connection with the students.

6.4 Limitations and Further Studies

In both phases of this thesis, data was collected through both quantitative and qualitative methods to make more accurate interpretations. As Creswell (2014) stresses, each form of data has different types of information and limitations, hence mixing them provides a chance to minimize the limitations of the study and maximize the understanding of research questions, more than collecting one type of data would. Even though this thesis verifies previous findings and brings light new ones, we acknowledge that there are limitations which will be explained below.

In the first phase of this thesis, our integrative analysis revealed the difficulty of recognizing students' SRL skills via one type of data source. On its own, our quantitative data indicated statistical differences in strategy use between the two achievement groups. However, it provided little insight into how and why this occurs. We did not ask about or mention any SRL strategies during interviews, and this allowed us to obtain non-biased descriptions through which we could go beyond statistics and uncover other internal and external components that might affect design students' SRL processes. The integrated approach led to a reconsideration of the complex and ambiguous design learning process. The inconsistent findings between the data sets (mostly in behavioral and motivational factors) also highlighted an important limitation about self-report for further studies. Some studies have questioned the effectiveness of self-report for capturing factual information (e.g., Winne & Jamieson-Noel, 2002) and dependency on the context of use (e.g., Alexander et al., 2011; DiFrancesca et al., 2016). Even though the questionnaire used in our study was designed as context-free and suitable for Turkish undergraduates (Erdogan & Senemoglu, 2016), we had to optimize the terms according to studio expressions. Therefore, it may not have completely captured accurate information in a design education context. Future research might therefore benefit from a self-report study with a design-education-oriented approach or from using additional SRL measurements that monitor and track learners' ongoing development.

Being aware of uncontrollable factors is important to develop the internal validity of a study (Creswell, 2014). Threats to internal validity are mostly about the procedure or treatments of experiments, or experiences of participants (Creswell, 2014). In the second phase of this thesis, the intervention having a quasi-experimental research

design has limitations about procedure and participants. First, participating in the study was planned to take place on a voluntary basis because the study was conducted within a studio course that had its own instructional goals and processes. The researcher had to send multiple emails to encourage students to participate. Some students joined following the first invitation, while others joined after a follow-up email. Although the researcher elucidated the relevant aims and position of the study within the studio course, students may have created a mindset, thinking that participating in this study is mandatory for the course. This issue was mitigated by making sure that students knew that they could leave the study. This may have caused another limitation for our study, as two participant students dropped out before the study was completed. In further studies, the reasons to drop out and the conditions of the students should be tracked. This will possibly give more insights on investigating the effects of the SRL activities.

As a result of voluntary participation and 2 participants dropping out, the sample size of the intervention study remained at 11 participants. Besides, there were 47 participants who complete the questionnaire and 16 participants who were interviewed in the first phase. In addition, the sample consisted of a small group of junior undergraduates majoring in ID in a private university in Turkey. This presents some potential limitations to our study's external validity which is about generalizing the findings beyond groups, settings, or time. This thesis tried to establish a foundation for understanding the SRL process in terms of industrial design studio rather than generalizable conclusions for design education. The findings are promising, yet should be validated by a larger sample size, including different sub-disciplines of design, multiple settings, and various education levels to generalize for entire design education.

Another limitation of these intervention studies is that students in the experimental group knew that they were participating in a study that involved the teaching of learning strategies. In educational research Rosenbloom (1961; as cited in Cook, 1962) discusses the Hawthorne effect as a well-known problem, where in an experimental situation, participants (i.e., teachers and students) are more highly motivated because of being in special learning context than others. Hawthorne effect should be considered as a limitation to the validity of our claims.

Another limitation in the procedure of the intervention involves the issue of measurements. Pre- and post-tests of the SSRL scale were conducted with the experimental group, yet not all students in the control group answered the questionnaires. Therefore, Single-Group Interrupted Time Series Design as a type of quasi-experimental design was applied for the scale points comparison tests. Hence, it was possible to calculate the change in the scale points before and after the intervention only for the experimental group. Even though while experimental group's jury grades increased, control group's decreased, and this opposite change of the groups' jury grades provided us an important understanding, it is highly recommended to do the tests for both groups to compare the results. This will provide more comprehension of the effects of the intervention study.

An important feature of our study is that the experiment was conducted in natural learning conditions while students prepared for the real deadlines of the design studio, in contrast to other studies in the literature (e.g., Lee et al., 2010; Nückles et al., 2009). Besides, the design studio, which engages with real-life problems as learning topics provides a simulation for the occupational life of a designer. Erdogan (2012) suggests that the effects of self-regulated strategies can be traced more effectively on the occupational lives of the students. Therefore, with its features of being a natural learning condition and simulation of a real-life, design studio can be a more suitable environment to apply and track the self-regulated strategies for further studies.

The explorative phase of this thesis (i.e., first phase) was conducted in a face-to-face design studio. However, the intervention (i.e., second phase) had to be developed and applied as an online study in an online design studio condition with an emergency remote learning environment because of Covid-19 restrictions. A major source of limitation is due to this differentiation in the mode of delivery in design studios. For design studio education, using online tools for the studio process is a new experience and little is known about this context. It is obvious that digitalization will be required in every aspect of our lives as a result of the pandemic. Although there is a growing number of studies about online self-regulated learning tools, the limited understanding of the online design studio environment needs more insights to develop effective SRL interventions for online or even blended design studio education.

Aside from a small number of studies, the design domain in SRL studies is under-researched and had not yet been studied in Turkey. Our study will hopefully serve as a base and provide a good starting point for discussion and further research.

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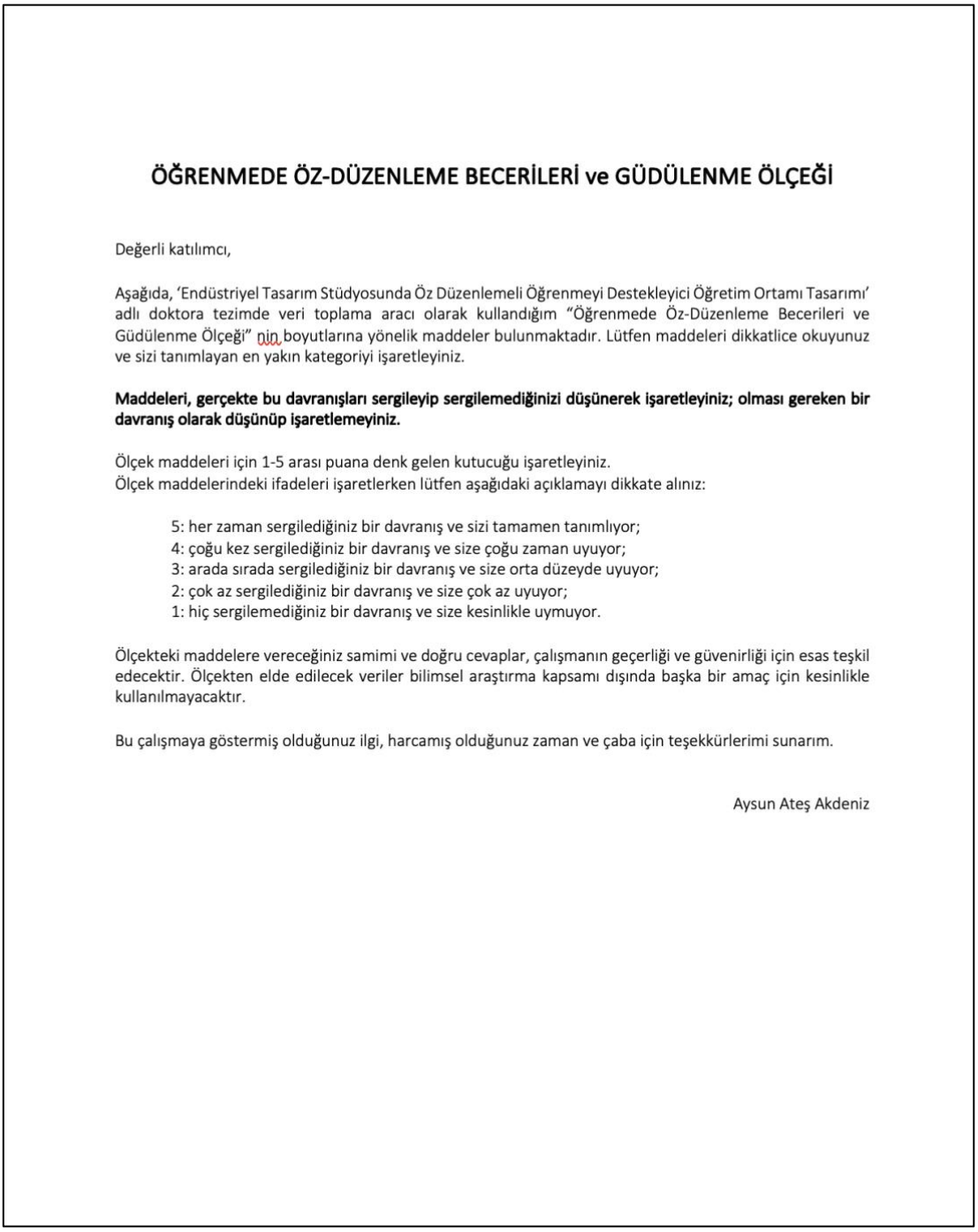
APPENDICES

APPENDIX A: Scale on Self-regulation in Learning (SSRL) (in Turkish)

Figure A.1 : Scale on Self-regulation in Learning (SSRL) (in Turkish) (Erdogan, 2006).



ÖĞRENMEDE ÖZ-DÜZENLEME BECERİLERİ ve GÜDÜLENME ÖLÇEĞİ

Değerli katılımcı,

Aşağıda, 'Endüstriyel Tasarım Stüdyosunda Öz Düzenlemeli Öğrenmeyi Destekleyici Öğretim Ortamı Tasarımı' adlı doktora tezimde veri toplama aracı olarak kullandığım "Öğrenmede Öz-Düzenleme Becerileri ve Güdülenme Ölçeği" nin boyutlarına yönelik maddeler bulunmaktadır. Lütfen maddeleri dikkatlice okuyunuz ve sizi tanımlayan en yakın kategoriyi işaretleyiniz.

Maddeleri, gerçekte bu davranışları sergileyip sergilemediğinizi düşünerek işaretleyiniz; olması gereken bir davranış olarak düşünüp işaretlemeyiniz.

Ölçek maddeleri için 1-5 arası puana denk gelen kutucuğu işaretleyiniz.
Ölçek maddelerindeki ifadeleri işaretlerken lütfen aşağıdaki açıklamayı dikkate alınız:

5: her zaman sergilediğiniz bir davranış ve sizi tamamen tanımlıyor;
4: çoğu kez sergilediğiniz bir davranış ve size çoğu zaman uyuyor;
3: arada sırada sergilediğiniz bir davranış ve size orta düzeyde uyuyor;
2: çok az sergilediğiniz bir davranış ve size çok az uyuyor;
1: hiç sergilemediğiniz bir davranış ve size kesinlikle uymuyor.

Ölçekteki maddelere vereceğiniz samimi ve doğru cevaplar, çalışmanın geçerliği ve güvenirliği için esas teşkil edecektir. Ölçekten elde edilecek veriler bilimsel araştırma kapsamı dışında başka bir amaç için kesinlikle kullanılmayacaktır.

Bu çalışmaya göstermiş olduğunuz ilgi, harcamış olduğunuz zaman ve çaba için teşekkürlerimi sunarım.

Aysun Ateş Akdeniz

Figure A.1 (continued) : Scale on Self-regulation in Learning (SSRL) (in Turkish) (Erdogan, 2006)

ÖĞRENMEDE ÖZ-DÜZENLEME BECERİLERİ BOYUTU MADDELERİ

A. Çalışmaya Başlamadan Önce

		1	2	3	4	5
1	Ödevlerimi proje yürütücülerinin kontrol edeceğini bildiğim zamanlarda yaparım.					
2	Çalışmaya başlamadan önce tüm kitapların, notların ve malzemenin elimin altında olduğundan emin olurum.					
3	Genellikle teslimlere bir gece önceden çalışırım.					
4	Zamanı etkili bir biçimde kullanmaya karar vermede zorlanırım.					
5	Uzun dönemli amaçlarım doğrultusunda faydalı olabilecek hangi dersleri ve notları almam gerektiği konusunda proje yürütücüleri ile konuşurum.					
6	Genellikle yoğunlaşabileceğim yerde çalışırım.					
7	Haftalık yapmam gerekenleri not defterime listelerim.					
8	Dersin zaman çizelgesini dikkate alarak hazırlamam gereken sunum ve ödevleri, okuyacağım materyalleri, gerekecek maket/çizim malzemesi, bilgisayar programı vb ihtiyaçları ve onlara ayırmam gereken zamanı önceden düzenlerim.					
9	Çalışacağım alanı çalışmalarıma yoğunlaşabileceğim şekilde düzenlerim (Televizyonu açmak/kapatmak, müzik açmak/kapatmak).					
10	Teslimlere birkaç gün öncesinden çalışmaya başlarım.					
11	Çalışmaya başlamadan önce dikkatimi dağıtacak her türlü şeyden kendimi uzaklaştırırım.					
12	Bir ödeve başlamadan önce durup bir planlama yapmak için zaman ayırırım.					
13	Yapacaklarımın ve bunları ne zaman yapmam gerektiğinin planlamasını genellikle dönemin başında yaparım.					

B. Çalışma sırasında

		1	2	3	4	5
14	Proje konusunu öğrenmeme yardımcı olması için basılı ya da dijital kaynaklarda geçen anahtar kelimelerin altını çizerim, farklı renk bir kalemle işaretlerim ya da not ederim.					
15	Stüdyodan sonra kütüphaneden ya da dijital ortamdan bulduğum kaynakları okurum.					
16	Stüdyoda anlamadığım bir konu olduğunda proje yürütücülerinden ve sınıf arkadaşlarımdan yardım isterim.					
17	Çalıştığım proje konusunu bir arkadaşıma anlatırım.					
18	Proje konusundaki anahtar noktaları belirler ve bu anahtar noktalar arasında bağlantı kurarım.					
19	Projenin önemli noktalarını anlamama yardımcı olması için özet çıkarırım, not tutarım, şekiller ve tablolar çizerim (Bunlardan bir tanesini ya da birden fazlasını işe koşarım).					
20	Diğer kaynakları pek araştırmam.					
21	Proje konusuyla ilgili önemli maddeleri listelerim ve o listeyi ezberlerim.					

Figure A.1 (continued) : Scale on Self-regulation in Learning (SSRL) (in Turkish) (Erdogan, 2006).

22	Bir ödevi en kolay nasıl yapabileceksem onun yollarını ve kaynaklarını ararım.					
23	Proje sürecinde konuyla ilgili kaynaklar okurken ya da notlarımı gözden geçirirken arada sırada durur ve kendime "Bu projede anlatılmak isteneni anlıyor muyum?" şeklinde sorarım.					
24	Bağlantıları kurabilecek şekilde, mesela başlık veya alt başlıklar halinde not çıkarırım.					
25	Daha detaylı bilgi için kütüphaneden ya da dijital ortamdan kaynaklar bulup derinlemesine okurum ve/veya sahada gözlem ve incelemeler yaparım.					
26	Not aldığım yerleri bulundukları ortam içinde hatırlamaya çalışırım.					
27	Proje konusu ile ilgili okuduğum metni kapatıp aklımdan tekrar ederim.					
28	Verilen proje konusuna benzer proje örnekleri için internete başvururum.					
29	Proje sürecinde kendime "Uygun çalışma stratejilerini kullanıyor muyum?" şeklinde sorarım.					
30	Projeme stüdyodaki diğer öğrencilerle beraber çalışırım.					
31	Proje sürecini anlayabileceğim şekilde organize etmek için resim çizmeye ya da şematize etmeye çalışırım.					
32	Proje konusunu anlamakta zorlandığımda, akranlarımdan ya da yetişkin birinden yardım isterim.					

C. Çalışma sonrasında

		1	2	3	4	5
33	Verilen proje konusu üzerinde çalışırken, yaklaşımımın doğruluğundan emin olmak için proje tanımını kontrol ederim.					
34	Ödev/teslim/sunumlardan iyi not aldığımda kendimi ödüllendireceğime söz veririm.					
35	Hazırladığım ödev/teslim/sunumun proje yürütücülerinin vermiş olduğu ölçütlere uygun olup olmadığını kontrol ederim.					
36	Başarılı olduğumda yapmaktan hoşlandığım şeyleri yaparım (sinema, alışveriş, vb.)					
37	Kendimi proje yürütücülerinin yerine koyarak ödevimi/teslimimi/sunumumu kontrol ederim.					
38	Başarısızlıklar beni yeniden çabalamaktan alıkoyar.					
39	Proje sürecinde, her ödevi/teslimi/sunumu bitirdikten sonra onu tekrar okuyup üzerinde düzeltmeler yaparım.					
40	Ödev/teslim/sunumum iyi geçerse kendimi bir sinema ya da yemek ile ödüllendiririm.					
41	Genelde bitirdiğim bir ödevi/teslimi/sunumu kontrol etmem.					
42	Başarılı olduğumda uzun zamandır sahip olmak istediğim bir şeyi (T-shirt, ayakkabı, cep telefonu, vb.) alırım.					
43	Başarısız olmak beni üzer, ama bu durumu düzeltmek için pek birşey yapmam.					
44	Yaptığım ödevin/teslimin/sunumun benzer çalışmalara göre yeterliliğini karşılaştırırım.					
45	Başarısızlıklar benim yeniden planlama yapmamı engeller.					

Figure A.1 (continued) : Scale on Self-regulation in Learning (SSRL) (in Turkish) (Erdogan, 2006).

ÖĞRENMEDE GÜDÜLENME BOYUTU MADDELERİ

		1	2	3	4	5
46	Proje içeriğinde yer alan en zor konuyu bile anlayabileceğimden eminim.					
47	Benim için şu an en tatmin edici şey stüdyo dersimden iyi bir not almaktır.					
48	Stüdyoda verilen ödev ve istenilen teslim/sunumları en iyi şekilde yapabileceğimden eminim.					
49	Aldığım stüdyoların mesleki yaşamımın uygulama alanına katkı getireceğini düşünüyorum.					
50	En iyisini yapacağıma inanıyorum.					
51	Stüdyoda öğretilen temel kavramları öğrenebileceğimden eminim.					
52	Stüdyoda proje yürütücüsünün sorusunu cevaplayan tek ben olduğumda çok mutlu olurum.					
53	Bir stüdyoda öğrendiklerimi diğer stüdyolarda da kullanabileceğimi düşünüyorum.					
54	Stüdyo dersinde çalıştığımız proje konularının gelecekte işimize yarayacağını düşünüyorum.					
55	Sunumumu yabancı dil kullanarak anlatamama düşüncesi kaygı düzeyimi yükseltir.					
56	Stüdyoda başarılı olacağımı düşünüyorum.					
57	Stüdyoda öğrendiklerimin benim için faydalı olduğunu düşünüyorum.					
58	Diğerlerinin benim zeki olduğumu düşünmesini istiyorum.					
59	Aşırı ödev ve teslim yükü beni başarısız kılmaktadır.					
60	Teslimi/sunumu zamanında yetiştirip yetiştiremeyeceğim düşüncesi kaygı düzeyimi arttırır.					
61	Proje konularının ilgimi çekmemesi beni başarısız kılmaktadır.					
62	Sunumlarda o kadar heyecanlanırım ki bildiklerimi dahi unuturum.					
63	Proje konusunda anlayamadığım noktalar olduğunu görmek projeye odaklanmamı engellemektedir.					
64	Stüdyolardaki başarısızlığımda proje yürütücülerinin payının büyük olduğunu düşünüyorum.					
65	Sunumlarda jüri üyelerinin yorumlarının ne olacağını bilememek kaygı düzeyimi arttırır.					
66	Stüdyoya yönelik motivasyonumun tam olmaması beni başarısız kılmaktadır.					
67	Aldığım stüdyoların mesleki yaşamımın kuramsal alanına katkı getireceğini düşünüyorum.					

APPENDIX B: Modification for terms in SSRL

Table B.1 : Modification for terms in SSRL.

CLASS COURSE TERMS	STUDIO COURSE TERMS
Teacher/sir-madam	Project Coordinator
Exam	Submission/presentation/jury
Class	Studio
Course	Project
Class materials	Modeling/drawing materials, computer and CAD programs
Book	Hard copy or soft copy sources
Going to the library	Making observations and research in the field
Homework example	Project example

APPENDIX C: Interview protocol

1. How would you describe the studio this fall semester?
   1.1. What did you think about the project when you saw the brief?
2. What was the project you were working on in the studio? How would you define it?
   2.1. Let's go through your project step by step.
   2.2. What kind of project was it? You can compare it with your other projects.
   2.3. How did it start?
   2.4. What approach did you take?
   2.5. How did you continue then?
   2.6. Did you like the project?
   2.7. What do you think you learned from this project? What did this studio add for you?
   2.8. What were the challenges for you? Were there any obstacles you encountered?
   2.9. What were the advantages and disadvantages for you?
   2.10. Would you change your project now if you had the chance? How?
3. How do you work in the studio?
   3.1. Are there any advantages/disadvantages of working in the studio?
   3.2. How do you spend your time in the studio?
   3.3. Do you like working with other students?
   3.4. Do you ever stay in the studio after class?
   3.5. Where do you usually prefer to work? Why is that?
   3.6. Can you describe your working environment?
   3.7. Do you have any unique methods/habits/rituals while working?
   3.8. How are you doing with your other courses? What is your favorite course?
   3.9. Do you ever benefit from your other courses while studying for your project? Example?
4. What do you think about the critics/comments?
   4.1. Do the jury comments impress you? How?
   4.2. What do you do after you get your critique in the studio / in the jury?
   4.3. Did you record the comments made to you in the critiques? How? (Notetaking, voice recording)
   4.4. How do you prefer to study? Writing, drawing, notebook, big papers, graphics, etc.?
5. What does it mean to be successful in the studio?
   5.1. What are the most important factors that make you successful in the studio?
   5.2. What are the biggest obstacles/handicaps that cause failure in the studio?
   5.3. What are your strengths/weakness in the studio?
6. If you were the head of the department, what would you change about the studio? And what wouldn't you change?
7. What do you think about the purpose of the studio in industrial design education?

APPENDIX D: SRIIDS Questionaries

Öz Motivasyon çalışması - 1. gün

Rahatla, arkana yaslan, kendine odaklan.

* Gerekli

1. Adın?
   Merak etme, cevapların bende saklı:)

2. Bugün nasıl hissediyorsun? *
   Bu soruyu okuduğunuz gün için cevaplayın.
   Yalnızca bir şıkkı işaretleyin.

	1	2	3	
iyi	◯	◯	◯	kötü

3. Bu çalışmaya katılma amacın ne? Neden aramızdasın? *

4. Şu hayatta seni en motive eden şey ne sence? *
   Her şey olabilir.

Hadi biraz proje süreçlerin üzerine düşünelim.

5. Projelerde seni güçlü kılan yönün nedir? *
   Bu zamana kadarki projelerinin bireysel süreçlerini düşünerek cevaplayabilirsin.

6. Projelerde seni zayıf kılan yönün nedir? *
   Bu zamana kadarki projelerinin bireysel süreçlerini düşünerek cevaplayabilirsin.

7. Bu yılki proje tanımına (brief) ait aklına gelen ilk 3 kelime ne? *
   Derin düşünmeden ilk aklına gelenleri yaz lütfen:)

8. Bu yılki projede kendine inancını puanlar mısın? *
   Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kötü bir sonuç elde edeceğimi düşünüyorum.	◯	◯	◯	◯	◯	İyi bir sonuç elde edeceğimi düşünüyorum.

OMG-3-1

Öz Motivasyon Grup Çalışması 3. etkinlik günü: Ara Jüri Değerlendirme

* Gerekli

1. E-posta adresi *

2. Buzdolabı fikirlerine 9 üzerinden kaç puan verirsin? *

Yalnızca bir şıkkı işaretleyin.

1	2	3	4	5	6	7	8	9
◯	◯	◯	◯	◯	◯	◯	◯	◯

3. Kurutucu fikirlerine 9 üzerinden kaç puan verirsin? *

Yalnızca bir şıkkı işaretleyin.

1	2	3	4	5	6	7	8	9
◯	◯	◯	◯	◯	◯	◯	◯	◯

4. Sözlü sunumuna 3 üzerinden kaç puan verirsin? *

Yalnızca bir şıkkı işaretleyin.

1	2	3
◯	◯	◯

5. Görsel sunumuna 3 üzerinden kaç puan verirsin? *

Yalnızca bir şıkkı işaretleyin.

1	2	3
◯	◯	◯

6. Ara jürine verdiğin toplam puan kaç? Bu puanı nasıl yorumluyorsun? *

İlk dört soruya verdiğin cevapların toplamı ara jüriye verdiğin toplam puandır.

7. Araştırma sonuçlarına dair sunumunda bir bilgi var mı? Ya da sözlü olarak bahsettin mi?

Her satırda yalnızca bir şıkkı işaretleyin.

	Sözlü olarak bahsettim.	Sözlü olarak bahsetmedim.
Sunuma koydum.	◯	◯
Sunuma koymadım.	◯	◯

8. Hedef kitlene dair sunumunda bir bilgi var mı? Ya da sözlü olarak bahsettin mi?

Her satırda yalnızca bir şıkkı işaretleyin.

	Sözlü olarak bahsettim.	Sözlü olarak bahsetmedim.
Sunuma koydum.	◯	◯
Sunuma koymadım.	◯	◯

9. Problem tanımına dair sunumunda bir bilgi var mı? Ya da sözlü olarak bahsettin mi?

Her satırda yalnızca bir şıkkı işaretleyin.

	Sözlü olarak bahsettim.	Sözlü olarak bahsetmedim.
Sunuma koydum.	◯	◯
Sunuma koymadım.	◯	◯

10. Kaç fikir geliştirdin? *

Her satırda yalnızca bir şıkkı işaretleyin.

	1	2	3-5 arası	6-10 arası	10 ve sonrası
Buzdolabı için	◯	◯	◯	◯	◯
Kurutucu için	◯	◯	◯	◯	◯

11. En güvendiğin fikrinin güçlü yönü ne? *

12. En güvendiğin fikrinin zayıf yönü ne? *

13. Güvenmediğin fikrinin zayıf yönü ne? *

14. Jüriden yararlı geridönüşler aldığını düşünüyor musun? *

15. İşine yarayacağını düşündüğün jüri yorumu var mı? Nasıl kullanmayı düşünüyorsun? *

16. İşine yaramacağını düşündüğün jüri yorumu var mı? Neden işine yaramaz? *

OMG-3-2

Öz Motivasyon Grup Çalışması 3. etkinlik günü: Hedefler
Mailini yazman önemli, verdiğin cevaplar sana mail olarak iletilecek.

* Gerekli

1. E-posta adresi *

Ne yapmak istediğini düşün ve hedefini belirle.
Evet biliyorum, böyle bir hedef belirleme sorusunu 5 dk da yanıtlamak zor. Ancak hedefini olabildiğince odaklı ve erişilebilir tutmalısın ki sıra ile hepsine varabilesin. At gözlüğü tak! Sadece o hedefi düşün geri kalan her türlü etkeni dışarda tut.

2. Mezun olduğun gün için bir hedef belirle. *
Sonunda mezun oldun. Ne gibi özelliklerin olsun istersin, ne gibi şeyler yapmak istersin? Nasıl bir işte çalışmak, ne ile uğraşmak istersin? Tüm ön yargılarından arınıp sadece bunu düşünmeye çalış. Mesela özendiğin bir profesyonel var mı? Onun hangi özelliği ilgini çekiyor?

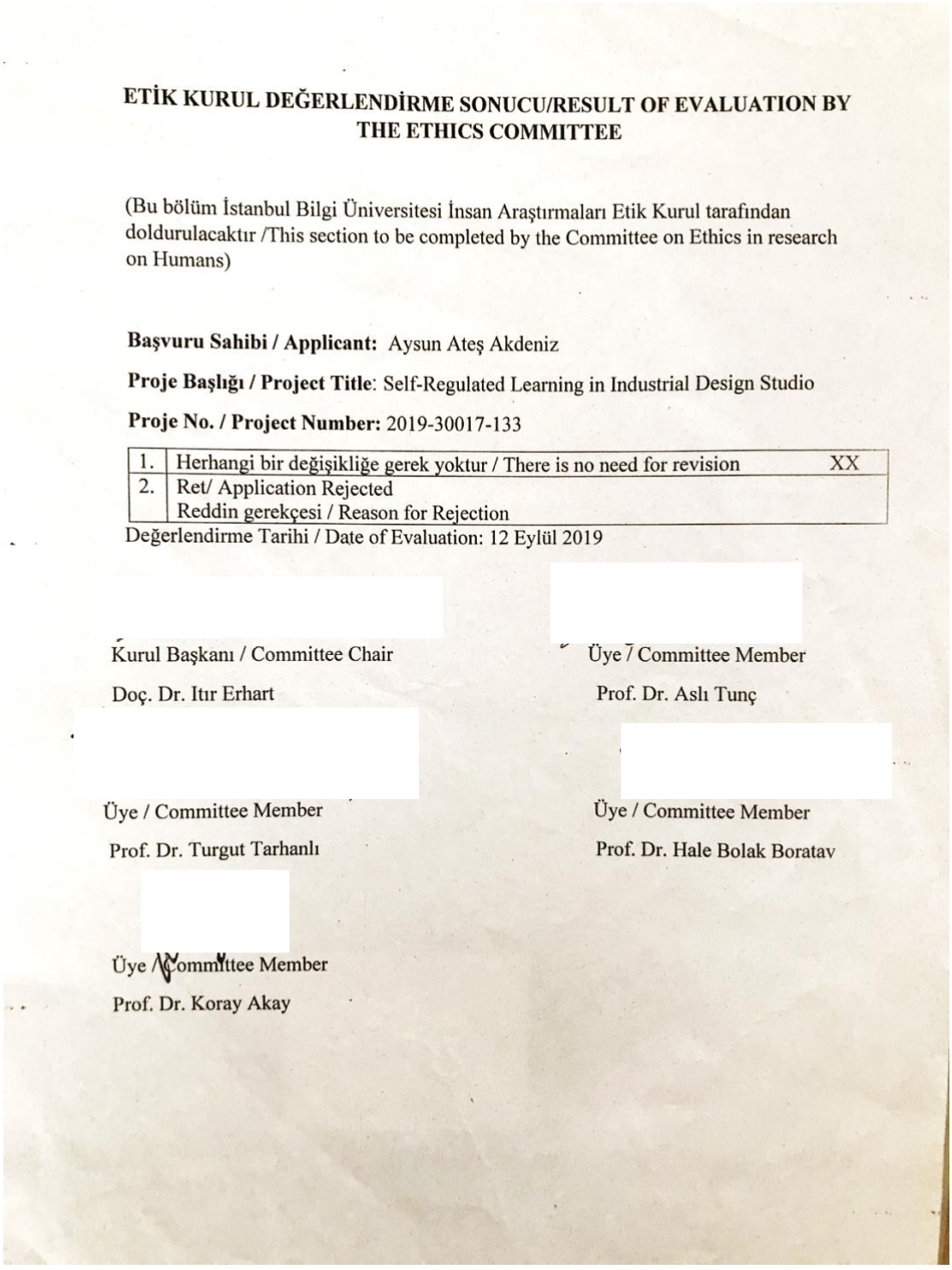
3. Bu dönemin sonu için bir hedef belirle. *
Bu dönemin sonunda akademik olarak nasıl olsan, nelere sahip olsan memnun olurdun?

4. Projen için hedef belirle. *
Dönem sonunda projen ne özelliklere sahip olsa memnun olurdun?

5. Projen için belirlediğin hedefe varmak için şuanda ne yapman akıllıca olur? *
Eksik hissettiğin yönlerini düşün, kendinle ilgili kararlar alma zamanı geldi.

6. Önceki soruya verdiğin cevabı ne kadar zamanda gerçekleştirirsin? *
Kısa vadeli hedefler koymak hem seni rahatlatır, hem de takibini kolaylaştırır.

APPENDIX E: Ethical approval by the University Ethical Committee



ETİK KURUL DEĞERLENDİRME SONUCU/RESULT OF EVALUATION BY THE ETHICS COMMITTEE

(Bu bölüm İstanbul Bilgi Üniversitesi İnsan Araştırmaları Etik Kurul tarafından doldurulacaktır /This section to be completed by the Committee on Ethics in research on Humans)

Başvuru Sahibi / Applicant: Aysun Ateş Akdeniz

Proje Başlığı / Project Title: Self-Regulated Learning in Industrial Design Studio

Proje No. / Project Number: 2019-30017-133

1.	Herhangi bir değişikliğe gerek yoktur / There is no need for revision	XX
2.	Ret/ Application Rejected Reddin gerekçesi / Reason for Rejection	

Değerlendirme Tarihi / Date of Evaluation: 12 Eylül 2019

Kurul Başkanı / Committee Chair
Doç. Dr. Itır Erhart

Üye / Committee Member
Prof. Dr. Aslı Tunç

Üye / Committee Member
Prof. Dr. Turgut Tarhanlı

Üye / Committee Member
Prof. Dr. Hale Bolak Boratav

Üye / Committee Member
Prof. Dr. Koray Akay

Figure E.1 : Ethical approval by the University Ethical Committee.

APPENDIX F: Feedback Questionary for Phase II

Öz Motivasyon Çalışması / geri bildirim formu

Bu form Öz Motivasyon Çalışma Grubu (OMG) etkinliklerine dair görüşlerinizi almak üzere hazırlanmıştır.
OMG çalışmasında hedef belirleme, kendini izleme ve proje sürecini değerlendirme üzerine etkinlikler yapmıştık. Aşağıdaki ifadeleri 1'den 5'e kadar bir ölçekte yanıtlayın.
İfade sizin için çok doğru ise 5'i işaretleyin.
İfade sizin için hiç doğru değilse 1'i işaretleyin.
Eğer ifade sizin için aşağı yukarı doğruysa 1 ile 5 arasındaki sizi en iyi tanımlayan sayıyı işaretleyin.

* Gerekli

1. Adım (isteğe bağlı)

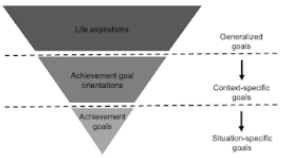
2. OMG çalışmasından önce öğrenmeme rehberlik edecek hedefler belirlerdim/belirleyerek çalışırdım. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

3. OMG çalışması sırasında yaptığımız hedef belirleme çalışmasını faydalı buldum. *

Hedef belirleme çalışması görselinin bir örneğini aşağıda bulabilirsin.



Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

4. Hedef belirleme çalışmasını bundan sonraki çalışmalarımda da uygulamayı düşünüyorum. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

5. OMG çalışması sırasında projemizle ilgili olarak yaptığımız aşağıdaki çalışmaları faydalı buldum. *

1 = Hiç doğru değil 5 = Çok doğru

Her satırda yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5
Proje brief'ini tekrar okuma	◯	◯	◯	◯	◯
Projenin takvimini inceleme	◯	◯	◯	◯	◯
Projenin öğrenme çıktılarını inceleme	◯	◯	◯	◯	◯
Projenin değerlendirme kriterlerini inceleme	◯	◯	◯	◯	◯
Projenin ana fikri üzerine düşünme	◯	◯	◯	◯	◯
Ara Jüri sunum kayıtlarını tekrar izleme	◯	◯	◯	◯	◯
Projenin güçlü yanını belirleme	◯	◯	◯	◯	◯
Projenin zayıf yanını belirleme	◯	◯	◯	◯	◯
Projenin zayıf yanını geliştirme odaklı plan yapma	◯	◯	◯	◯	◯

6. Projemiz üzerine yaptığımız bu çalışmaları bundan sonraki çalışmalarımda da uygulamayı düşünüyorum. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

7. OMG çalışmamız sırasında Miro üzerinde yaptığımız "projede başarılı olmak için neye ihtiyacım var?" çalışmasını faydalı buldum. *

Çalışmanın görselinin aşağıda bulabilirsin.

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

8. OMG çalışmamız sırasında Miro üzerinde yaptığımız zayıf hissettiğimiz yönleri geliştirmeye yönelik 5 günlük plan yapma çalışmasını faydalı buldum. *

Çalışmanın görselinin aşağıda bulabilirsin.

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

9. Projemiz üzerine Miro üzerinde yaptığımız bu çalışmaları bundan sonraki çalışmalarımda da uygulamayı düşünüyorum. *

Miro üzerinde olmak zorunda değil.

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Hiç doğru değil	◯	◯	◯	◯	◯	Çok doğru

10. OMG çalışmasında en yararlı bulduğum şey şuydu: *

11. OMG çalışmasına dair başka yorumum:

APPENDIX G: Interview protocol for Phase II

1. Let's consider the first day of SRIIDS. What did you think? What did you expect and what did you find?
2. Let's think about the work we've done, was it useful to you? What was the most helpful part? Is there any part that you could not use, apply or not be interested in? Did you use it again? Are you planning to use it?
3. Before SRIIDS, do you think you had an approach to learning? How was it? Have you thought about it? Was it effective for you? Did it work?
4. In terms of learning, what specifically challenged you as an architecture student?
5. The SRIIDS study was trying to help you develop your skills to be a self-directed student. SRL - What did it make you think when I described the SRLmodel? Do you think it is applicable? What does it do for you? Was it tempting to try?
6. For example, there was a part called task analysis, we analyzed the project and tried to make plans on it. Was this phase productive for you?
7. We also focused on goal setting in the study. We used the inverted triangle system to help you structure your goals. How did you start choosing an area/goal to focus on for your goal? Did the goal help you structure or focus your learning? Have you used this or any other goal setting technique to focus on your other goals?
8. How do you evaluate your project? How do you think it went? How were the juries? How were you prepared?
9. During the study, we had the opportunity to discuss the study/learning techniques with the peers. Have you discovered anything new in these discussions that you think might be helpful to you? What was this? Did you use it?
10. What do you think of SRIIDS's timing? Frequency, date in the project calendar? Was it suitable for you? How would the timing be better?
11. Do you have any suggestions for the improvement of the work? What would have been better?
12. Do you have any additional comments?

APPENDIX H: Student list for acknowledgments

Table H.1 : Student list for acknowledgments.

2017-2018	2020-2021
Ali Rıza Atakan Gür	Ahmet Berke İnan
Aziz Burakhan Viltan	Ahmet Cem Uğur
Belinda Şahin	Alım Özdemir
Buse Özcan	Ali Aydaş
Can Dumlupınar	Alihan Çavuşoğlu
Efe Akıncıoğlu	Asude Nur Yalçınkaya
Gözde Erdem	Batuhan Bozdemir
Havvanur Sönmez	Berfin Bekişoğlu
Hazal Kırıkçı	Bijan Ramazan Öztürk
Kahraman Ege Ceri	Bora Musal
Oktay Özer	Cerensu Bartu
Özge Adanır	Ceyda Tar
Pelin Daldık	Deniz Ilgaz Demiralp
Pelin Şimşek	Dikris Koyuncu
Rana Cabi	Dilara Ateş
Sena Ortaç	Ecem Deniz Karabacak
	Egemen Keskinbora
	Elif Şentürk
	Esra Pirim
	Eyad Osama Mansour Ahmed Emam
	Gözde Önen
	Gülşim İrem Sarıca
	Güneş Er
	Hatice İdil Pala
	İdil Deniz
	İpek Çolakoğlu
	İrem Akkuş
	Kris Havluciyan
	Lena Canyan
	Melisa Toprak
	Numan Deniz Erdem
	Ömer Nasuh Karaer
	Özlem Gökçe
	Pelin Sidar Genç
	Sami Mert Akçakır
	Sevim Sinem Özçelik
	Sude Aydın
	Umutcan Öncü
	Yağmur Uygun
	Yahya Kemal Gürcüoğlu

CURRICULUM VITAE

Name Surname **:** Aysun ATEŞ AKDENİZ

EDUCATION **:**

- **B.Sc.** **:** 2010, Istanbul Technical University, Faculty of Architecture, Department of Industrial Design
- **M.Sc.** **:** 2015, Istanbul Technical University, Department of Industrial Design, Industrial Design Programme

PUBLICATIONS, PRESENTATIONS, AND PATENTS ON THE THESIS:

- **Ateş-Akdeniz, A**. & Turan, G. (2022). Differences in self-regulated learning strategies among industrial design students: A convergent mixed-methods study. *A|Z ITU Journal of the Faculty of Architecture*.
  doi number: 10.5505/itujfa.2022.44522
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  https://dl.designresearchsociety.org/conference-volumes/8
  doi: 10.21606/learnxdesign.2019.19144

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- Öz, G., & **Ateş Akdeniz, A**. (2019). Project Kapıdağ: Locality of Production'. *Conference Proceedings of the Academy for Design Innovation Management*, 2(1), 1680–1688. https://doi.org/10.33114/adim.2019.c16.112
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