ZENA TALEB YOUSEF ALSHAWA THE INFLUENCE OF CREATIVE SPACE TYPES ON THE DESIGN THINKING PROCESS BILKENT UNIVERSITY 2024

THE INFLUENCE OF CREATIVE SPACE TYPES ON THE DESIGN THINKING PROCESS

A Master's Thesis

by

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September 2024

To My Parents,

Leena & Taleb

THE INFLUENCE OF CREATIVE SPACE TYPES ON THE DESIGN THINKING PROCESS

The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

by

ZENA TALEB YOUSEF ALSHAWA

In Partial Fulfillment of the Requirements for the Degree of
MASTER OF FINE ARTS IN INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN

THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN
İHSAN DOĞRAMACI BİLKENT UNIVERSITY
ANKARA

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THE INFLUENCE OF CREATIVE SPACE TYPES ON THE DESIGN THINKING PROCESS
By Zena Taleb Yousef Alshawa

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

Halime Demirkan
Advisor

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

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ABSTRACT

THE INFLUENCE OF CREATIVE SPACE TYPES ON THE DESIGN THINKING PROCESS

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September 2024

The design thinking process induces innovation and creativity. Modern organizations require designated workspaces to support the design thinking process. Thus, this study provides experimental evidence on the role of spatial types in influencing the creative design thinking process, namely divergent and convergent thinking. Fifty-nine participants performed divergent and convergent thinking tasks in open or private spaces. Flow state, situational interest, and presence assessed participants' task engagement. The task engagement levels in both spaces were compared using independent sample t-tests. Results revealed that flow state, situational interest, and presence were significantly higher in the open space than in the private space during divergent tasks. During convergent tasks, only situational interest was significantly higher in the private space than in the open space. In addition, results revealed a significant positive correlation between flow state and situational interest, and flow state and presence. Also, results indicated a nonsignificant positive correlation between presence and situational interest. These results contribute to understanding of the physical spaces in impacting the creative design thinking process.

Keyworks**:** Design Thinking Process, Flow State, Presence, Situational Interest, Spatial Types

ÖZET

YARATICI MEKAN TİPLERİNİN TASARIM DÜŞÜNCE SÜRECİ ÜZERİNDEKİ ETKİSİ

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Eylül 2024

Yenilik ve yaratıcılık, tasarım odaklı düşünme sürecini teşvik eder. Modern organizasyonlar tasarım düşünme sürecini desteklemek için belirlenen çalışma alanlarına ihtiyaç duyarlar. Böylece, bu çalışma, mekanların açık ve özel alanlarında gerçekleşen yaratıcı tasarım sürecinin, ıraksak ve yakınsakdüşünme üzerindeki etkilerine ait deneysel kanıtlar sunmaktadır. Elli dokuz katılımcı, açık veya özel alanlarda ıraksak ve yakınsak düşünme görevlerini yerine getirdi. Katılımcıların görev katılımı, akış durumu, durumsal ilgi ve bulunuşluk ile değerlendirildi. Her iki alandaki görev katılım seviyeleri, bağımsız örneklem t-testleri kullanılarak karşılaştırıldı. Sonuçlar, ıraksak düşünme görevleri sırasında akış durumunun, durumsal ilginin ve bulunuşluğun açık alanda özel alana göre önemli ölçüde daha yüksek olduğunu ortaya koydu. Yakınsak düşünme görevleri sırasında, yalnızca durumsal ilginin özel alanda açık alana göre anlamlı şekilde daha yüksek olduğu saptandı. Ayrıca, sonuçlar akış durumu ile durumsal ilgi seviyesi, ve akış durumu ile bulunuşluk arasında anlamlı bir pozitif korelasyon olduğunu ortaya koydu. Ayrıca, sonuçlar bulunuşluk ile durumsal ilgi arasında anlamlı olmayan pozitif bir korelasyon olduğunu göstermiştir. Bu sonuçlar, fiziksel mekanların yaratıcı tasarım düşünme sürecini etkilemedeki rolünün anlaşılmasına katkıda bulunmaktadır.

Anahtar Kelimeler: Akış Durumu, Bulunuşluk, Durumsal İlgi, Mekansal Türler, Tasarım Düşüncesi Süreci

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor Prof. Dr. Halime Demirkan for her guidance, insightful feedback, professionalism, and continuous encouragement for me to present the work of this paper. Her expertise and commitment to academic excellence have been an inspiration in shaping the direction of this paper. I am deeply indebted to the examining committee members Assoc. Prof. Dr. Nilgün Olguntürk and Assoc. Prof. Dr. İpek Memikoğlu for their insightful feedback and suggestions to improve the work of this paper.

I am also immensely grateful to Yasmine Abdulghani and Rahma Khaled for their great assistance with data collection. In addition, I would like to acknowledge all the fifty-nine participants, among them my dearest friends at Bilkent University, for taking part in the experiment and contributing to the research of this paper. Their interest in the trajectory of this paper motivated me in pursuing the results of the study.

I also would like to acknowledge my sisters, Hala and Sara, and my brothers, Qusay and Bashar, who have provided me with emotional and moral support throughout this experience. Lastly, my heartfelt thanks go to my caring and supportive parents for their unwavering encouragement and belief in me which kept my motivation high throughout the research process.

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CHAPTER I

INTRODUCTION

Modern organizations are constantly looking for new methods to creatively solve problems. This fact requires having designated spaces to foster the creative problem-solving process. Based on earlier suggestions in innovation management, engineering, and design research, physical work environments might induce creativity by supporting the creative process of design thinking (Elsbach & Stigliani, 2020). Design thinking refers to the problem-solving approach driven by creative thinking, analytical thinking, empathy, and iterative learning (Kwon et al., 2021; Mayer et al., 2023). Design thinking emerged from architecture and product design fields which applied it to solve vague, ill defined, or "wicked" design problems (Brown, 2009). Non-design contexts became interested in adopting the design thinking strategy and seen a significant success in business operations (Chaves et al., 2022; Curedale, 2019). Leading corporations such as Autodesk, Proctor and Gamble (P&G), and International Business Machines (IBM) invested millions of dollars in training their staff and incorporating design thinking practices into their organizational culture (Chaves et al., 2022; Kwon et al., 2021).

Although significant attention was given to the implementation of design thinking, less attention was given to the role of physical environment in affecting the design thinking process (Elsbach & Stigliani, 2020; Thoring et al., 2021). Previous studies focused on the effects of other tangible and intangible office elements on divergent and convergent thinking (Lee & Lee, 2023). However, the impact of spatial types on the creative process of divergent and convergent thinking is yet to be discovered (Elsbach & Stigliani, 2020; Thoring et al., 2021). More research is required to gain a comprehensive understanding

on the role of physical environment in impacting the design thinking process (Elsbach & Stigliani, 2020; Haner, 2005, Thoring et al., 2021).

The creative process of design thinking can be measured by positive psychological constructs such as flow state, situational interest, and presence. Flow state is characterized by a high degree of absorption in a task and a positive predictor of creative performance and innovation (Peng et al., 2024; Stollberger & Debus, 2019). Flow state and situational interest were always considered as positive measures of engagements in educational psychology research (Kiili et al., 2021). In addition, studies compared presence in multiple environments (i.e., real, remote, and immersive environments) as a positive measure of engagement (Khenak et. al, 2020; Pizzolante et al., 2024).

1.1 Problem Statement

Given the importance of the design thinking approach in design, management, business, and engineering research to promote innovation and creativity, it is essential to gain experimental findings on what space types impact the creative design thinking process. In addition, less research investigated the role of physical space types on the concurrent phases of the creative design thinking process, namely divergent and convergent thinking (Lee & Lee, 2023). Thoring et al. (2021) suggested propositions on what spatial facilitations induce the creative process of divergent and convergent thinking.

According to Thoring et al. (2021), open and highly stimulating space types are more conducive to phases of divergent thinking, while secluded and undistracted spaces are more conducive to phases of convergent thinking. Yet, these propositions require more research using controlled experiments to validate them (Thoring et al., 2021). Additionally, Haner (2005) gave early insights on the importance of designated spaces supporting individual and team efforts during convergent and divergent thinking activities. Haner's (2005) case study revealed that the most spatially open zone in an organization known as the action-zone is conducive to divergent thinking. Yet, more

research is required to investigate the direct effects of physical space types on divergent and convergent thinking phases (Lee & Lee, 2023).

1.2 Aim of the Study

The study aims to experimentally investigate how two physical space types, open and private, directly influence components of the design thinking process. To achieve this, flow state, situational interest, and the sense of presence will measure the engagement levels of participants performing divergent and convergent thinking tasks. Participants' engagement levels in both space types will be compared using the parametric Independent Samples T-Test. This study will also investigate the correlation between presence, situational interest, and flow state as the measures of engagement during divergent and convergent thinking tasks using Spearman's Rho Correlation Test.

The results of this study aim to provide experimental evidence on the role of physical spaces influencing the creative design thinking process. This evidence will aid managers in innovative organizations as well as architects and spatial planners in design decisions intended for creative workspaces. The results will also be of relevance to design practitioners by giving them insights on which appropriate space types support phases of the creative design thinking process and inspire them to perform creatively at optimal levels.

1.3 Structure of the Thesis

The second chapter covers the literature review of the study. This chapter begins with a defining creativity followed by the concept of the design thinking process. Then, the chapter reveals factors affecting the design thinking process in work environments. Following this subsection, the chapter presents previous empirical studies investigating the role of tangible and intangible office elements in impacting divergent and convergent thinking. Finally, the chapter briefly introduces the measures of engagement – flow state, situational interest, and presence.

The third chapter covers the methodology. This chapter includes the research questions, hypotheses, and the conceptual framework articulated based on the gaps covered in the second chapter. In addition, the chapter covers the participants, experimental settings, the assigned design thinking tasks, and the instruments used. The last section of the chapter provides the procedure of the experiment in detail.

The fourth chapter presents the results of the study. This chapter covers the descriptive analysis, the independent sample t-test results, and the correlation analysis between flow state, situational interest, and presence. The t-test results for each measure of engagement includes two sections, once during divergent thinking tasks and once during convergent thinking tasks.

The fifth chapter discusses the results of the study and relates the findings to the existing literature. The chapter also discusses the decisions on whether each hypothesis of this study is supported or rejected. Finally, the chapter includes the relation between the decisions of the study and previous research.

The final chapter concludes the overall thesis by mentioning the main findings, limitations, and advances for future work. The conclusion chapter is followed by the references and appendices presenting the questionnaires, the briefs of every divergent and convergent thinking task, as well as the ethics committee approval document.

CHAPTER II

LITERATURE REVIEW

Previous innovation management, business, and engineering research suggested that modern organizations can enhance creativity and innovation by providing spaces crafted for the creative process of design thinking (Elsbach & Stigliani, 2020). Since the creative design thinking process is characterized by recurrent series of divergent and convergent thinking (Brown, 2009), experimental studies are required to investigate how designated spaces support the activities occurring during each phase of the process (Elsbach & Stigliani, 2020; Haner, 2005, Lee & Lee, 2023; Thoring et al., 2021). Yet, less studies explored the direct effect of spatial types in promoting creativity through the process of design thinking (Elsbach & Stigliani, 2020).

The design thinking process became a significant creative problem-solving strategy in both design and non-design contexts. The strategy emerged from traditional designers' iterative process in solving problems. Traditional product and architectural designers follow an iterative process characterized by ideating, prototyping, and testing to solve vague and ill-defined design problems (Brown, 2008, 2009; Liedtka et al., 2009; Liedtka & Ogilvie, 2011).

Previous experimental studies investigated the role of ambient lighting, spatial volumes, various ceiling heights, and roundness or sharpness of furniture on divergent and convergent thinking (Lee & Lee, 2023). However, less experimental evidence investigated what spatial types promote the creative process by supporting the divergent and convergent thinking phases (Lee & Lee, 2023). Numerous hints and theories in the

literature suggest which possible spatial types may support the creative design thinking process (Elsbach & Stigliani, 2020; Thoring et al., 2021). Thus, this chapter provides a thorough review on the concepts of individual creativity and the design thinking process followed by the theories, hints, and suggestions on which spatial types might be conducive to the divergent and convergent thinking phases. Later, the chapter presents previous experimental studies that investigate how other physical elements influence divergent and convergent thinking. Finally, the chapter briefly introduces the three positive measures of task engagement – flow state, situational interest, and presence - as well as previous empirical studies related to each measure.

2.1 Creativity

Creativity in work environments refers to the generation of original and practical ideas in any field (Amabile et. al, 1996). Innovation, a subset of creativity, refers to the successful application of creative ideas in an organization (Amabile et. al, 1996). Rhodes (1961) introduced a model classifying creativity into four aspects which includes the creative person, process, product, and press. The creative "*person"* involves the personality traits, intellect, attitudes, value systems, and defense mechanisms, as well as fluency of ideas, and divergent thinking. The creative "*process"* encompasses perception, learning, thinking, and communication (Rhodes, 1961). An idea according is a thought that has been expressed to others through various mediums such as words, paint, sketches, clay, or any other material (Rhodes, 1961). If the concept is original, it means that it is new and innovative. Once an idea has been transformed into a tangible form, it becomes a creative product (Rhodes, 1961).

Creative *"press"* refers to how the environment affects creative individuals (Rhodes, 1961). Scritchfield (1999) defines press as the location where the creative person is, where the creative product is generated, or where the creative process is situated. Based on Rhodes' four aspects of creativity, Woodman et al. (1993) developed the Interactionist Model of Organizational Creativity. The interactionist model considers the contextual and social factors, as well as the multilevel structure of organizational creativity,

including individual, group, and organizational levels, with cross-level interactions (see Figure 1). The interactionist model by Woodman et al. (1993) describes creativity as a complex process influenced by a variety of factors. These factors include antecedent conditions, cognitive processes such as divergent and convergent thinking, intrinsic motivation, relevant knowledge, personality traits like self-esteem, social influences such as social facilitation, and contextual influences like the physical environment and task requirements.

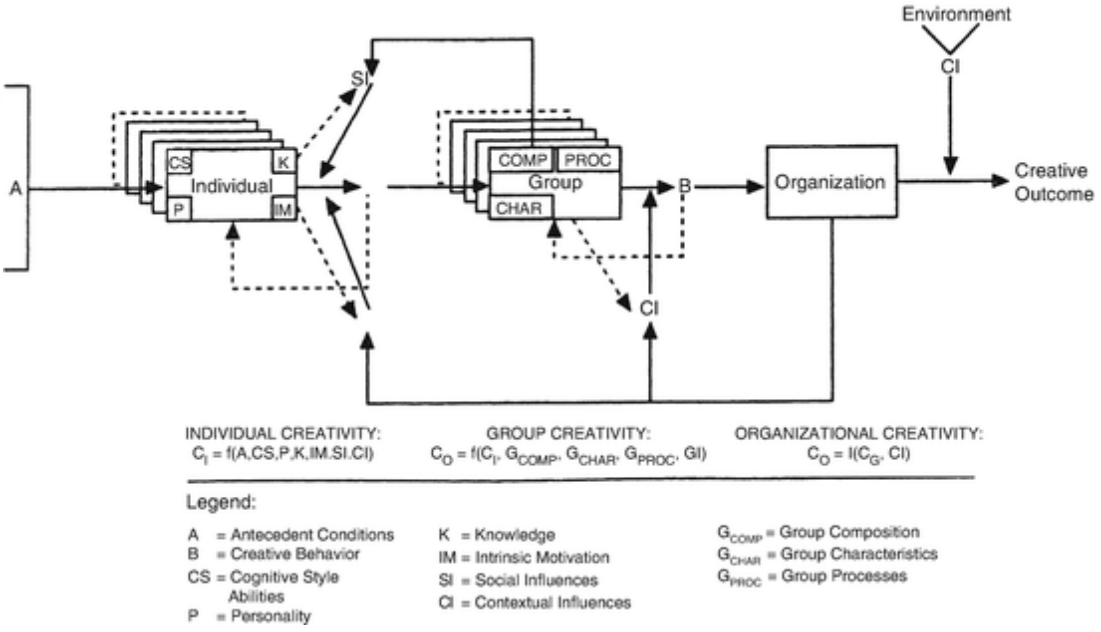


Figure 1. An Interactionist Model of Organizational Creativity (Source: Woodman et al., 1993, p. 295)

Creative Process. Wallas (1926) classifies the creative process into four stages known as the preparation, incubation, illumination, and verification phases. During the preparation phase, a problem is defined, and preliminary research is conducted. In the following incubation phase, unconscious thinking dominates as a person relaxes without spending mental work on the problem. During the illumination phase, a sudden idea rises to consciousness. Following the illumination phase, the verification phase, or the analytical validation of ideas occurs. In the verification phase, and idea is evaluated, judged, and refined. The creative process is iterative and non-linear, meaning that a person may re-visit any of the four phases (Wallas, 1926).

2.2 Design Thinking Process

Design thinking process is defined as a systematic problem-solving approach that employs design tools such as brainstorming, rapid prototyping, user observation, and visualization of ideas to develop innovative products, services, and business models (Brown, 2008). Lindberg et al. (2011) categorized the design thinking process into the problem space (observing, synthesizing) and the solution space (ideating, prototyping) (see Figure 2). In the problem space, the problem is identified by exploring the user or the environment using divergent methods, then the information gathered is synthesized using convergent methods (Lindberg et al., 2011). In the solution space, ideas are generated using divergent methods, and a unique solution is logically deducted using convergent methods (Lindberg et al., 2011).

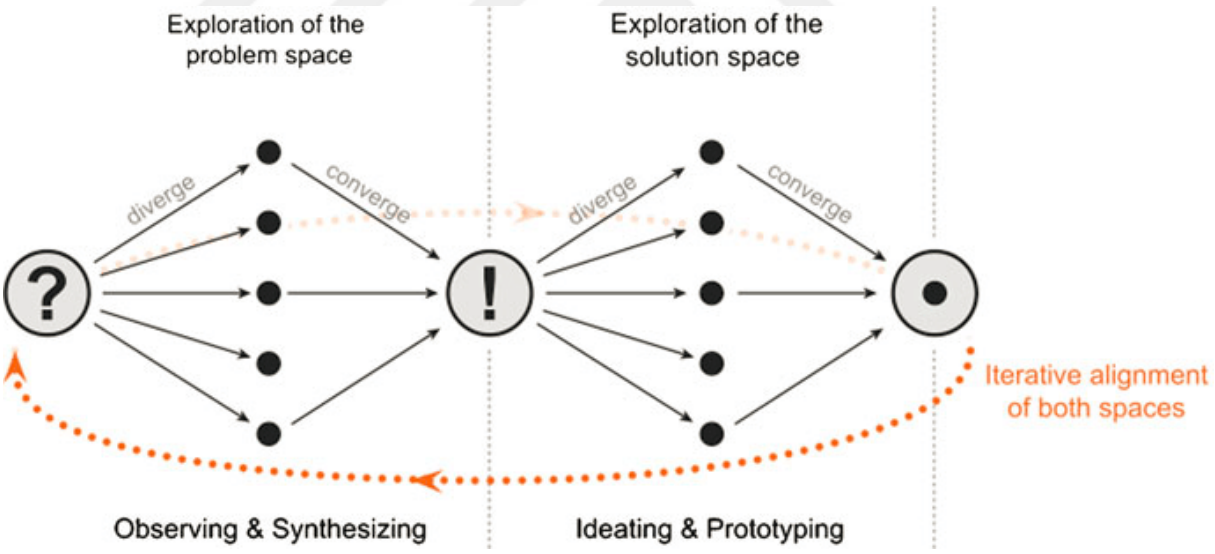


Figure 2. Problem and Solution Spaces in Design Thinking (Source: Lindberg et al., 2011, p. 5)

The design thinking process relies on iterative phases of divergent and convergent thinking (Brown, 2009). *Divergent thinking* is defined as the expansive way of thinking characterized by making unconventional combinations and the generation of original ideas (Cropley, 2006; Palmiero et al., 2020; Runco & Acar, 2012). *Convergent thinking* is

described as the analytical and logical thinking process characterized by the production of a single-solution or idea (Cropley, 2006; Runco & Acar, 2012). During divergent thinking, individuals generate choices, while during convergent thinking, individuals critically eliminate and make choices (Brown, 2009) (see Figure 3).

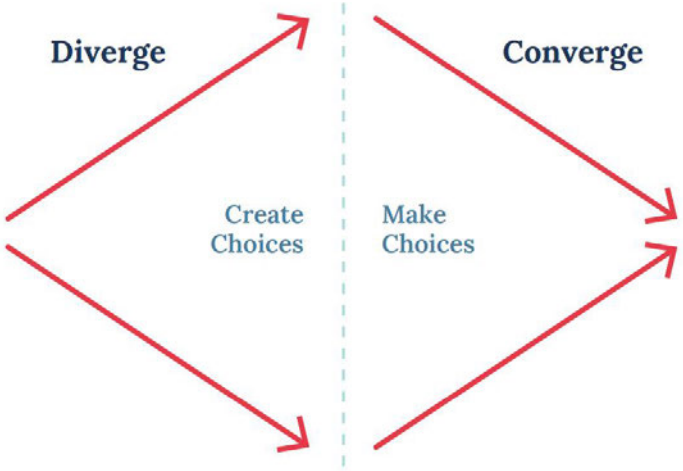


Figure 3. Divergence and Convergence in Design Thinking (Source: Brown, 2009, p. 41)

Early theories on creativity as well as innovation management research relate to the concepts of divergent and convergent thinking (Haner, 2005). Literature on creativity sees convergent thinking as a single-focus activity, while divergent thinking as a multi-focus activity (Haner, 2005). Convergent thinking leads to a single solution, while divergent thinking leads to conflicting, ambiguous, and paradoxical ideas (Thompson, 2003).

In innovation management literature, divergent behavior is characterized by exploration, experimentation, and expansion, while convergent behavior is characterized by integration, verification, and reduction (Van de Ven et al., 1999). Divergent thinking tends to increase the complexity of a system, while convergent thinking reduces the complexity and moves the system into an equilibrium (Van de Ven et al., 1999).

A few authors related features of divergent and convergent thinking to phases in creativity and innovation processes. According to Haner (2005), convergence in

creativity exists in the preparation, elaboration, and evaluation phases, while divergence exists in the incubation and insight phases. In innovation management, divergent behavior prevails in the ideation phase, while convergent behavior exists in the validation phase (Haner, 2005).

However, a more recent proposition by Thoring et al. (2021) on the relation of divergent and convergent thinking to the creative processes prevails divergence in the preparation, incubation, and illumination phases of creative process, while prevails convergence in the evaluation, elaboration, and verification phases. Brophy (2001) identified divergent thinkers as individuals inclined towards ideation, whereas convergent thinkers are inclined towards evaluation.

2.3 Factors Affecting the Design Thinking Process in Work Environments

Spatial Types. Thoring et al. (2020) categorized six space types in work environments that potentially affect creative processes. The first type of spaces fosters individual work and include the personal space, the focus space, the incubation space, and the reflection space (Dul et al., 2011; Dul and Ceylan, 2014; Haner, 2005; McCoy, 2002; Meinel et al., 2017). The second space type is the meeting rooms that foster collaborative work (Meinel et al., 2017). The third types of spaces are designed to assess the production of things such as experimentation, analysis, verification, and workshop spaces (Haner, 2005; Pittaway et al., 2020; Schmidt & Brinks, 2017).

The fourth type of spaces includes spaces for presentations such as lecture or exhibition spaces. The fifth types of spaces are for research work or preparation phases and include the exploration space (Pittaway et al., 2020; Storvang & Nguyen, 2020; Hoff & Oberg, 2015; Haner, 2005). The last types of spaces according to Thoring et al. (2020) are the spaces that support informal meetings among employees such as the disengaged spaces, the relaxation spaces, and the well-being spaces (Storvang & Nguyen, 2020; Wagner & Growe, 2020; De Paoli et al., 2019). Disengaged spaces are playgrounds for activities like billiards and darts or social zones like kitchens or gyms designed to provide mental

break for individuals by engaging with other employees (Chi et al., 2020; De Paoli et al., 2019; Meinel et al., 2017; Yekanialibeiglou et al., 2021).

Spatial Layouts. Spatial layouts in work environments refer to the general alignment of the physical workspace characterized by privacy, flexibility, customization, balance, and other aspects (Meinel et al., 2017). Privacy in work environments is defined as the separation from others and intends to promote individual creativity. As opposed to privacy, visibility in work environments enhances interactions among employees and intends to support team creativity. Haner (2005) discusses that both privacy and visibility are essential in supporting different phases of the creative process for both individuals and teams.

In addition, flexibility, customization, and balance in work environments tend to support individual and group creativity (Martens, 2011; Meinel et al., 2017). Flexibility refers to the ability to rearrange the workplace according to the creative activities. Customization allows employees to personalize the space with their own equipment. Balance refers to the provision of a balanced work setting that allows employees to switch from privacy to visibility and eventually enhances creativity (Haner, 2005; Lee, 2016).

Office Elements. Office elements such as intangible and tangible elements tend to influence creativity (Meinel et al., 2017, Thoring et al., 2020). Intangible elements refer to the ambience of the workspace including sound, light, color, temperature, and smell (Thoring et al., 2020). Negative sounds or extreme noise hinders creativity as opposed to silence and music (Meinel et al., 2017). Natural daylight was found to support creativity (Dul & Ceylan, 2011, 2014; Dul et al., 2011). Previous findings on the effect of artificial light and color on creativity are inconsistent (Thoring et. al., 2020). Adequate temperature in a workplace supports creativity as opposed to extreme high temperature (Meinel et al., 2017). Fresh air and positive smell also tend to support creativity (Dul & Ceylan, 2011, 2014; Dul et al., 2011).

Tangible elements refer to furniture, plants, office equipment, vistas, decorative elements, materials, and surfaces which tend to influence creativity (Meinel et al., 2017). Previous preferences mentioned the role of comfortable furniture, activating furniture, highchairs, unusual furniture such as hammocks in supporting creativity (Thoring et al., 2020). In addition, the presence of indoor plants promotes creativity. Low-tech office equipment such as whiteboard surfaces, writable walls, tinker desks support idea generation and eventually enhances creativity (Meinel et al., 2017). High-tech equipment such as wireless connectivity or audiovisual display tools also support creativity (Meinel et al., 2017). Offices providing electronic idea generation software enhanced creativity (Magadley & Birdi, 2009). Windows providing vistas of changing environments or nature are also conducive to creativity (Thoring et al., 2021).

Thoring et al. (2020) defines creative workspaces as spaces characterized by the factors mentioned above. Although previous sources discussed the influence of spatial types, spatial layouts, and office elements on creativity, less studies elaborated on how these factors influence different stages of the creative process (Lee & Lee, 2023). However, theories, suggestions, and hints in the literature provide the possible influence of these factors on the creative process (Elsbach & Stigliani, 2020). For example, Csikszentmihalyi (1996) discussed the possible space types facilitating phases of the creative process of artistic fields such as music, poetry, or fine arts. His suggestions were relating the multi-step creative process of preparation, incubation, elaboration, and evaluation by Wallas (1926) to the appropriate environments.

According to Csikszentmihalyi (1996), the preparation phase is optimal in familiar or humdrum environments, whereas a more stimulating environment with views would be more appropriate for the incubation phase. Towards the end of the multi-step process, a familiar or ordered environment would be optimal again for the elaboration and evaluation phases to complete the task in a focused mode. In practical terms, the spaces should support the activities occurring during the phases of creative processes and innovation for individual and team efforts (Haner, 2005).

Based on Csikszentmihalyi's theory, Thoring et al. (2021) developed a casual theory of spatial design which suggests the possible space types in facilitating the creative process of design thinking. Thoring et al. (2021) combined Wallas' (1926) four-stage model of creative behavior and Guilford's (1950) concepts of divergence and convergence to develop ten propositions that shed light on the potential impacts of space types on the creative process. Their theory suggests that different stages of the creative process require specific space types for optimal divergent and convergent thinking phases. Figure 4 shows suggested space types for each step of the creative process Thoring et al. (2021).

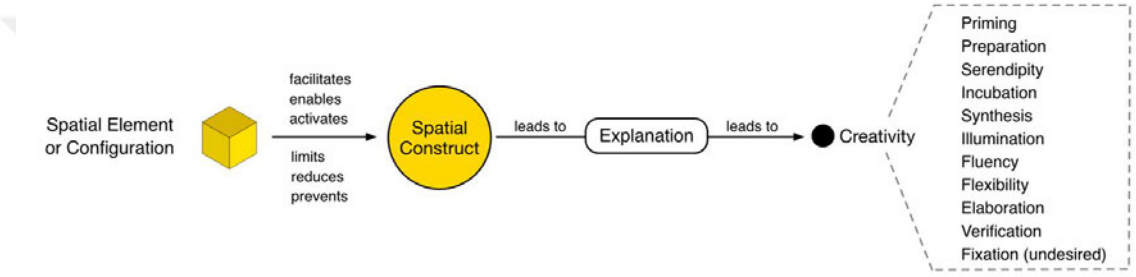


Figure 4. Proposed Relation between Space and Creative Process (Source: Thoring et al., 2021, p. 22)

Open Creative Space Types and Divergent Thinking. Open creative space types are defined as the communal work areas, meeting lounges, open-plan office structures, and disengaged spaces in the work environment intended to promote creativity (Thoring et al., 2020, Lee & Lee, 2023; Wagner & Growe, 2020). Open creative space types facilitate visual proximity, communication, collaboration, social interaction, and unexpected encounters (Thoring et al., 2020).

While experimental studies are needed to validate their theory, Thoring et al. (2021) suggest that during the creative process, phases of divergent thinking or diffused mode– such as preparation, incubation, fluency, and flexibility – would require highly sensory stimulating open creative spaces with an abundance of natural and artificial lights, presence of indoor plants, inclusion of informal libraries with open bookshelves, and vistas that can be seen from any point of the space (see Figure 5).

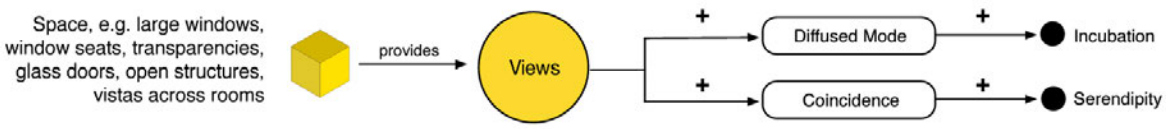


Figure 5. Suggestion on the Role of Open Spaces in Influencing Divergent Thinking (Source: Thoring et al., 2021, p. 27)

Private Creative Space Types and Convergent Thinking. Private creative space types are the enclosed rooms, booths, shields, curtains, high-back furniture, or partitioned walls that provide seclusion in the work environment (Thoring et al., 2021). Private space types enhance visual and acoustic privacy, reduce social interactions, eliminate distractions, maximizes the efficiency of deep-focused work, and promotes individual creativity (Chafi et al., 2020; Biddle, 2023; Newport, 2016; Thoring et al., 2020; Yekanialibeiglou et al., 2021).

Thoring et al. (2021) suggests that during the creative process, phases of convergent thinking or focused mode – such as synthesis, elaboration, and verification – would require private creative spaces with reduced stimulation, less distractions, and designated spaces to allow the manifestation of ideas (see Figure 6). However, experimental studies are needed to validate this suggestion (Thoring et al., 2021).

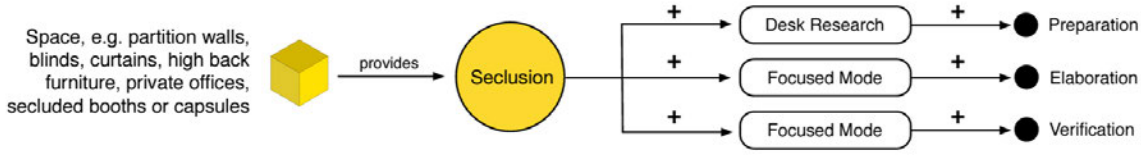


Figure 6. Suggestion on the Role of Private Spaces in Influencing Convergent Thinking (Source: Thoring et al., 2021, p. 25)

2.4 Previous Findings on the Effect of Physical Work Environment on Divergent and Convergent Thinking

Design, management, business, and engineering research suggest that to promote creativity in the work environment, creative spaces should support the design thinking process (Elsbach & Stigliani, 2020). However, since less experimental research explored the role of creative space types on divergent and convergent thinking (Elsbach & Stigliani, 2020; Lee & Lee, 2023, Thoring et al., 2021), this section reviews previous findings on how other elements in the physical environment influence divergent and convergent thinking.

Previous empirical findings (see Table 1) have shown that intangible office elements such as lighting (Lan et al., 2021) and roundness of furniture (Wu et al., 2021) affect divergent and convergent thinking (Lee & Lee, 2023). Chan and Nokes-Malach (2016) experimented with spatial volumes and found that large rooms with high ceilings are more conducive to divergent thinking compared to small rooms with lower ceilings. A more recent study by Zhou et al. (2020) investigated the effects of spatial private meeting room versus open collaborative space on team fluency and creative flow during a divergent thinking task. Their findings reveal that team fluency was induced in the private meeting room, yet creative flow was not significancy different in the private versus common space.

Table 1. Role of the Physical Environment on Divergent Thinking, Convergent Thinking, and Creative Idea Generation Adapted from (Lee & Lee, 2023)

Source	Research Aim	Physical Setting	Research Design	Instruments
Lan et al. (2021)	Effect of lighting illuminance & color temperature on creative thinking	Varying illuminance & lighting colors at existing private university offices	Experimental	Figural TTCT, Verbal AUT, Analytical Tasks
Zhou et al. (2020)	Effect of spatial & material context on generation of ideas during a creative toy design task	* Spatial (private vs. common) collaborative spaces at a university * Material (pen-paper vs. tablet)	Experimental	Team fluency, creative flow

Table 1. (Cont'd)

Source	Research Aim	Physical Setting	Research Design	Instruments
Chan & Noke-Malach (2016)	Effect of different room sizes and ceiling height on divergent & convergent problem-solving tasks	Existing offices and auditoriums at a university with varying spatial volumes	Experimental	AUT; Shape invention task; RAT; Letter series task
Wu et al. (2021)	Effect of shapes of makerspaces (rounded vs. angular) on convergent and divergent creativity	Spatial forms of makerspaces (rounded vs. angular)	Experimental	AUT; RAT; Approach/avoidance motivation

Table 2 lists relevant studies that used descriptive or qualitative methods to examine how spatial types support or inhibit team or individual divergent thinking, convergent thinking, and creative idea generation. Besides one notable study by Zhou et al. (2020), less experiments explored how space types affect divergent and convergent thinking (Batey et al., 2020; Elsbach & Stigliani, 2020; Lee & Lee, 2023; Thoring et al., 2021; Van Hooijdonk et al., 2022).

Table 2. Space Types Influence on the Creative Process Adapted from (Lee & Lee, 2023)

Spatial Types	Creative Process	Spatial Characteristics	Research Design
Private Rooms	**Supports** Team Fluency	Private Meeting room (Zhou et al., 2020)	Experimental
Social Spaces	**Supports** Creative Idea Generation **Supports** Team Divergent Thinking	Common spaces for communication (Oksanen & Stahle, 2013) Interactive areas for team collaboration (Magadley & Birdi, 2009) Informal, formal, and impromptu meeting spaces for idea generation (Haner, 2005; Lee, 2016) Open spaces for informal knowledge sharing (Haner, 2005)	Descriptive (Case Study) Descriptive (Case Study) Descriptive (Case Study) Descriptive (Qualitative) Descriptive (Case Study)
Exploration Zones	**Supports** Creative Idea Generation	Resource room for inspiration (Magadley & Birdi, 2009) Workroom for brainstorming (Magadley & Birdi, 2009)	Descriptive (Case Study)

Table 2. (Cont'd)

Spatial Types	Creative Process	Spatial Characteristics	Research Design
Recharging Spaces	**Supports** Creative Idea Generation **Supports** Individual Divergent Thinking	Recharghing spaces for mental breaks (Lee, 2016) Retreating zones for privacy and individual adjustment (Haner, 2005)	Descriptive (Qualitative) Descriptive (Case Study)
Mixed-use Spaces	**Supports** Creative Idea Generation **Supports** Creative Behavior	Modifiability for a versatile range of activites (Oksanen & Stahle, 2013) Silence rooms next to leisure spaces facilitate immersive thinking and socializing (Wanqing et al., 2020)	Descriptive (Case Study) Descriptive (Case Study)
Balanced Layouts	**Supports** Creative Idea Generation	Balance among work modes (Lee, 2016)	Descriptive (Qualitative)
Adjustable Workspaces	**Inhibits** Individual Divergent Thinking	Personalized workspaces (Chi et al., 2020) Highly stimulated workspaces with personalized decorations, plants, and colors (Chi et al., 2020)	Descriptive (Qualitative)

2.5 Measures of Engagement

Engagement is defined as extreme investment in a task or a specific goal (Matthews et al., 2002). Task engagement related to the creative design thinking process can be measured by flow state, situational interest, and presence. This section introduces each measure along with similar studies that adopted them as engagement measures.

2.5.1 Flow State

Flow state is a momentary positive psychological state characterized by utmost immersion and deep concentration on the task at hand (Fullagar & Kelloway, 2009). The term "flow" stems from positive psychology literature and was first coined by Csikszentmihalyi (1975) in his theory of optimal experiences, also referred to as flow theory. Constructs of flow include enjoyment, challenge, intrinsic motivation, focused attention, positive reinforcement, clear goals, personal control, and temporal dissociation (Csikszentmihalyi, 1975). The concept of flow has been related to organizational psychology research and is referred to as the uttermost experience characterized by work absorption, enjoyment, and intrinsic motivation (Liu et al., 2022).

Flow state can be assessed using neuroscientific techniques such as analyzing electromyographic (EMG) brain signals (Van der Linden et al., 2020). Additionally, observation methods like the Flow Observational Grid (FOG) developed by Tordet et al. (2021) are utilized for this purpose. Flow state can also be assessed using the daily diary methods which monitor flow experiences over an extended period (Stollberger & Debus, 2019). Momentary self-report scales, such as the Flow State Scale (consisting of 36 items) introduced by Jackson & Marsh (1996) and the Flow Short Scale (comprising 10 items) developed by Engeser & Rheinberg (2008), are also employed to measure flow state. Recent organizational psychology research (Peng et al., 2024; Pitchforth et al., 2020; Stollberger & Debus, 2019) relies extensively on the daily diary method and self-report scales to assess flow state.

Recent organizational research found that higher flow state indicates higher creative performance (Stollberger & Debus, 2019) and innovative behavior (Peng et al., 2024). Ever since its introduction in the literature, managers are interested in inducing flow state in employees (Pitchforth et al., 2020; Weintraub et al., 2021). Soriano et al. (2021) found that the design of the task and the workspace can influence flow state. Designated workspaces meeting employees' work activities are more likely to induce flow, which will eventually benefit the organization (Primus & Sonnenburg, 2018). Pitchforth et al. (2020) found that open-plans and team-office designs positively induced flow state as opposed to activity-based offices. However, more studies are required to explore the relationship between flow state and workspace designs (Pitchforth et al., 2020).

2.5.2 Situational Interest

Situational interest refers to the immediate psychological state triggered by stimulating contexts or activities, rather than by an individual's stable characteristics (Krapp, 1999; Renninger & Hidi, 2016; Silvia, 2008). Situational interest is characterized by short-term experiences involving emotions of curiosity and enjoyment (Hidi & Renninger, 2006; Silvia, 2008), concentration, and entertainment (Kiili et al., 2021). In addition, recent empirical research found that increased situational interest induces sustained attention (Ainley et al., 2002; Rotgans & Schmidt, 2014), cognitive appraisals

(Silvia, 2008), and persistence (Su, 2020) leading to increased engagement (Kiili et al., 2021).

Situational interest gained more attention in educational psychology than in organizational psychology (Nye, 2022; Su, 2020). In educational psychology, situational interest is perceived as an origin of intrinsic motivation powering learning and knowledge acquisition (Su, 2020). Empirical studies in educational psychology investigate situational interest in a reading context using experimental designs (Crouch et al., 2018; Renninger et al., 2014; Su, 2020). For example, situational interest is measured by enjoyment induced in a classroom environment (Su, 2020). In addition, the attention, engagement, processing, and time devoted during a reading task are also measured (Su, 2020). However, more empirical studies in organizational psychology are encouraged to evaluate situational interest as a measure of engagement (Ann & Hidi, 2019; Nye, 2022; Su, 2020).

Situational interest in educational research has been evaluated using self-report scales such as the individual interest questionnaire (comprising of 7 items) developed by (Rotgans, 2015). In game-based learning research, situational interest has been assessed using a single-item questionnaire during a game task (Kiili et al., 2021). The single item is rated after each game level making it appropriate to not distract the engagement level of participants during an experiment (Kiili et al., 2021). In other education contexts, situational interest has been evaluated using the 24-item situational interest scale (SIS) developed by Chen et al. (1999).

Empirical studies in educational psychology proved that the nature of a task is significant in sustaining situational interest (Su, 2020). For instance, students' situational interest was enhanced after adopting the design thinking model in a problem-solving task (He et al., 2023). Flow experience and situational interest are important measures of engagement used widely in gaming education research (Kiili et al., 2021).

2.5.3 Presence

Presence refers to the psychological state of "being in" and "being able to take action in" an environment (Usoh et al., 2000; Zahorik & Jenison, 1998). This definition of presence focuses on one's ability to act in an environment rather than one's perception of how things look and sound (Usoh et al., 2000). A higher sense of presence indicates a greater ability to act in an assigned space (Usoh et al., 2000). Based on Usoh et al.'s definition of presence, empirical studies found mixed results on the relation between presence and performance. For instance, Khenak et al. (2020) compared presence and performance in real, remote, and virtual environments during a navigation task. Results of their experimental method indicated that the highest sense of presence was in the real environment, along with the highest performance in the navigation task. On the contrary, Khenak et al. (2018) found no correlation between presence and performance scores during a task conducted in a real and a rendered simulated office space displayed on a Head Mounted Display (HMD).

Presence is a prominent construct investigated in virtual environments more than in real environments (Usoh et al., 2000). Yet, the most common approach to measure presence in both environments has been by using self-report questionnaires provided to participants after the completion of an experiment. For example, the Slater-Steed-Usoh presence questionnaire (comprising of 6 items and 2 open-ended questions) developed by Slater et al. (1995) and the igroup presence questionnaire (IPQ) (comprising of 14 items) introduced by (Schubert, 2003) has been used to assess presence in real and virtual environments (Busch et al. 2014; Li et al., 2022; Pizzolante et al., 2024; Usoh et. al, 2000).

Empirical studies obtained mixed results when comparing presence between real and virtual environments. For instance, a study comparing presence between a real office space and its virtual simulation by Usoh et al. (2000) revealed that presence was higher in the real office space. Similarly, participants experienced significantly higher presence in a real seminar room compared to a virtual simulation in another study by Mania (2001).

More recently, Busch et al. (2014) analyzed participants' user experience of a navigation application and compared the presence of participants between a real laboratory and its virtual simulation. Results revealed no statistical differences between either environment. On the contrary, Pizzolante et al. (2024) compared presence between a 'real' physical space, including a real bike, and a 'virtual' space, including a rendered bike, displayed on an HTC Vive Pro HMD. Results revealed higher presence in the virtual space.

CHAPTER III

METHODOLOGY

This chapter covers the methodology of the study including the conceptual framework, research questions, and hypotheses. It also provides information about the participants, experimental settings, procedure, and instruments used for the experiment.

3.1 Conceptual Framework

The conceptual framework of this study suggests that open and private creative spaces influence task engagement during divergent and convergent thinking tasks (see Figure 7). Flow state, situational interest, and presence are the task engagement measures in this study.

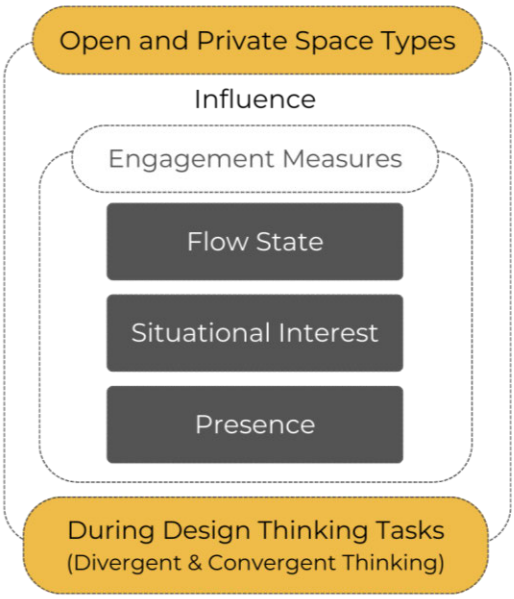


Figure 7. Conceptual Framework of the Study

3.2 Research Questions and Hypotheses

This study experimentally investigated the difference in flow state, situational interest, and presence during divergent and convergent thinking tasks between two space types: open creative space (OCS) and private creative space (PCS). Based on the gap in the literature, the following questions were addressed:

RQ_1: What is the difference in flow state, situational interest, and presence during divergent thinking tasks in open versus private creative space types?

> **H_{1A}:** During divergent thinking tasks, *flow state* is higher in the open than in the private creative space.
>
> **H_{1B}:** During divergent thinking tasks, *situational interest* is higher in the open than in the private creative space.
>
> **H_{1C}:** During divergent thinking tasks, *presence* is higher in the open than in the private creative space.

RQ_2: What is the difference in flow state, situational interest, and presence during convergent thinking tasks in open versus private creative spaces?

> **H_{2A}:** During convergent thinking tasks, *flow state* is higher in the private than in the open creative space.
>
> **H_{2B}:** During convergent thinking tasks, *situational interest* is higher in the private than in the open creative space.
>
> **H_{2C}:** During convergent thinking tasks, *presence* is higher in the private than in the open creative space.

RQ3: Is there a correlation between flow state, situational interest, and presence during divergent and convergent thinking tasks?

H3A: There is a significant positive correlation between flow state and situational interest during divergent and convergent thinking tasks.

H3B: There is a significant positive correlation between flow state and presence during divergent and convergent thinking tasks.

H3C: There is a significant positive correlation between presence and situational interest during divergent and convergent thinking tasks.

Hypotheses one and two are depicted in Figures 8 and 9. Hypothesis one shows that the *open creative space* fosters flow state, situational interest, and presence during divergent thinking tasks better than the private creative space (see Figure 8). Hypothesis two conveys that the *private creative space* fosters flow state, situational interest, and presence during convergent thinking tasks better than the open creative space (see Figure 9).

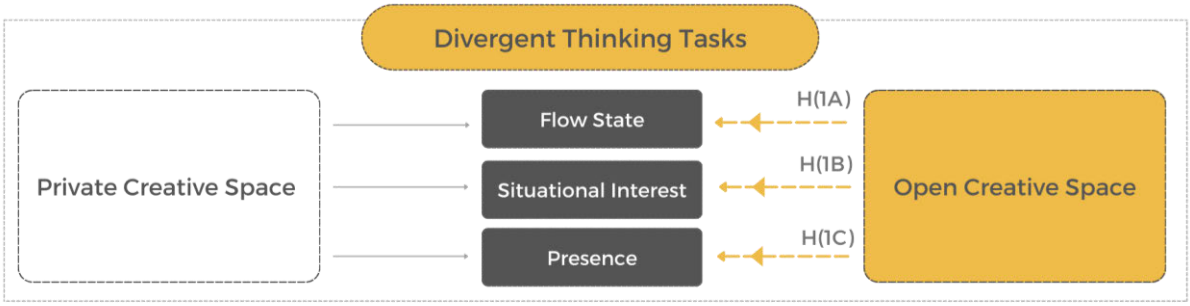


Figure 8. Hypothesis One (Source: Own Image)

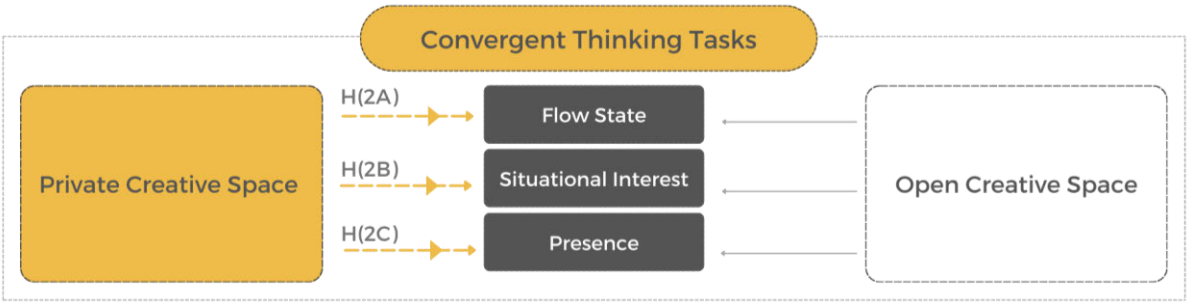


Figure 9. Hypothesis Two (Source: Own Image)

3.3 Participants

The snowball sampling method recruited 59 undergraduate and graduate students. Among the overall number of participants, 32 were design-based students (pursuing architecture, interior architecture, graphic design degrees) and 27 were non-design based (pursuing management, software, mechanical engineering degrees) at Bilkent University. The age range of participants was between 19 and 30 years old. Among the 59 participants, 39 were females and 20 were males. Participants were randomly assigned to private or open creative space. This between-subject design ensures that any difference detected in the flow state, situational interest, and presence of the two groups is due to the creative space types.

Since both space types were at the university campus, a few of the non-design students were familiar with the open-space type located in the science building of the campus. Almost all design students were unfamiliar with the open space. However, architecture and interior architecture design graduate students were familiar with private space type located in the architecture building of the university campus. Non-design students were completely unfamiliar with the private space type.

Prior to engaging in the experiment, participants voluntarily agreed to participate by signing a consent form (see Appendix A) and received no compensation, course credits, or monetary rewards. The Bilkent University ethics committee (No. 2024_05_21_01) reviewed the consent form and a document outlining the study's purpose, experimental

procedure, and instruments before approving the recruitment of Bilkent students (see Appendix B).

3.4 Experimental Settings

This study's two experimental settings, open and private spaces, are located at Bilkent University Main Campus in Ankara, Turkey. Participants completed the design thinking tasks in either one of the experimental settings during the spring semester of 2023-2024, anytime between 9 a.m. and 7 p.m. The open creative space type and the private creative space type are identified as dichotomous variables of this study.

The "open creative space" located in the physics department building (see Figure 10) is characterized by tangible office elements such as multiple workstations, informal couch seating, indoor plants, large windows, skylights, and whiteboards as well as intangible natural daylight which are suggested to be conducive to creativity (Thoring et al., 2020). This space included 10 to 15 other students present when a participant was conducting the experiment. The space simulates the open and informal working spaces found in offices. Thoring et al. (2021) suggested that such space would be conducive for divergent thinking phases.

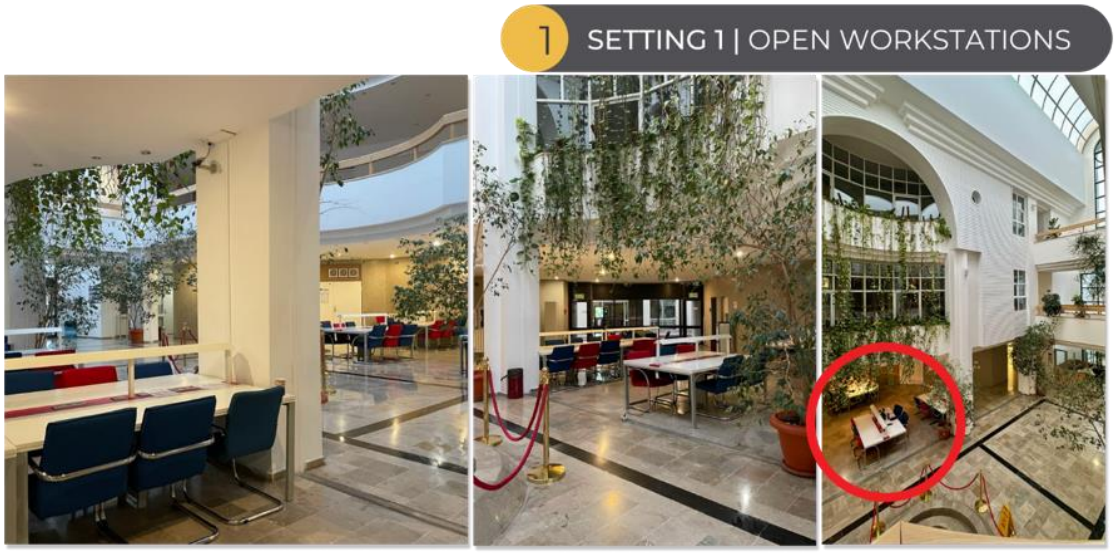


Figure 10. Open Space Experimental Setting (Source: Own Image)

The "private creative space" found in the architecture department building (see Figure 11) is an enclosed meeting room characterized by tangible office elements such as conference table, chairs, moving whiteboard, windows displaying a changing environment which tends to promote creativity (Thoring et al., 2020). This room simulates private and formal working spaces found in offices. Thoring et al. (2021) suggest that such space characterized by an absence of noise and other individuals are conducive for convergent thinking. Participants completed the design thinking tasks seated while facing the windows. Figure 12 shows participants taking part in the experiment.

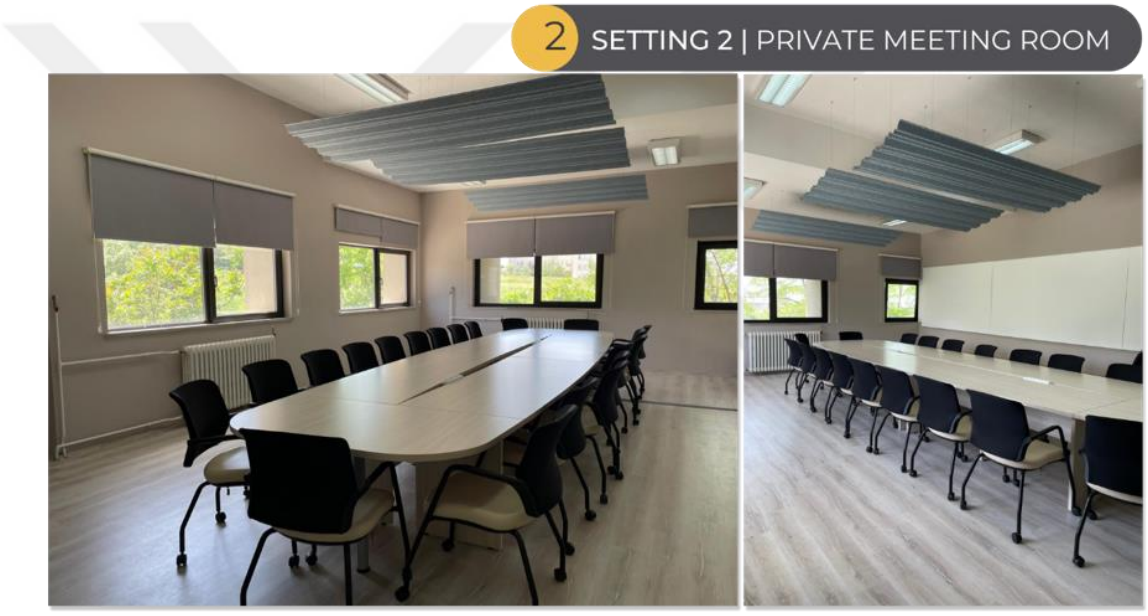


Figure 11. Private Space Experimental Setting (Source: Own Image)

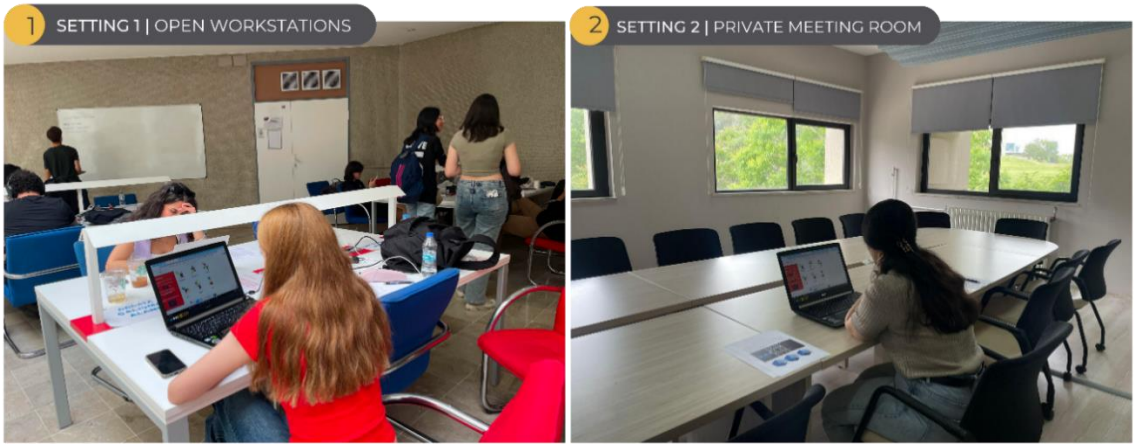


Figure 12. Participants during the Experiment (Source: Own Image)

3.5 Design Thinking Tasks

Participants completed either divergent or convergent thinking tasks in the experimental settings. Divergent thinking tasks include the poly-cube figural combination and the modifying figures tasks. Convergent thinking tasks include the orthographic projections and the tangram puzzle tasks.

3.5.1 Divergent Thinking Tasks

The poly-cube figural combination task (see Appendix C) and the modifying existing figures task (see Appendix D) represent divergent processing. The following section describes the objective for each task.

(A) Poly-cube Figural Combination Task

In this task, participants generated six figures by combining several isometric cubes. The categories of the figures were two objects, two structures, and two animals. Before engaging in the task, participants were presented with two possible combinations of each category (see Appendix C for the task brief). Participants first replicated a given isometric cube, assembled the replicated cubes, and labeled their final creations using the FigJam whiteboard (see Figure 13).

The poly-cube figural combination task was adapted from Finke et al.'s original figural combination task (1996). In the original task, participants had to combine and generate objects belonging to one of three categories (e.g., toys and games, transportation) using three assigned components: a cone, a pot, and a horn. Another version of the task included only abstract 3D shapes as the assigned components (Verstijnen et al., 1998). The figural combination task by Finke et al. (1996) is like other divergent thinking tasks in that it asks participants to use abstract prompts to come up with new combinations that belong to certain categories (Chan & Nokes-Malach, 2016; Palmiero, 2020; Verstijnen et al., 1998).

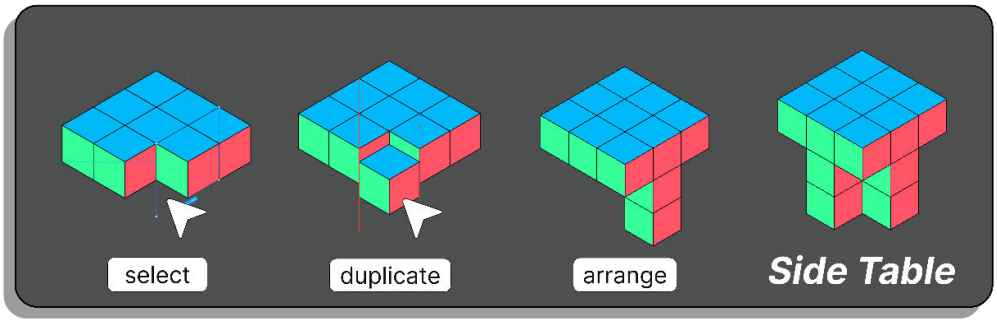


Figure 13. Sample of the Poly-cube Figural Combination Task (Source: Own Image)

(B) Modifying Figures Task

In this task, participants modified six ambiguous figures. Each figure had seven dissected geometric shapes (see Appendix D for the task brief). Participants rotated and moved the dissected shapes to match the prompts under each figure (see Figure 14). The task is based on the SCAMPER technique's "Modify" prompt, denoted as "M" (Curedale, 2019). SCAMPER is a creative brainstorming and ideation technique that promotes divergent thinking (Curedale, 2019). Individuals generated more useful and practical ideas using the SCAMPER technique than traditional brainstorming methods (Deo et al., 2021).

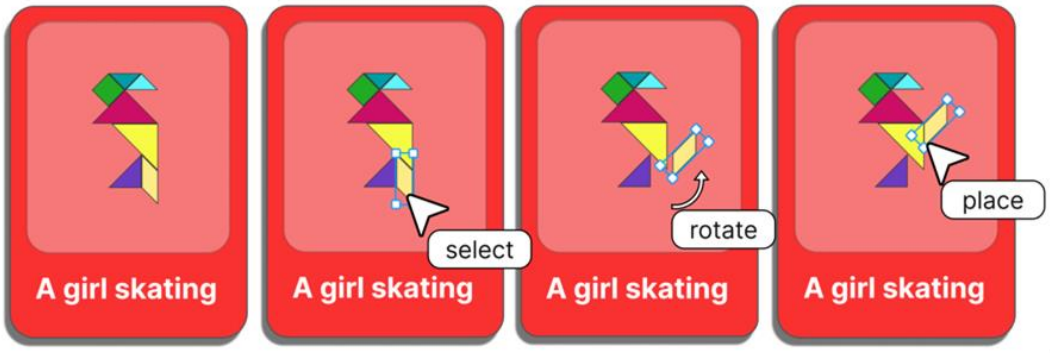


Figure 14. Sample of the Modifying Figures Task (Source: Own Image)

3.5.2 Convergent Thinking Tasks

The orthographic projections task (see Appendix E) and the tangram puzzle task (see Appendix F) represent convergent processing. The following section describes the objective for each task.

(C) Orthographic Projections Task

In this task, participants generated 2D projections (i.e., left, front, and top views) of four 3D isometric figures by duplicating given color-coded squares (see Appendix E for the task brief and solutions). Each color-coded square represented a side view: green denoted the left view, pink denoted the front view, and blue denoted the top view. Participants aligned their responses next to the corresponding 3D isometric figures (see Figure 15).

The Architectural Spatial Ability (ASAT) test inspired the orthographic projections task of this study (Cho, 2012, 2017; Cho & Suh, 2019). Both the ASAT and the orthographic projection task induce convergent processing to solve a single correct answer task using analytical and logical thinking. The objective of the ASAT and the orthographic projections task is to fluently switch two-dimensional spatial information into three-dimensions and contrariwise.

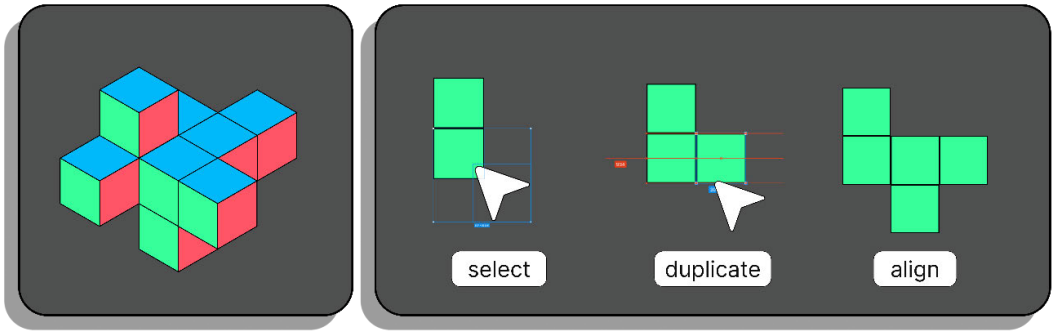


Figure 15. Sample of the Orthographic Projections Task (Source: Own Image)

(D) Tangram Puzzle Task

The Tangram is a dissection puzzle comprising seven polygons assembled to form unique figures (Cahyanita et al., 2021; Domino, 1980). In this study, participants used seven geometric pieces, five triangles, a square, and a parallelogram, to fill eight given Tangram figures (see Appendix F for the task brief and task solutions). The provided

figures were rated as complex in a previous study by Heiligensetzer et al., (2021). Participants filled in the figures by moving, rotating, and positioning the dissected pieces (see Figure 16).

The tangram puzzle is a creative problem-solving task that evaluates convergent thinking by synthesizing given figures using a limited number of elements (Bi et al., 2020; Cahyanita et al., 2021; Domino, 1980). A recent study used a two-part Tangram test to assess divergent and convergent thinking (Heiligensetzer et al., 2021). Participants created figures from their imaginations using seven dissected pieces to assess divergence. Participants replicated the given forms using the same dissected fragments in the second part of the test to evaluate convergence (Heiligensetzer et al., 2021).

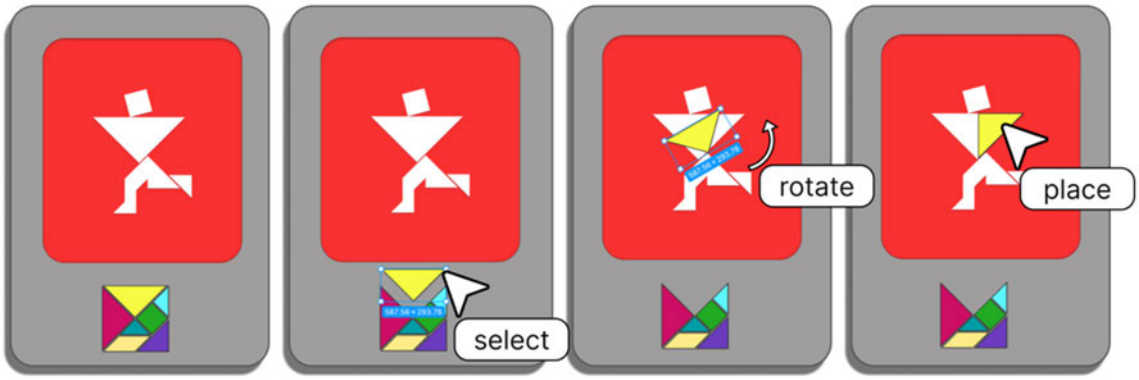


Figure 16. Sample of the Tangram Puzzle Task (Source: Own Image)

3.6 Instruments

All the design thinking tasks were completed on the FigJam whiteboard using a Windows PC (see Figure 17). Five survey instruments were used in this study, including the demographic questionnaire, preference for ideation and evaluation scale (PIES), flow short scale (FSS), situational interest scale (SIS), and Slater-Usoh-Steed presence questionnaire (SUS-PQ).

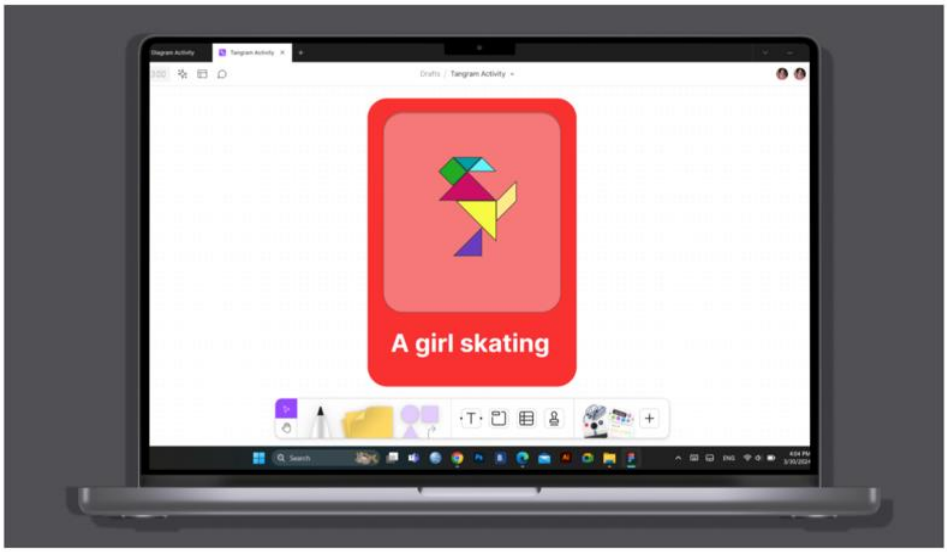


Figure 17. A Task on the FigJam Whiteboard (Source: Own Image)

3.6.1 FigJam Whiteboard in Figma

Figma is the leading web design and desktop application for building digital products compatible with macOS and Windows PCs. Figma is designed to assist every step of the design thinking process, such as ideating, prototyping, and wireframing (Staiano, 2022). The FigJam tool in Figma is a whiteboard collaborative space created for brainstorming, building flows, organizing ideas, and playing games.

The FigJam whiteboard is used to ideate, organize, visualize, and test ideas. FigJam's interface is intuitive and clear (see Figure 18). The toolbar at the bottom includes a navigation bar, a marker for freehand sketching, sticky notes to add quick ideas, templates, and many other tools that aid in customizing the output. FigJam includes limited fonts, colors, and styles because its tools do not support designing but support ideating (Staiano, 2022).

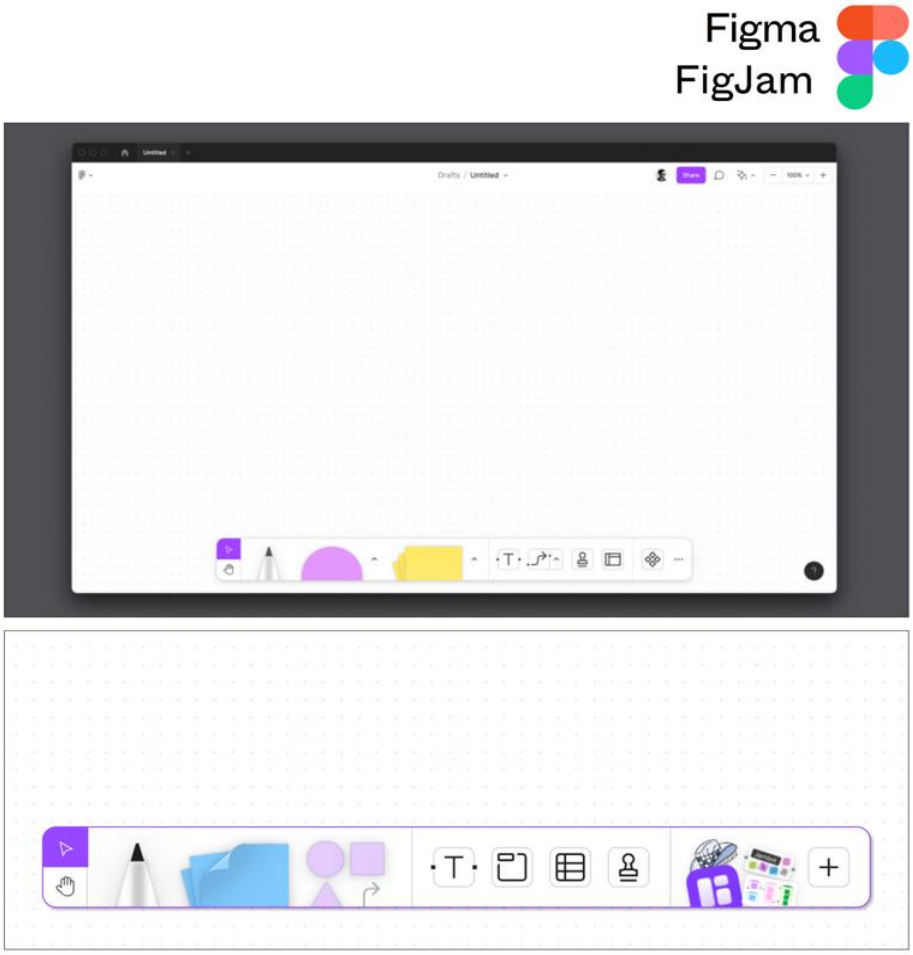


Figure 18. FigJam Whiteboard's Interface (Source: Own Image)

3.6.2 Demographic Questionnaire

The demographic questionnaire collects participants' information such as age, gender, and education level. In addition, two subjective questions assessed participants' preferences for creative spaces when they needed to complete certain tasks (see Appendix G for the full questionnaire). The first question assessed participants' spatial preference when conducting a brainstorming session. The second question assessed participants' spatial preference when conducting a synthesizing of information or analyzing a task.

Participants completed the questionnaire in 3 minutes via a Google Forms document before beginning the tasks. After the demographic questionnaire, they completed the Preference for Ideation and Evaluation Scale (PIES).

3.6.3 Preference for Ideation and Evaluation Scale (PIES)

Basadur et al. (1982) described "ideation" and "evaluation" as the steps of the thinking process. Ideation refers to generating ideas without judgment, while evaluation involves judging generated ideas (Basadur and Finkbeiner, 1985). Divergent thinkers are inclined towards ideation, whereas convergent thinkers are inclined towards evaluation (Brophy, 2001). This study adapted the 14-item Preference for Ideation and Evaluation Scale (PIES) to determine whether a participant is a divergent, convergent, or balanced thinker (see Appendix H for full items).

The PIES items are rated on a 5-point Likert scale: (1 = *strongly agree*) and (5 = *strongly disagree*). Basadur and Finkbeiner (1985) developed PIES by combining the preference for ideation (6 items) and evaluation preference (8 items) subscales (see Table 3 for sample items). The internal consistencies of the subscales were at 0.68 and 0.88, and the correlation between them was at -0.26 (Basadur & Finkbeiner, 1985).

The overall PIES score of each participant was calculated by subtracting their evaluation score from their ideation score. The difference scores (ds) were then computed to 1 for a divergent thinker, 2 for a balanced thinker, and 3 for a convergent thinker. If (ds) is less than < -0.01, then an individual is a divergent thinker. If (ds) is between $-0.01 \leq ds \leq 0.01$, then an individual is a balanced thinker. If (ds) is greater than > 0.01, then an individual is a convergent thinker.

Table 3**.** PIES Sample Items (Source: Basadur & Finkbeiner, 1985, p. 42-43)

Sample Items		Preference for Ideation	Preference for Evaluation
Q1	One new idea is worth ten old ones.	x	
Q2	I should do some prejudgment of my ideas before telling them to others.		x
Q3	Quality is a lot more important than quantity in generating ideas.	x	
Q4	Lots of time can be wasted on wild ideas.		x
Q5	The best way to generate new ideas is to listen to others then tailgate or add on.	x	

3.6.4 Flow Short Scale (FSS)

Engeser et al. (2021) define flow as a mental state of complete absorption in a task characterized by a deep sense of control and a lack of self-consciousness. In this study, participants rated their flow experience using the 10-item Flow Short Scale (FSS) after completing the design thinking tasks in both space types (see Table 4 for sample items and Appendix I for the full items). The FSS consists of the fluency of performance (6 items) and absorption by activity (4 items) subscales (Engeser & Rheinberg, 2008). The items were rated on a 7-point Likert scale (1 = *not at all*) and (7 = *very much*).

Reliability of the overall scale was reported at ($\alpha = 0.92$) (Engeser & Rheinberg, 2008), indicating high internal consistency. The FSS was based on eight components from the conceptual flow model (Csikszentmihalyi, 1996), including challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, and time transformation. The FSS was applied in different methods such as experiments, correlation studies, and experience-sampling (Schüler, 2007).

Table 4. FSS Sample Items (Source: Engeser & Rheinberg, 2008, p. 170)

Sample Items		Fluency of performance	Absorption by activity
Q1	I felt just the right amount of challenge.		x
Q2	I had no difficulty concentrating.	x	
Q3	I was totally absorbed in what I was doing.		x
Q4	I felt that I had everything under control.	x	

3.6.5 Situational Interest Scale (SIS)

Hidi and Renninger (2019) define situational interest as an immediate and spontaneous psychological state influenced by the context. In this study, participants rated their situational interest after completing the design thinking tasks using the 24-item situational interest scale (SIS) developed by Chen et al. (1999) (see Appendix J for full items). The SIS items are rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The SIS comprises six subscales, including exploration intention (4 items), instant enjoyment (5 items), novelty (3 items), attention quality (4 items), challenge (4 items), and total interest (4 items) (see Table 5 for sample items). Chen et al. (1999) reported the internal consistencies of the subscales at .78, .80, .90, .91, .90, and .95, indicating high reliability.

Table 5**.** SIS Sample Items (Source: Chen et al., 1999, p. 174-175)

Sample Items		SIS Subscales
Q2	This activity is new to me.	Novelty
Q7	These activities were fresh.	
Q11	The activities inspired me to participate.	Instant Enjoyment
Q23	They were enjoyable activities for me.	
Q5	I wanted to find out more about how to do these activities.	Exploration Intention
Q20	I want to discover all the tricks of these activities.	

Table 5. (Cont'd)

Sample Items		SIS Subscales
Q4	My attention was high.	Attention Quality
Q17	I was focused.	
Q6	They were complex activities.	Challenge
Q22	These activities were demanding tasks.	
Q13	It was fun for me to try these activities.	Total Interest
Q9	These were interesting activities for me to complete.	

3.6.6 Slater-Usoh-Steed Presence Questionnaire (SUS-PQ)

Presence refers to the psychological state of "being in" and "being able to take action in" a specific environment (Usoh et al., 2000; Zahorik & Jenison, 1998). A higher sense of presence indicates a greater ability to act in an assigned space (Usoh et al., 2000). In this study, the 8-item Slater-Usoh-Steed presence questionnaire (SUS-PQ) developed by Slater et al. (1995) was adapted to measure and compare the sense of presence between both space types. All the "virtual environment" phrases in the original SUS-PQ items were changed to the "assigned space" (see Table 6 for sample items). The first six items are rated on a 7-point Likert scale, where 7 indicates the utmost presence. The last two items are open-ended questions (see Appendix K for the full items).

Table 6. SUS-PQ Sample Items (Source: Usoh et al., 2000, p. 5)

Sample Items	
Q1	I had a sense of "being there" in the assigned space…
Q2	There were times during the experience when this space was the reality for me…
Q3	I think of the assigned space as a place in a way like other places that I've been today...

3.7 Procedure

This study assigned two independent groups to either a private or open creative space, with each group following the same procedure (see Figure 19). Participants initially signed a consent form (see Appendix A) reviewed by the Bilkent University Local Ethics Committee (see Appendix B). Then, participants read a printed brief of either the divergent (see Appendices C & D) or convergent tasks (see Appendices E & F). After reading the briefs, participants completed the demographic questionnaire (see Appendix G), which includes the Preference for Ideation and Evaluation Scale (see Appendix H).

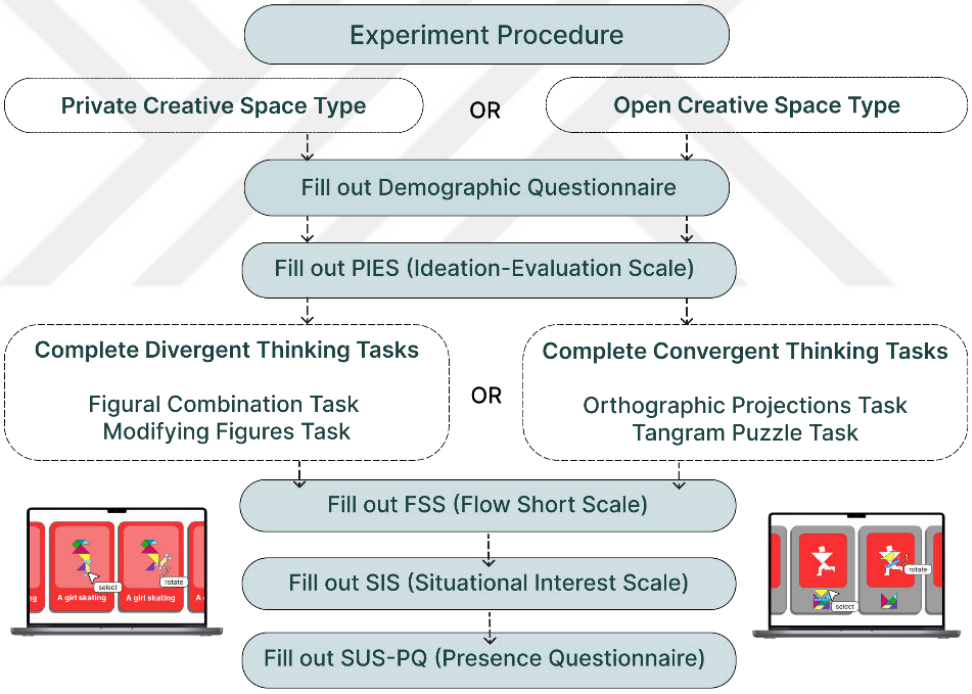


Figure 19. Procedure of the Study (Source: Own Image)

Each experimental setting had a Windows PC displaying the tasks on the FigJam whiteboard. Before initiating the tasks, each participant spent 3 minutes learning how to use the FigJam whiteboard. Participants then took an average of 25 to 50 minutes to complete either the divergent or the convergent tasks. Figures 20 and 21 show participants' sample responses to both divergent tasks. Appendices E and F include the answer keys to the convergent tasks. To avoid order effects, half of the participants in

each group followed one series of tasks while the other half completed another series of tasks. After completing the tasks, participants completed the 13-item FSS (see Appendix I) and the 24-item SIS (see Appendix J) on printed A4 sheets. Then, each participant filled out the SUS-PQ (see Appendix K) via Google Forms as soon as they left their assigned space.

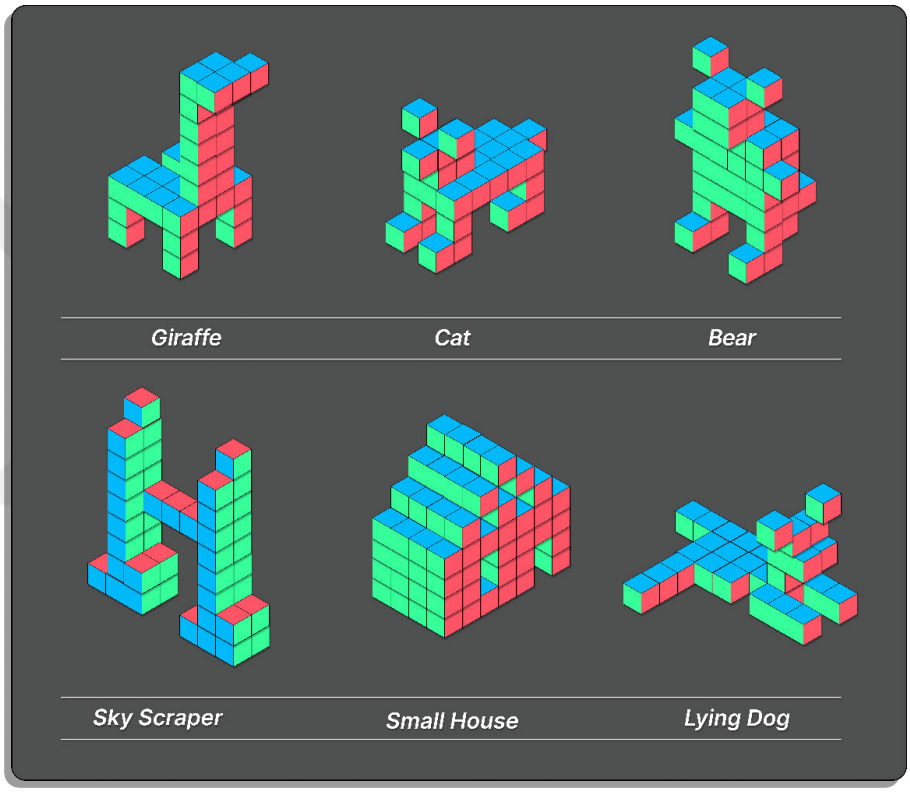


Figure 20**.** Participants' Sample Responses to the Poly-cube Figural Combinations Task (Source: Own Image)

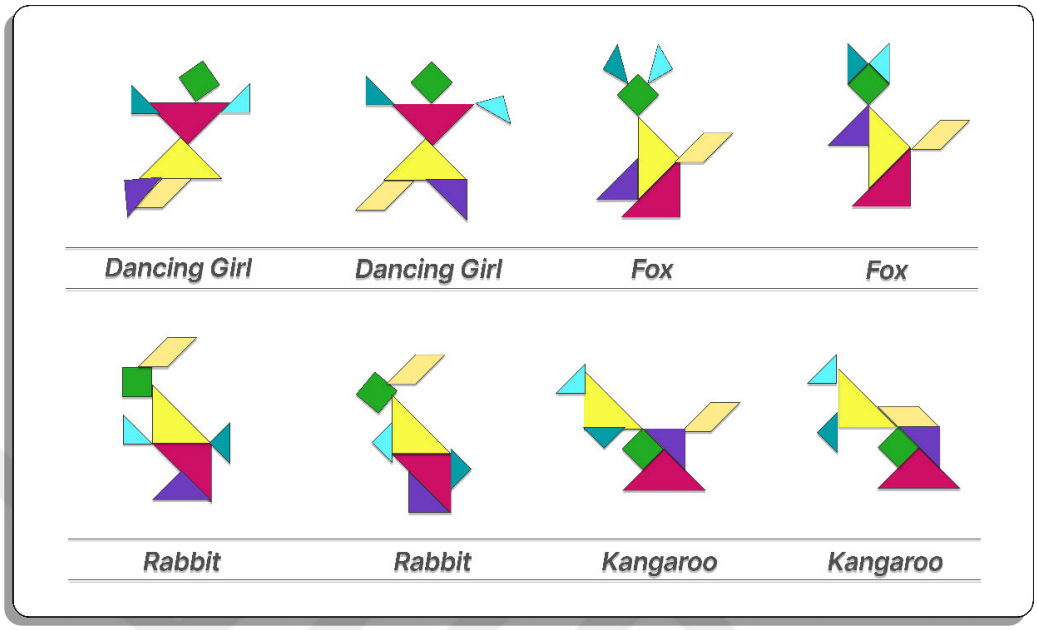


Figure 21. Participants' Sample Responses to the Modifying Figures Task (Source: Own Image)

CHAPTER IV

RESULTS

Responses to the demographic questionnaire, Preference for Ideation and Evaluation Scale (PIES), Flow Short Scale (FSS), Situational Interest Scale (SIS), and the SUS Presence Questionnaire (SUS-PQ) were entered into the IBM SPSS Statistics 20 software for statistical analysis. First, descriptive analysis calculated the median and mode scores. Reliability analysis determined the internal consistency of the PIES, FSS, SIS, and SUS-PQ and their subscale items. Then, an independent sample t-test detected if a mean difference existed in the FSS, SIS, and SUS-PQ scores of participants between both space types. Lastly, a Spearman-Rho correlation test revealed the correlation between the FSS, SIS, and SUS-PQ scores.

4.1 Analysis of the Demographic Questionnaire

Among the 59 participants recruited by the snowball sampling method, 30 were assigned to the open creative space and 29 to the private creative space. The age range was between 19 and 30 years (M = 22.53 years, SD = 2.49). Among the 59 participants, 39 were females, and 20 were males. The education levels were 41 undergraduate students, 14 Master students, and 4 Ph.D. students. Table 7 shows the distribution of participants' age, gender, education level, thinking styles, and profession by space type.

Responses to the preferences for space types based on task-type questions were also analyzed. During the browsing and brainstorming tasks, 27 participants preferred a "secluded space with partitions to withdraw themselves from distractions." In contrast, 30

preferred an "open workstation where they can see and interact with their colleagues." While structuring and eliminating ambiguous ideas, 42 participants preferred a "private space," while 19 preferred an "open workstation."

Table 7. Demographics by Space Type (% within the Space Types)

	Space Types				
	Open Space		**Private Space**		**Total**
Demographics	*N=30*	*%*	*N=29*	*%*	***N=59** (%)*
Assigned Tasks					
Convergent Tasks	15	50%	15	51.7%	**30** (50.8%)
Divergent Tasks	15	50%	14	48.3%	**29** (49.2%)
Gender					
Female	16	53.3%	23	79.3%	**39** (66.1%)
Male	14	46.7%	6	20.7%	**20** (33.9%)
Age (in years)					
19 – 22	19	63.3%	17	58.6%	**36** (61%)
23 – 26	9	30%	9	31%	**18** (30.5%)
27 – 30	2	6.7%	3	10.3%	**5** (8.5%)
Education Level					
Undergraduate	22	73.3%	19	65.5%	**41** (69.5%)
Master	7	23.3%	7	24.1%	**14** (23.7%)
Ph.D.	1	3.3%	3	10.3%	**4** (6.8%)
Thinking Styles					
Balanced Thinker	1	3.3%	0	0%	**1** (1.7%)
Divergent Thinker	13	43.3%	13	44.8%	**26** (44.1%)
Convergent Thinker	16	53.3%	16	55.2%	**32** (54.2%)

Table 7. (Cont'd)

	Space Types				
	Open Space		**Private Space**		**Total**
Demographics	*N=30*	*%*	*N=29*	*%*	***N=59** (%)*
Profession					
Design Based	14	46.7%	18	62.1%	**32** (54.2%)

4.2 Analysis of the Preference for Ideation and Evaluation Scale (PIES)

The PIES was adapted to identify whether a participant is a divergent, convergent, or balanced thinker. The PIES comprises the 8-item evaluation subscale (1, 2, 5, 6, 7, 10, 11, 14), and the 6-item ideation subscale (3, 4, 8, 9, 12, and 13). Convergent thinkers prefer evaluation, whereas divergent thinkers prefer ideation (Brophy, 2001). Participants evaluated each item on a 5-point Likert scale, where 1 = *strongly agree*, and 5 = *strongly disagree*.

The overall PIES score of each participant was calculated by subtracting their evaluation score from their ideation score. The difference scores were then computed to 1 for a divergent thinker, 2 for a balanced thinker, and 3 for a convergent thinker. Descriptive analysis revealed that 32 participants were identified as convergent thinkers, 26 as divergent thinkers, and one as a balanced thinker. Table 8 shows the distribution of age, gender, education level, and profession of participants by their thinking style.

Reliability analysis using SPSS determined the internal consistency of each subscale. The alpha values were at ($\alpha = 0.622$) and ($\alpha = 0.548$) for the "evaluation" and "ideation" subscales. Cronbach's alpha (α) values ranging from $0.5 < \alpha < 0.8$ indicate moderate

(acceptable) reliability (Ekolu & Quainoo, 2019; Hinton et al., 2014; Thigpen et al., 2017). Spearman's rho correlation test between the subscales indicated a negative significant correlation (r = -0.302, p = 0.020) at the 0.05 level (2-tailed).

Table 8. Demographics by Thinking Style (% within Thinking Styles)

	Thinking Styles						
	Divergent Thinker		**Balanced Thinker**		**Convergent Thinker**		**Total**
Demographics	*N=26*	*%*	*N=1*	*%*	*N=32*	*%*	***N=59** (%)*
Gender							
Male	7	26.9%	-	-	13	40.6%	**20** (33.9%)
Female	19	73.1%	1	100%	19	59.4%	**39** (66.1%)
Age (in years)							
19 – 22	15	57.7%	-	-	21	65.6%	**36** (61%)
23 – 26	8	30.8%	1	100%	9	28.1%	**18** (30.5%)
27 – 30	3	11.5%	-	-	2	6.2%	**5** (8.5%)
Education Level							
Master's	8	30.8%	-	-	6	18.8%	**14** (23.7%)
Ph.D.	2	7.7%	-	-	2	6.2%	**4** (6.8%)
Undergraduate	16	61.5%	1	100%	24	75%	**41** (69.5%)
Profession							
Design Based	17	65.4%	-	-	15	46.9%	**32** (54.2%)
Non-design Based	9	34.6%	1	100%	17	53.1%	**27** (45.8%)

4.3. Descriptive Analysis of the FSS

Participants rated their flow state experience using the 10-item FSS in both space types. Tables 9 and 10 show the median (Mdn) and mode (Mod) scores for each FSS item during divergent and convergent tasks. During divergent tasks, the Mdn and Mod scores of the FSS items were higher in the open space than the private space. During convergent tasks, the Mdn and Mod scores of the FSS items were almost equal in both space types. Reliability analysis of the overall FSS reported the Cronbach's alpha value at ($\alpha = 0.646$), indicating moderate and acceptable reliability.

Table 9. Analysis of the FSS during Divergent Tasks

Open Space Type										
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Mdn	6	6	7	6	5	6	5	6	6	4
Mod	6	6	7	6, 7*	4	7	5, 7*	7	4, 7*	4, 7*
Private Space Type										
Mdn	5	5	7	5	5	6	5	5	5	2
Mod	4, 5*	4	7	5	4, 6*	6	5	4	5	3

*Multiple modes exist. All values are shown.

Table 10. Analysis of the FSS during Convergent Tasks

Open Space Type										
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Mdn	6	6	6	6	5	6	5	6	6	2
Mod	6	5, 7*	6	6	6	6, 7*	5	5, 7*	5, 7*	1
Private Space Type										
Mdn	5	5	6	6	5	7	6	6	5	2
Mod	5, 6*	5	6, 7*	7	7	7	5, 7*	7	3	2

*Multiple modes exist. All values are shown.

4.4. Descriptive Analysis of the SIS

The SIS assessed participants' situational interest in both space types. Tables 11 and 12 show the median (Mdn) and mode (Mod) scores for each SIS item during divergent and convergent tasks. During divergent tasks, the Mdn and Mod scores of the SIS items were higher in the open space than the private space. During convergent tasks, the Mdn and Mod scores of the SIS items were higher in the private space.

Reliability analysis of the overall SIS reported an alpha value of ($\alpha = 0.881$), indicating high reliability. A Cronbach's alpha (α) value between $0.70 < \alpha < 0.90$ denotes high internal consistency (Ekolu & Quainoo, 2019; Thigpen et al., 2017). Reliability analysis of the six subscales also reported high reliability. The alpha values were reported at 0.83, 0.82, 0.923, 0.86, 0.79, and 0.9, respectively.

Table 11. Analysis of the SIS during Divergent Tasks

Open Space Type												
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Mdn	5	4	2	4	4	3	4	4	5	2	4	5
Mod	5	5	2	4	4	3	5	4	5	2	4	5
	Q13	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**	**Q21**	**Q22**	**Q23**	**Q24**
Mdn	5	4	4	4	4	5	5	4	5	3	5	4
Mod	5	4	4	4	3, 4*	5	5	4	5	1, 4*	5	3, 5*
Private Space Type												
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Mdn	4	5	2	4	4	3	4	3	4	2	4	4
Mod	4	5	2	3, 4*	4	3	4	2, 4*	4	2	4	4, 5*
	Q13	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**	**Q21**	**Q22**	**Q23**	**Q24**
Mdn	5	3	3	3	4	4	4	4	4	2	4	4
Mod	5	2, 3*	3	3	4	4	4	4	4	2	4	4

*Multiple modes exist. All values are shown.

Table 12. Analysis of the SIS during Convergent Tasks

Open Space Type												
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Mdn	4	3	2	4	4	2	3	4	4	2	4	4
Mod	4	5	2	4, 5*	4	2, 3*	3	4	4	2	4	4
	Q13	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**	**Q21**	**Q22**	**Q23**	**Q24**
Mdn	5	4	3	4	4	4	5	4	3	2	4	4
Mod	5	4	3	3, 5*	5	4, 5*	5	4	2	2	4	4
Private Space Type												
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Mdn	5	4	3	4	4	3	4	4	5	3	4	4
Mod	5	4	4	5	5	4	5	4	5	2, 4*	5	4, 5*
	Q13	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**	**Q21**	**Q22**	**Q23**	**Q24**
Mdn	5	4	3	4	5	5	5	4	4	3	5	5
Mod	5	4	3	4	5	5	5	5	4	4	5	5

*Multiple modes exist. All values are shown.

4.5 Descriptive Analysis of the SUS-PQ

Participants rated their sense of presence in both space types using the SUS-PQ. Tables 13 and 14 show the median (Mdn) and mode (Mod) scores for each SUS-PQ item during divergent and convergent tasks. During divergent tasks, the Mdn and Mod scores of the SUS-PQ items were higher in the open space type. During convergent tasks, the Mdn and Mod scores were almost the same. Reliability analysis of the overall PQ scale revealed Cronbach's alpha score of 0.606, indicating moderate (acceptable) reliability and internal consistency.

Table 13. Analysis of the SUS-PQ during Divergent Tasks

Open Space Type						
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
Mdn	6	5	5	6	5	5
Mod	6, 7*	6	5	6	6	6
Private Space Type						
Mdn	5	5	4	5	5	4
Mod	3	4, 5, 7*	4	7	2, 5*	4, 6*

*Multiple modes exist. All values are shown.

Table 14. Analysis of the SUS-PQ during Convergent Tasks

Open Space Type						
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
Mdn	5	5	6	5	5	3
Mod	4, 5*	5	7	5, 6*	6	2, 5*
Private Space Type						
Mdn	5	5	4	5	3	4
Mod	7	5	2*	5	3	2, 4, 7*

*Multiple modes exist. All values are shown.

4.6 Analysis of the Space Types Influence on the Design Thinking Process

The independent sample t-test detected if a mean difference existed in the flow state, situational interest, and presence scores of participants between both space types. This study predicts that participants assigned to divergent tasks will experience higher flow state, situational interest, and presence scores in the open space type. Conversely, participants assigned to convergent tasks will experience higher flow state, situational interest, and presence scores in the private space type.

4.6.1 Analysis of the Space Types Influence on Flow State

Following each design thinking task, participants completed the Flow Short Scale (FSS) to evaluate their flow state. The FSS consists of 10 items rated on a 7-point Likert scale, where one denotes *(not at all)* and seven denotes *(very much)*. Two independent sample t-tests were conducted to compare participants' average FSS scores in both space types, once during divergent thinking tasks and another during convergent thinking tasks.

T-Test of the FSS during Divergent Tasks. The independent sample t-test results revealed a significant difference in the flow state of participants in both space types, (t (27) = 3.15, p = 0.004), with equal variances assumed. During divergent thinking tasks, participants in the open space reported a higher flow state (M = 5.47, SD = 0.66) than in the private space (M = 4.74, SD = 0.57) as seen in Table 15. The Mdn and Mod scores of participants average FSS scores were a "6" in the open space and a "5' in the private space (see Appendix L).

Table 15. Independent Samples T-Test of FSS during Divergent Tasks

FSS during Divergent Tasks						
Space Type	***N=29***	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	15	5.47	.66	3.15	27	**0.004**
Private	14	4.74	.57			

Participants' responses to the FSS subscales were also compared using an independent samples t-test. The "absorption by activity" subscale consists of items 1, 3, 6, and 10. The "fluency of performance" subscale consists of items 2, 4, 6, 7, 8, and 9. The t-test results indicate a significant difference in the "absorption by activity" (t (27) = 3.01, p = 0.006) and "fluency of performance," (t (27) = 3.15, p = 0.024) of participants in both space types, with equal variances assumed. During divergent tasks, participants reported higher "absorption by activity" and "fluency of performance" in the open space than in the private space (see Table 16).

Table 16. Independent Samples T-Test of FSS Subscales during Divergent Tasks

Absorption by Activity (Items 1, 3, 6, 10)					
Space Type	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	5.56	.67	3.01	27	**0.006**
Private	4.78	.72			
Fluency of Performance (Items 2 ,4 ,6, 7, 8, 9)					
Space Type	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	5.41	.84	3.15	27	**0.024**
Private	4.71	.70			

T-Test of the FSS during Convergent Tasks. The independent samples t-test results revealed no significant difference in the flow state of participants in both spaces (t (28) = -0.09, p = 0.092) with equal variances assumed. During convergent tasks, participants in the open space type reported a medium flow state (M = 5.16, SD = 0.62), almost equal to participants in the private space type (M = 5.18, SD = 0.87) as seen in Table 17. The median and mode scores were a "5" in both space types. This indicates that during convergent tasks, participants experienced a high flow state in both spaces (see Appendix M).

Table 17. Independent Samples T-Test of FSS during Convergent Tasks

FSS during Convergent Tasks						
Space Type	***N=30***	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	15	5.16	.62	-0.096	28	**0.092**
Private	15	5.18	.87			

T-test results of the FSS subscale items also indicate no significant difference in the "absorption by activity" (t (28) = -0.326, p = 0.746), with equal variances assumed, and "fluency of performance" (t (23.9) = 0.068, p = 0.946), with equal variances not assumed (see Table 18). However, we can observe a slight difference in the mean scores of the absorption by activity subscale average responses. Participants were absorbed by the activity slightly higher in the private space type than in the open space type.

Table 18. Independent Samples T-Test of FSS Subscales during Convergent Tasks

Absorption by Activity (Items 1, 3, 6, 10)					
Space Type	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	4.76	.863	-0.326	28	**0.746**
Private	4.86	.817			
Fluency of Performance (Items 2 ,4 ,6, 7, 8, 9)					
Space Type	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	5.42	.681	0.068	23.9	**0.946**
Private	5.40	1.05			

4.6.2 Analysis of the Space Types Influence on Situational Interest

Following each design thinking task, participants also completed the Situational Interest Scale (SIS) to evaluate their situational interest. The SIS consists of 24 items rated on a 5-point Likert scale, where one denotes *(strongly disagree)* and five denotes *(strongly agree)*. Two independent sample t-tests were conducted to compare participants' average SIS scores in both space types, once during divergent thinking tasks and another during convergent thinking tasks.

T-Test of the SIS during Divergent Tasks. The independent samples t-test results revealed a significant difference in the situational interest of participants in both space types (t (27) = 2.36, p = 0.026), with equal variances assumed. During divergent thinking tasks,

participants in the open space reported a higher situational interest ($M = 3.96$, $SD = 0.432$) than participants in the private space ($M = 3.48$, $SD = 0.656$) as seen in Table 19. The median and mode scores for participants' average SIS responses were a "4" on a 5-point Likert scale, where 5 is *strongly agree*. This indicates that participants experienced high situational interest while performing divergent tasks in both space types (see Appendix N).

Table 19. Independent Samples T-Test of SIS during Divergent Tasks

SIS during Divergent Tasks						
Space Type	***N=29***	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	15	3.96	.432	2.36	27	**0.026**
Private	14	3.48	.656			

In addition, the t-test results of the six SIS subscales (see Table 20) indicate a significant difference in instant enjoyment (items 1, 11, 12, 15, 23) and total interest (items 9, 13, 18, 19) of participants in both space types during divergent tasks, with equal variances not assumed. Participants reported higher instant enjoyment and total interest scores in the open space type than in the private space type.

Table 20. Independent Samples T-Test of SIS Subscales during Divergent Tasks

Exploration Intention Items (5, 8, 10, 14)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.80	.813	2.092	18.856	**0.050**
Private	3.85	.934			
Instant Enjoyment Items (1, 11, 12, 15, 23)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.88	.679	3.466	18.740	**0.003**
Private	4.18	.462			

Table 20. (Cont'd)

Attention Quality Items (4, 16, 17, 24)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.95	.973	.619	27	**0.541**
Private	4.38	.573			
Challenge Items (3, 6, 10, 22)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	2.23	.644	.067	27	**0.947**
Private	3.01	.837			
Novelty Items (2, 7, 21)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.28	1.006	.800	27	**0.431**
Private	3.82	.907			
Total Interest Items (9, 13, 18, 19)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	4.35	.618	2.336	15.177	**0.034**
Private	4.53	.581			

T-Test of the SIS during Convergent Tasks. The independent samples t-test results revealed a significant difference in the situational interest of participants in both space types (t (28) = -2.598, p = 0.015), equal variances assumed. During convergent tasks, participants in the private space reported a higher situational interest (M = 3.98, SD = 0.333) than participants in the open space (M = 3.60, SD = 0.443) as seen in Table 21. The median (Mdn) and mode (Mo) scores were a "4" on a 5-point Likert scale, where 5 is *strongly agree*. This indicates that participants reported high situational interest while performing convergent tasks in both space types (see Appendix O).

Table 21. Independent Samples T-Test of SIS during Convergent Tasks

SIS during Convergent Tasks						
Space Type	***N=30***	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	15	3.60	0.44	-2.598	28	**0.015**
Private	15	3.98	0.33			

T-test results of the six SIS subscales (see Table 22) indicate a significant difference only in the challenge scores of participants in both space types (t (28) = -2.873, p = 0.008), with equal variances assumed. While performing convergent tasks, participants reported a higher challenge score (M = 3.01, SD = 0.837) in the private space than in the open space (M = 2.23, SD = 0.644).

Table 22. Independent Samples T-Test of SIS Subscales during Convergent Tasks

Exploration Intention Items (5, 8, 10, 14)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.80	.813	-0.156	28	**0.877**
Private	3.85	.934			
Instant Enjoyment Items (1, 11, 12, 15, 23)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.88	.679	-1.445	28	**0.160**
Private	4.18	.462			
Attention Quality Items (4, 16, 17, 24)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.95	.973	-1.485	22.6	**0.151**
Private	4.38	.573			
Challenge Items (3, 6, 10, 22)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	2.23	.644	-2.873	28	**0.008**
Private	3.01	.837			

Table 22. (Cont'd)

Novelty Items (2, 7, 21)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	3.28	1.006	-1.524	28	**0.139**
Private	3.82	.907			
Total Interest Items (9, 13, 18, 19)					
Space Type	*Mean*	*SD*	*t*	*df*	*Sig. (2-tailed)*
Open	4.35	.618	-0.837	28	**0.410**
Private	4.53	.581			

4.6.3 Analysis of the Space Types Influence on Presence

The 6-item SUS presence questionnaire (PQ) assessed presence in both space types. The items were rated on a 7-point Likert scale, where 7 denotes the highest sense of presence. Each PQ item has a different label for "1" and "7". Figures 8 and 9 show the frequency distribution of responses by space type. An overall presence score was first computed for each participant by averaging their responses to compare the sense of presence experienced by participants in both space types. Then, an independent samples t-test was conducted separately for the average presence scores of participants during divergent and convergent tasks.

T-Test of the SUS-PQ during Divergent Tasks. The t-test results indicate a significant difference in the presence experienced by participants in both space types (t (27) = 2.43, p = 0.022), with equal variances assumed. During divergent tasks, participants in the open space reported a higher sense of presence (M = 5.11, SD = 0.662) than participants in the private space (M = 4.27, SD = 1.14) as seen in Table 23. The median and mode scores were a "5" in the open space type and a "4" in the private space type. A score of "7" represents the highest sense of presence. This indicates that during divergent tasks, participants reported a higher presence in the open space than in the private space (see Appendix P).

Table 23. Independent Samples T-Test of SUS-PQ during Divergent Tasks

PQ during Divergent Tasks						
Space Type	***N=29***	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	15	5.11	.662	2.43	27	**0.022**
Private	14	4.27	1.14			

T-Test of the SUS-PQ during Convergent Tasks. The t-test results indicate no significant difference in the sense of presence experienced by participants in both space types (t (28) = -0.115, p = 0.909), with equal variances assumed. During convergent tasks, participants reported a medium sense of presence in the open (M = 4.43, SD = 1.19) and private (M = 4.47, SD = 0.90) space types as seen in Table 24. The median and mode scores were a "5" in both space types, also indicating a medium sense of presence (see Appendix Q).

Table 24. Independent Samples T-Test of SUS-PQ during Convergent Tasks

PQ during Convergent Tasks						
Space Type	***N=30***	***Mean***	***SD***	***t***	***df***	***Sig. (2-tailed)***
Open	15	4.43	1.19	-0.11	28	**0.909**
Private	15	4.47	0.90			

4.7 Correlation Analysis between Measures of Engagement

Spearman's rho correlation test (r) was conducted between the average scores of flow state, situational interest, and presence (see Table 25). Correlation test results indicate a significant positive correlation (r = 0.401, p = 0.002) between flow state and presence. In addition, correlation test results indicate a significant positive correlation between situational interest and flow state (r = 0.338, p = 0.009) and a non-significant positive correlation between presence and situational interest (r = 0.063, p = 0.633).

Table 25. Correlation Analysis

Spearman's Rho Correlation				
		Situational Interest	**Flow State**	**Presence**
Situational Interest	*Correlation Coefficient*	1.000	0.338**	0.063
	Sig. (2-tailed)	.	0.009	0.633
	N	59	59	59
Flow State	*Correlation Coefficient*	0.338**	1.000	0.401**
	Sig. (2-tailed)	0.009	.	0.002
	N	59	59	59
Presence	*Correlation Coefficient*	0.063	0.401**	1.000
	Sig. (2-tailed)	0.633	0.002	.
	N	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

CHAPTER V

DISCUSSION

This study is the first to experimentally investigate how certain space types, namely open and private space types, affect engagement in tasks related to the creative design thinking process, namely divergent and convergent thinking. The measures of engagement used in this study were flow state, situational interest, and presence. Based on the literature, all three measures were predictors of engagement and that higher scores in them indicated higher levels of engagement. Elaborating on existing organizational psychology research, this study contributes to understanding the direct role of spatial types on individual design thinking process.

The creative process of design thinking, which includes recurring divergent and convergent thinking phases, gained attention in innovation management, engineering, and design fields since it was suggested that applying it promotes innovation and creativity. Based on this, more empirical findings were required to understand what space types in organizations would support the divergent and convergent thinking phases of the design thinking process. Thus, this study experimentally compared measures of engagement between the open and the private space types during divergent and convergent thinking tasks.

The study findings revealed that during divergent thinking tasks, flow state, situational interest, and presence were significantly higher in the open space type than in the private space type. During convergent thinking tasks, only situational interest scores were significantly higher in the private space than the open space. However, flow state and

presence scores were not different between the open and private space type during convergent thinking tasks. This study addresses a significant gap and gives new insights to managers in innovative management, business, and engineering organizations on the effect of physical spaces in encouraging creativity through design thinking.

In addition, the findings of this study extend significant theoretical contributions to the understanding of the physical environment and task requirements on creative behavior (Woodman et al., 1993), introduce original approaches to studying creative design thinking processes through measures of engagement, and provide practical contributions to understanding the role of physical spaces on the creative process of design thinking to facilitate individual creativity. The following section discusses the hypotheses with their relation to the literature.

5.1 Discussion on the Space Type Influence on the Measures of Engagement During Divergent Tasks

This study compared the flow state, situational interest, and presence in the open versus private space types during divergent thinking tasks. The first research question investigates how the measures of engagement during divergent thinking tasks differ in the open and private space types (**RQ_1:** What is the difference in flow state, situational interest, and presence during divergent thinking tasks in open versus private spaces?). The independent sample t-test results and their relation to the hypotheses are discussed below.

5.1.1 Space Types Influence on Flow State During Divergent Tasks

The t-test results revealed a significant difference in participants' flow state between the open and private space types. During divergent thinking tasks, participants experienced a significantly higher flow state in the open space type compared to the private space type. These results support $H_{1A,}$ which states (**H_{1A}:** During divergent thinking tasks, *flow state* is higher in the open than in private space type).

This study empirically proved that the open space type promotes a flow state during divergent thinking tasks. The results are similar to Soriano et al.'s (2021) findings that the

nature of the task and the workspace design can influence flow state. However, the age range of participants in Soriano et al.'s (2021) study was between 20 to 62 years old with an average of (M = 39.67, SD = 8.84) which is different than the average age of this study. Furthermore, their study was conducted in a real office environment and did not specify the profession of participants (whether they are design or non-design employees). Then we cannot completely validate the consistency with Soriano et al.'s (2021) findings.

Similarly, the results of this study agree with Pitchforth et al.'s (2020) claims that open-plan workspaces positively induce flow state. Yet, the age range of participants in Pitchforth et al.'s (2020) study was between 22–59 years old with an average age of 32. The profession of the employees was not specified as design and non-design based. So, we cannot completely agree that the findings of this study are consistent with Pitchforth et al.'s (2020). Perhaps if the methodology of this study was adapted with the same age range of participants in Pitchforth et al.'s (2020) and Soriano et al.'s (2021) studies, then we can validate the consistency.

The results of this study contradict the findings of Zhou et al. (2020), indicating that there was no significant difference in the creative flow of the student groups performing idea generation task in the common (open) versus private (enclosed) meeting room. The age range of participants in Zhou et al.'s, (2020) study was between 21 to 37 years (M = 25.25, SD = 3.92), which is similar to the mean age of participants in this study. The participants of their study were graduate level mechanical engineering design students. The age range and the profession of participants are very similar to that of this study.

Then a potential reason for the inconsistency with Zhou et al.'s (2020) findings is that they explored team creative flow, whereas this study focused on individual flow states. This reason is supported by Haner's (2005) discussion in which different space types should be designed to promote divergent and convergent thinking for individual and collaborative work. In addition, all the previous three studies focused on the spatial types influence on flow state without taking the tangible and intangible elements into consideration.

5.1.2 Space Types Influence on Situational Interest During Divergent Tasks

The t-test results revealed a significant difference in participants' situational interest between the open and private space types. During divergent thinking tasks, participants experienced a significantly higher situational interest in the open space type than the private space type. These results support hypothesis 1B, which states (**H_{1B}:** During divergent thinking tasks, *situational interest* is higher in the open than in private space type).

This study notably found that situational interest during divergent thinking tasks is induced in the open space type. No previous empirical studies investigated the role of space types on situational interest during divergent thinking tasks. However, since attention quality is one of the situational interest constructs, the study's findings contradict previous studies' claims (Block & Stokes, 1989; Lottrup et al., 2013), indicating that spatial layouts do not significantly affect attention quality and cognitive performance.

However, the sample characteristics of this study and that of Lottrup et al.'s (2013) are completely different. In Lottrup et al.'s (2013) study, the age range was between 21 to 64 years with a mean age 43 years. Perhaps if the same approach used in this study was repeated with the age range of participants similar to Lottrup et al.'s (2013) study, then we can achieve different situational interest scores. This is not the case with Block and Stokes's (1989) study, where the age range was between 18 to 22 years, which is similar with the age range of participants in this study.

5.1.3 Space Types Influence on Presence During Divergent Tasks

The t-test results revealed a significant difference in participants' sense of presence between the open and private space types. During divergent thinking tasks, participants experienced a significantly higher presence in the open space type compared to the private space type. These results support hypothesis 1C which states (**H_{1C}:** During divergent thinking tasks, *presence* is higher in the open than in private space type).

Based on this study's conceptual framework, presence is a positive measure of engagement. The results indicate that in the open space, participants experienced a higher presence and engagement during divergent thinking tasks than participants in the private space. In addition to the independent samples t-test results, participants in both spaces responded to the last two open-ended questions of the SUS-PQ. The first question, "What things helped to give you a sense of really being in the assigned space" and the second question, "What things acted to pull you out of the assigned space?" asked participants to comment further on their experience.

Among the things that made participants feel a sense of really 'being' in the open space were the tangible elements of the space including the comfortable design of the tables and seats and the natural decorations in the space. Intangible elements such as the background noise of people talking or passing by have also helped them gain a sense of presence. Participants also frequently mentioned that they found the open space ideal for completing divergent thinking tasks. These comments along with the independent sample t-test results are consistent with previous empirical studies claiming that a higher sense of presence in an assigned space indicates a greater task ability (Khenak et al., 2020; Usoh et al., 2000).

However, responses to the second question regarding the open space were contradictory. A few were "pulled out" due to the noise of people talking or passing by, while the majority reported otherwise. The majority found themselves so engaged and focused on the tasks that they disregarded the sounds of people talking or passing by. A potential reason for these mixed comments could be the degree of noise experienced by both groups along with the number of other people present. Participants at different times were surrounded by 10 to 15 people and sometimes less. Thoring et al.'s (2021) suggestions support this reason that moderate sound levels in an open space might be ideal to induce divergent thinking. However, loud noises exceeding the moderate level could become distracting and inhibit creativity (Meinel et al., 2017; Thoring et al., 2020, 2021).

Among the things that made participants feel a sense of being in the private space were the intangible elements such as natural light from the windows and tangible elements

such as the view of a changing environment, the indoor acoustic panels, and the workspace table. McCoy and Evans (2002) suggested that viewing nature enhances creativity. In addition, several authors suggested the positive influence of natural light from windows to promote creativity (Ceylan et al., 2008; Dul et al., 2011; Dul & Ceylan, 2011, 2014). Thoring et al. (2021) elaborates that viewing nature along with the natural light from windows is more conducive to divergent thinking, thus supporting participants' comments about what things gave them a sense of being in private space.

Participants felt "pulled out" from the private space when they had to brainstorm. Otherwise, they were fully immersed in the divergent thinking tasks and reported that nothing else pulled them out. Although comments regarding the private space are also positive, the t-test results of the SUS-PQ indicate otherwise.

The findings indicated that presence, flow state and situational interest are positive measures of engagement in this study. Thus, higher flow state, situational interest, and presence scores indicate a greater ability to engage in a task. The t-test results for all three measures revealed that participants were more engaged in the open space type than in the private space while performing creative divergent thinking tasks. These results validate Thoring et al.'s (2021) suggestions that open and stimulating spaces are more conducive to divergent thinking. The findings are also consistent with Haner's (2005) claims that divergent thinking activities are induced in the "action zone", or the spatially most open zone in the organization.

Other factors could have influenced the results of this study such as participants' familiarity with the space as well as the age group. Non-design-based participants were familiar with the open space type since it was located at the science building of the university campus. However, most of the design-based students were completely unfamiliar with the open-space type. Perhaps if the non-design-based participants were also unfamiliar with the open space, the results could be otherwise. Another factor is the age group. Since the age range of participants was between 19 to 30 years, perhaps separating the results of undergraduate and graduate students within this age range might reveal different results.

5.2 Discussion of the Space Type Influence on the Measures of Engagement During Convergent Tasks

The second research question investigates how the measures of engagement during convergent thinking tasks differ in the open and private space types (**RQ_2:** What is the difference in flow state, situational interest, and presence during convergent thinking tasks in open versus private spaces?). The independent sample t-test results and their relation to the hypotheses are discussed below.

5.2.1 Space Type Influence on Flow State During Convergent Tasks

The t-test results revealed no significant difference in participants' flow state between the open and private space types. During convergent thinking tasks, participants experienced a medium flow state in the open space and the private space. These results reject $H_{2A,}$ which states (**H_{2A}:** During convergent thinking tasks, *flow state* is higher in the private than in the open space type).

Compared to Soriano et al.'s (2021) findings, flow state was not affected by the type of space. These results also contradict with Csikszentimihalyi's (1996) suggestions that a private space characterized by a lack of textures and noise might facilitate flow more than a highly stimulated space. Similarly, these results do not support Thoring et al.'s (2021) suggestions that creative flow might be induced in private booths or rooms during convergent thinking.

A potential explanation for the indifference in the flow state means scores could be due to the individual thinking styles of participants. Based on the demographic analysis, 32 participants were convergent thinkers, and 26 were divergent thinkers. Perhaps the nature of the convergent thinking tasks fit participants' thinking styles in both space types, leading to indifference in the flow state. Future studies can relate participants' flow state scores with their thinking styles.

Furthermore, the t-test results of the FSS sub-scales indicate a non-significant difference in the "absorption by activity" scores between the open and private space types. Participants in the private space were slightly more absorbed by the convergent thinking

tasks than participants in the open space. Thus, we can moderately validate that the private space type is ideal for flow state during convergent thinking tasks.

5.2.2 Space Type Influence on Situational Interest During Convergent Tasks

The t-test results revealed a significant difference in participants' situational interest between the open and private space types. During convergent thinking tasks, participants experienced a significantly higher situational interest in the private space type than the open space type. These results support H_{2B} (**H_{2B}:** During convergent thinking tasks, *situational interest* is higher in the private than in the open space type).

Less research related situational interest to physical workspaces. However, in previous studies, situational interest constructs such as attention quality have been related to spatial office layouts (Liu et al., 2023). Two earlier studies found that attention quality and cognitive performance cannot be significantly affected by the office space type or layout (Block & Stokes, 1989; Lottrup et al., 2013). The current study results contradict these previous findings and notably prove that situational interest is significantly promoted in the private space type during convergent thinking tasks.

A more recent study by Jahncke and Hallman (2020) investigated the role of quiet work zones and open active zones on performance during a cognitive task. Their cognitive task requires convergent thinking, focused attention, and deep concentration. They found that employees' performance, focused attention, and concentration levels were higher in the quiet zone than the active zone. Attention demand and concentration are situational interest constructs. Thus, Jahncke and Hallman (2020)'s findings are consistent with this study's results revealing that situational interest is more induced in the private space type than in the open space.

5.2.3 Space Type Influence on Presence During Convergent Tasks

The t-test results revealed no significant difference in participants' sense of presence between the open and private space types. During convergent thinking tasks, participants experienced a medium sense of presence in the open space and the private space. These

results reject H_{2C} (**H_{2C}:** During convergent thinking tasks, *presence* is higher in the private than in the open space type).

A possible reason for the mean indifference in the presence scores is the nature of convergent thinking tasks. As a response to the second SUS-PQ open-ended question, "What things pulled you out of the assigned space?", participants in both space types commonly reported that the task was "complex and challenging", and they were "struggling to complete the tasks" that they were "too engrossed to finish the assignment and ignored the surroundings". This finding could also explain why both space types' average flow state scores during convergent thinking tasks were indifferent.

Further comments about the things that made participants "pulled out" of the open space type included "I was thinking about my upcoming exams and deadlines", "the noise of other students conversing about the exams", "I was wandering about what should I plan on eating after this", "noise from vending machines and people passing by" indicating that participants were distracted by the intangible elements such as the surrounding noise. These comments support Newport's (2016) propositions that a private and undistracted environment is ideal for convergent thinking tasks. However, besides the tasks being challenging, comments about the private space were that nothing pulled them out of the space, and the "silence" or the "quiet room" helped them focus on the tasks at hand.

Among the things that gave participants the sense of being in the open space during convergent thinking tasks were the tangible elements such as the plants, natural decoration, the fountain and intangible elements such as the lighting and the sound from people talking nearby. Others commented that viewing other people working gave them a sense of being in space. In the private space type, participants commented that the tangible elements such as the acoustic panels in the room, the natural view from windows, and intangible elements such as the natural daylight gave them the sense of being in space. These comments are very similar to participants' comments to the SUS-PQ during divergent thinking tasks.

Previous studies compared the presence between virtual versus real environments, where the real environment is the baseline (Khenak et al., 2020). However, this study is one of

the first few to compare presence between two real space types and their influence on convergent thinking tasks. The t-test results and participants' comments to the SUS-PQ open-ended questions are consistent with previous findings that indicate that the sense of presence in a certain environment is positively related to the cognitive performance in a task (Cooper et al., 2018; Khenak et al., 2020; Stevens & Kincaid, 2015). Thus, participants' comments on the convergent thinking tasks being "difficult, challenging, or too demanding" can explain a medium sense of presence in both space types.

The findings indicated that during convergent thinking tasks, participants experienced higher situational interest in the private space than in the open space. Flow state and presence were the same in both space types. As reported by participants, a potential reason for the mean indifference in the flow state and presence is the difficult nature of the convergent thinking tasks.

The findings reject Thoring et al.'s (2021) suggestions that an undistracted environment characterized by booths, partitions, or private rooms is more conducive to the creative convergent thinking process. The results are also inconsistent with Newport (2016) propositions that deep-focused convergent thinking work is induced more in private and secluded areas. However, the findings might be influenced by the degree of participants' familiarity with the space types. If all design-based and non-design-based participants are unfamiliar with both spaces, perhaps the t-test results could reveal different values.

5.3 Discussion on the Correlation between the Measures of Engagement

This study conducted a correlation test between flow state, situational interest, and presence in the open and private space types during divergent and convergent thinking tasks. Flow state, situational interest, and presence are the positive engagement measures in this study. The third research question inquires the correlation between the engagement measures. (**RQ_3:** Is there a correlation between flow state, situational interest, and presence during divergent and convergent thinking tasks?).

Correlation test results indicate a significant positive correlation between flow state and situational interest. Thus, the hypothesis (**H_{3A}**: There is a significant positive correlation

between flow state and situational interest) is supported. Recent studies examined how physical spaces influence the flow state. However, no empirical studies investigated how physical spaces influence situational interest. In educational game research, flow state and situational interest are considered positive engagement constructs. Although flow state and situational interest are predictors of creative performance, no previous study explored the correlation between flow state and situational interest during divergent and convergent thinking tasks.

In addition, correlation test results between flow state and presence indicate a significant positive correlation. Thus, the hypothesis (**H_{3B}:** There is a significant positive correlation between flow state and presence) is supported. Previous studies found a positive relation between flow state and creative performance (Stollberger & Debus, 2019; Thomson & Jaque, 2023; Weintraub et al., 2021), flow state and innovative behavior (Peng et al., 2024), and presence and cognitive performance (Khenak et. al, 2020). Additionally, the flow state was affected by presence during immersive storytelling (Yang & Zhang, 2022) and computer games (Weibel & Wissmath, 2011). However, no previous studies explored the relationship between flow state and presence during divergent and convergent thinking tasks.

Lastly, correlation test results between situational interest and presence indicated a non-significant positive correlation between presence and situational interest. Thus, the hypothesis (**H_{3C}:** There is a significant positive correlation between presence and situational interest), is partially supported. This study is the first to explore the relationship between presence and situational interest during divergent and convergent thinking tasks. Table 26 lists the findings and hypotheses of this study.

Table 26. Hypotheses and Findings of the Study

Hypotheses	***Results***	***Conclusion***	***Consistent With***	***Inconsistent With***
H_{1A}: *During divergent thinking tasks,* ***flow state*** *is higher in the open than in private space type.*	t (27) = 3.15 p = 0.004	Hypothesis is supported.	–	Zhou et al., 2020
H_{1B}: *During divergent thinking tasks,* ***situational interest*** *is higher in the open than in private space type.*	t (27) = 2.36 p = 0.026	Hypothesis is supported.	–	Block and Stokes, 1989
H_{1C}: *During divergent thinking tasks,* ***presence*** *is higher in the open than in private space.*	t (27) = 2.43 p = 0.022	Hypothesis is supported.	Khenak et al., 2020	–
H_{2A}: *During convergent thinking tasks,* ***flow state*** *is higher in the private than in the open space.*	t (28) = -0.09 p = 0.092	Hypothesis is not supported.	–	Soriano et al., 2021
H_{2B}: *During convergent thinking tasks,* ***situational interest*** *is higher in the private than in the open space.*	t (28) = -2.59 p = 0.015	Hypothesis is supported.	Jahncke and Hallman, 2020	–
H_{2C}: *During convergent thinking tasks,* ***presence*** *is higher in the private than in the open space.*	t (27) = 2.43 p = 0.909	Hypothesis is not supported.	–	–
H_{3A}*: There is a significant positive correlation between flow state and situational interest.*	r = 0.401 p = 0.002	Hypothesis is supported.	–	–
H_{3B}: *There is a significant positive correlation between flow state and presence.*	r = 0.338 p = 0.009	Hypothesis is supported.	Yang and Zhang, 2022	–
H_{3C}: *There is a significant positive correlation between presence and situational interest.*	r = 0.063 p = 0.633	Hypothesis is partially supported.	–	–

CHAPTER VI

CONCLUSION

The work of the present study notably clarifies the direct impact of private and open space types on the creative design thinking process, namely convergent and divergent thinking through engagement measures. Previous studies investigated the role of environmental stimuli such as lighting, nature, colors, and acoustics on the creative process related to design thinking practice (Lee & Lee, 2023). Only one study investigated the role of a private meeting room and open common spaces on group creative flow in a divergent thinking task (Zhou et. al., 2020). By adopting the interactionist model of organizational creativity by Woodman et al. (1993), this study investigated how physical space types influence the individual design thinking process rather than a group.

In addition, the study addresses a significant gap in the literature highlighted by Elsbach and Stigliani (2018), Lee and Lee (2023), and Thoring et al. (2021) that more attention is required in understanding the direct effect of physical space types on the creative design thinking process. Since the design thinking approach was identified as the predictor of innovation, it gained significant attention in design, management, engineering, and business organizations. However, empirical validation on the role of physical space types inducing the creative design thinking process needs to be improved (Elsbach & Stigliani, 2018).

Based on the literature gap, this study articulated the research questions and tested the hypotheses through a controlled experiment. Independent sample t-test compared the

mean flow state, situational interest, and presence scores between the private and open space types during convergent and divergent thinking tasks. Correlation analysis tested the relationship between flow state, presence, and situational interest during convergent and divergent thinking tasks.

The main study findings reveal that the physical space types can affect the positive measures of engagement, flow state, situational interest, and presence. Second, the measures of engagement during divergent thinking tasks were all significantly higher in the open space type compared to the private space type. Only situational interest during convergent thinking tasks was significantly higher in the private space type. The presence and flow state during convergent thinking tasks were not significantly different in both space types. Third, the study found a significant positive correlation between flow state and situational interest as well as flow state and presence during convergent and divergent thinking tasks. Presence and situational interest were non-significantly and positively correlated during divergent and convergent thinking tasks.

Results of this study supported the hypotheses and validated Thoring et al.'s (2021) proposition that spatially open space types are more conducive to divergent thinking. However, the results do not support the hypotheses of the second research question and reject Thoring et al.'s (2021) proposition that spatially private space types are more conducive to convergent thinking. The results of this study provide new insights for designers, architects, and managers in business, management, and engineering organizations. Architects and planners can adopt and consider the findings of this study when designing creative workspaces intended for the creative design thinking approach. The results will also be of relevance to design practitioners by giving them insights on which appropriate space types support phases of the creative design thinking process and inspire them to perform creatively at optimal levels.

6.1 Study Limitations

The work presented in this study has a few limitations. First, the physical spaces of the controlled experiment were at a university campus, simulating spaces in a real office environment. Second, the study investigated the role of physical spaces on the cognitive

components of the design thinking process. Third, all engagement measures were assessed using self-report data. Fourth, the small number of as well as the sample characteristics of participants in this study posed a limitation.

Participants were undergraduate and graduate university students at Bilkent University where some of them were familiar with the space types. Non-design students were completely unfamiliar with the private space type. However, design students, especially graduate architecture and interior architecture students were familiar with the private space type. Similarly, the non-design students were familiar with the open space type at the university campus, while only a few of the design students were familiar with the open space type.

Additionally, results of the engagement measures in the open space type could have been different if the number of people present were controlled. For example, a participant's results in the open space type with only 6 people present could be different from the results of a participant with 12 people around. Perhaps controlling the number of participants present could affect the results in the open space type. If no other person was present in the open space type, the results could possibly be similar to that of the private space type.

Furthermore, the difference in age (between 19 to 30 years) and education levels of participants (undergraduate and graduate students) posed a limitation in this study. Perhaps separating the results and scores of undergraduate students and graduate students could give new insights on how spatial types affect their creative design thinking processes.

6.2 Suggestions for Future Directions

Based on the findings of this study and its limitations, several suggestions can be made. First, future research can investigate the role of spatial types on the design thinking process in a real office environment. Alternatively, future research can render spaces simulating a real office environment and view them through immersive virtual reality equipment. Second, future research can investigate the direct influence of physical spaces

on the non-linear steps of the creative design thinking process. Third, new methods can adopt physiological data and neuroscientific techniques in assessing flow state, situational interest, and presence during divergent and convergent thinking tasks in a specific context. Fourth, future research could include a greater and equal number of design and non-design-based participants and compare the influence of space types on their engagement measures during divergent and convergent thinking tasks.

This study explored the effects of physical space types on the individual creative design thinking process. Future research can investigate the direct influence of physical space types on the team's creative design thinking process using controlled experiments or by adopting the daily diary method. This approach will give new insights into how individuals collectively perform design thinking activities and how these activities are influenced by physical space types (Thoring et al, 2021). Haner (2005) signified the importance of having space types designated for individual and team efforts in divergent and convergent thinking activities. However, empirical studies have yet to pay attention to how team creative performance is influenced by spatial types (Lee & Lee, 2023).

Furthermore, this study investigated each participant's thinking styles by identifying whether they were divergent thinkers, convergent thinkers, or combination thinkers. These individual differences would benefit future studies in understanding whether open and private space types fit the skills or preferences of divergent, convergent, or combination thinkers. Brophy (2001) related the thinking styles of individuals inclined to divergent or convergent thinking to their performance in creative problem-solving tasks. Future research can investigate the relation of creative design thinking performance to individuals' thinking styles.

In addition, flow state, situational interest, and presence were previously investigated separately as positive measures of engagement in other contexts. Recent studies began investigating the role of flow state and performance in work environments (Pitchforth et al., 2020; Soriano et al., 2021), presence and performance (Khenak et al., 2018, 2020), yet no previous studies investigated the role of situational interest and creative performance in organizational research. This study notably proved that spatial types and

task types can significantly influence all three measures of engagement. Thus, future research can measure the engagement levels of groups indulged in design thinking activities by assessing their flow state, situational interest, and presence.

This study contributes to innovative and organizational psychology research by filling an important gap in understanding how spatial types influence the creative design thinking process. However, more experimental research is required to comprehend the role of space types on individual and team creative design thinking processes while taking into consideration other tangible and intangible elements such as lighting, acoustics, colors, furniture, windows, vistas within the space types.

REFERENCES

Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology*, *94*(3), 545-561. https://doi.org/10.1037//0022-0663.94.3.545

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, *39*(5), 1154-1184. https://doi.org/10.5465/256995

Ann, K., & Hidi, S. E. (2019). Supporting the development of interest in the workplace. *Workforce Readiness and the Future of Work*, 17-34. https://doi.org/10.4324/9781351210485-2

Basadur, M., & Finkbeiner, C. T. (1985). Measuring preference for ideation in creative problem-solving training. *The Journal of Applied Behavioral Science*, *21*(1), 37-49. https://doi.org/10.1177/002188638502100104

Basadur, M., Graen, G. B., & Green, S. G. (1982). Training in creative problem solving: Effects on ideation and problem finding and solving in an industrial research organization. *Organizational Behavior and Human Performance*, *30*(1), 41-70. https://doi.org/10.1016/0030-5073(82)90233-1

Batey, M., Hughes, D. J., Crick, L., & Toader, A. (2020). Designing creative spaces: An experimental examination of the effect of a nature poster on divergent thinking. *Ergonomics*, *64*(1), 139-146. https://doi.org/10.1080/00140139.2020.1811398

Bi, H., Mi, S., Lu, S., & Hu, X. (2020). Meta-analysis of interventions and their effectiveness in students' scientific creativity. *Thinking Skills and Creativity*, *38*, 100750. https://doi.org/10.1016/j.tsc.2020.100750

Biddle, K. (2023). *Post Covid-19 Design for Flexible Workspaces* (Publication No. 30491285) [Master Thesis, The University of Arizona]. ProQuest Dissertations and Theses Global.

Block, L. K., & Stokes, G. S. (1989). Performance and satisfaction in private versus Nonprivate work settings. *Environment and Behavior*, *21*(3), 277-297. https://doi.org/10.1177/0013916589213003

Brophy, D. R. (2001). Comparing the attributes, activities, and performance of divergent, convergent, and combination thinkers. *Commemorating Guilford's 1950 Presidential Address*, 439-456. https://doi.org/10.4324/9781410608604-20

Brown, T. (2008). Design Thinking. *Harvard Business Review*, *86*(1), 84-92.

Brown, T. (2009). *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. Harper Collins.

Busch, M., Lorenz, M., Tscheligi, M., Hochleitner, C., & Schulz, T. (2014). Being there for real. *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*. https://doi.org/10.1145/2639189.2639224

Cahyanita, E., Sunardi, S., Yudianto, E., Aini, N. R., & Wijaya, H. T. (2021). The development of tangram-based geometry test to measure the creative thinking ability of junior high school students in solving two-dimensional figure problems. *Journal of Physics: Conference Series*, *1836*(1), 012051. https://doi.org/10.1088/1742-6596/1836/1/012051

Ceylan, C., Dul, J., & Aytac, S. (2008). Can the office environment stimulate a manager's creativity? *Human Factors and Ergonomics in Manufacturing & Service Industries*, *18*(6), 589-602. https://doi.org/10.1002/hfm.20128

Chafi, M. B., Harder, M., & Danielsson, C. B. (2020). Workspace preferences and non-preferences in activity-based flexible offices: Two case studies. *Applied Ergonomics*, *83*, 102971. https://doi.org/10.1016/j.apergo.2019.102971

Chan, J., & Nokes-Malach, T. J. (2016). Situative creativity: Larger physical spaces facilitate thinking of novel uses for everyday objects. *The Journal of Problem Solving*, *9*(1), 29-45. https://doi.org/10.7771/1932-6246.1184

Chaves, T. C., Da C. Filgueira, A. P., Picanco, K. K., S. de Araujo, J., Giuntini, F. T., & De S.Santos, F. (2022). Design process adoption: A survey in the Brazilian software industry. *2022 XVLIII Latin American Computer Conference (CLEI)*. https://doi.org/10.1109/clei56649.2022.9959961

Chen, A., Darst, P. W., & Pangrazi, R. P. (1999). What constitutes situational interest? Validating a construct in physical education. *Measurement in Physical Education and Exercise Science*, *3*(3), 157-180. https://doi.org/10.1207/s15327841mpee0303_3

Chi, N., Liao, H., & Chien, W. (2020). Having a creative day: A daily diary study of the interplay between daily activating moods and physical work environment on daily creativity. *The Journal of Creative Behavior*, *55*(3), 752-768. https://doi.org/10.1002/jocb.488

Cho, J. Y. (2012). Spatial ability, creativity, and studio performance in architectural design. *Proceedings of the 17th International Conference on Computer-Aided Architectural Design Research in Asia/Chennai, CAADRIA 2012*, *25*, 131-140. https://doi.org/10.52842/conf.caadria.2012.131

Cho, J. Y. (2017). An investigation of design studio performance in relation to creativity, spatial ability, and visual cognitive style. *Thinking Skills and Creativity*, *23*, 67-78. https://doi.org/10.1016/j.tsc.2016.11.006

Cho, J. Y., & Suh, J. (2019). Understanding spatial ability in interior design education: 2D–to–3D visualization proficiency as a predictor of design performance. *Journal of Interior Design*, *44*(3), 141-159. https://doi.org/10.1111/joid.12143

Cooper, N., Milella, F., Pinto, C., Cant, I., White, M., & Meyer, G. (2018). The effects of substitute multisensory feedback on task performance and the sense of presence in a virtual reality environment. *PLOS ONE*, *13*(2), e0191846. https://doi.org/10.1371/journal.pone.0191846

Cropley, A. (2006). In praise of convergent thinking. *Creativity Research Journal*, *18*(3), 391-404. https://doi.org/10.1207/s15326934crj1803_13

Crouch, C. H., Wisittanawat, P., Cai, M., & Renninger, K. A. (2018). Life science students' attitudes, interest, and performance in introductory physics for life sciences: An exploratory study. *Physical Review Physics Education Research*, *14*(1). https://doi.org/10.1103/physrevphyseducres.14.010111

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. Jossey-Bass.

Csikszentmihalyi, M. (1996). *Creativity: The Psychology of Discovery and Invention*. Harper Collins.

Curedale, R. (2019). *Design thinking process & methods* (5th ed.). Design Community College.

De Paoli, D., Sauer, E., & Ropo, A. (2019). The spatial context of organizations: A critique of 'creative workspaces.' *Journal of Management & Organization*, *25*(2), 331–352. https://doi.org/10.1017/jmo.2017.46

Deo, S., Blej, A., Kirjavainen, S., & Hölttä-Otto, K. (2021). Idea generation mechanisms: Comparing the influence of classification, combination, building on others, and stimulation mechanisms on ideation effectiveness. *Journal of Mechanical Design*, *143*(12), 121403. https://doi.org/10.1115/1.4051239

Domino, G. (1980). Chinese tangrams as a technique to assess creativity. *The Journal of Creative Behavior*, *14*(3), 204-213. https://doi.org/10.1002/j.2162-6057.1980.tb00244.x

Dul, J., & Ceylan, C. (2011). Work environments for employee creativity. *Ergonomics*, *54*(1), 12-20. https://doi.org/10.1080/00140139.2010.542833

Dul, J., & Ceylan, C. (2014). The impact of a creativity-supporting work environment on a firm's product innovation performance. *Journal of Product Innovation Management*, *31*(6), 1254-1267. https://doi.org/10.1111/jpim.12149

Dul, J., Ceylan, C., & Jaspers, F. (2011). Knowledge workers' creativity and the role of the physical work environment. *Human Resource Management*, *50*(6), 715-734. https://doi.org/10.1002/hrm.20454

Ekolu, S. O., & Quainoo, H. (2019). Reliability of assessments in engineering education using Cronbach's alpha, KR and split-half methods. *Global journal of engineering education*, *21*(1), 24-29.

Elsbach, K. D., & Stigliani, I. (2018). Design Thinking and Organizational Culture: A Review and Framework for Future Research. *Journal of Management*, *44*(6), 2274-2306. https://doi.org/10.1177/0149206317744252

Elsbach, K. D., & Stigliani, I. (2020). The Physical Work Environment and Creativity: How Creative Workspaces Support and Encourage Design Thinking. In *Organizational Behavior and the Physical Environment* (pp. 13-36). Routledge.

Engeser, S., & Rheinberg, F. (2008). Flow, performance and moderators of challenge-skill balance. *Motivation and Emotion*, *32*(3), 158-172. https://doi.org/10.1007/s11031-008-9102-4

Engeser, S., Schiepe-Tiska, A., & Peifer, C. (2021). Historical lines and an overview of current research on flow. In *Advances in Flow Research* (pp. 1–29). Springer International Publishing.

Finke, R. A. (1996). Imagery, creativity, and emergent structure. *Consciousness and Cognition*, *5*(3), 381-393. https://doi.org/10.1006/ccog.1996.0024

Fullagar, C. J., & Kelloway, E. K. (2009). Flow at work: An experience sampling approach. *Journal of Occupational and Organizational Psychology*, *82*(3), 595-615. https://doi.org/10.1348/096317908x357903

Guilford, J. P. (1950). Creativity. *American Psychologist*, *5*(9), 444-454. https://doi.org/10.1037/h0063487

Haner, U. (2005). Spaces for Creativity and Innovation in Two Established Organizations. *Creativity and Innovation Management*, *14*(3), 288-298. https://doi.org/10.1111/j.1476-8691.2005.00347.x

He, W., Yan, J., Wang, C., Liao, L., & Hu, X. (2023). Exploring the impact of the design thinking model on fifth graders' creative self-efficacy, situational interest, and individual interest in STEM education. *Thinking Skills and Creativity*, *50*, 101424. https://doi.org/10.1016/j.tsc.2023.101424

Heiligensetzer, S. A., Schmittlutz, T. H., & Carbon, C. (2021). Creativity and complexity: Creative solutions are complex and need time. *Art & Perception*, *9*(1), 21-45. https://doi.org/10.1163/22134913-bja10010

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111-127. https://doi.org/10.1207/s15326985ep4102_4

Hidi, S. E., & Renninger, K. A. (2019). Interest development and its relation to curiosity: Needed Neuroscientific research. *Educational Psychology Review*, *31*(4), 833-852. https://doi.org/10.1007/s10648-019-09491-3

Hinton, P. R., McMurray, I., & Brownlow, C. (2014). *SPSS explained*. Routledge.

Hoff, E. V., & Öberg, N. K. (2015). The role of the physical work environment for creative employees – a case study of digital artists. *The International Journal of Human Resource Management*, *26*(14), 1889–1906. https://doi.org/10.1080/09585192.2014.971842

Jackson, S. A., & Marsh, H. W. (1996). Development and validation of a scale to measure optimal experience: The Flow State Scale. *Journal of Sport & Exercise Psychology, 18*(1), 17–35. https://doi.org/10.1123/jsep.18.1.17

Jahncke, H., & Hallman, D. M. (2020). Objective measures of cognitive performance in activity-based workplaces and traditional office types. *Journal of Environmental Psychology, 72*, 101503. https://doi.org/10.1016/j.jenvp.2020.101503

Khenak, N., Vezien, J., & Bourdot, P. (2020). Spatial presence, performance, and behavior between real, remote, and virtual immersive environments. *IEEE Transactions on Visualization and Computer Graphics, 26*(12), 3467-3478. https://doi.org/10.1109/tvcg.2020.3023574

Khenak, N., Vézien, J., Théry, D., & Bourdot, P. (2018). Spatial presence in real and remote immersive environments and the effect of multisensory stimulation. *Presence: Teleoperators and Virtual Environments, 27*(3), 287-308. https://doi.org/10.1162/pres_a_00332

Kiili, K. J., Lindstedt, A., Koskinen, A., Halme, H., Ninaus, M., & McMullen, J. (2021). Flow experience and situational interest in game-based learning: Cousins or identical twins. *International Journal of Serious Games, 8*(3), 93-114. https://doi.org/10.17083/ijsg.v8i3.462

Krapp, A. (1999). Interest, motivation and learning: An educational-psychological perspective. *European Journal of Psychology of Education, 14*(1), 23-40. https://doi.org/10.1007/bf03173109

Kwon, J., Choi, Y., & Hwang, Y. (2021). Enterprise design thinking: An investigation on user-centered design processes in large corporations. *Designs, 5*(3), 43. https://doi.org/10.3390/designs5030043

Lan, L., Hadji, S., Xia, L., & Lian, Z. (2021). The effects of light illuminance and correlated color temperature on mood and creativity. *Building Simulation, 14*(3), 463-475. https://doi.org/10.1007/s12273-020-0652-z

Lee, Y. S. (2016). Creative workplace characteristics and innovative start-up companies. *Facilities, 34*(7/8), 413-432. https://doi.org/10.1108/f-06-2014-0054

Lee, J. H., & Lee, S. (2023). Relationships between physical environments and creativity: A scoping review. *Thinking Skills and Creativity, 48*, 101276. https://doi.org/10.1016/j.tsc.2023.101276

Li, J., Woik, L., & Butz, A. (2022). Designing mobile MR workspaces: Effects of Reality Degree and Spatial Configuration During Passenger Productivity in HMDs. *Proceedings of the ACM on Human-Computer Interaction, 6*(MHCI), 1-17. https://doi.org/10.1145/3546716

Liedtka, J., & Ogilvie, T. (2011). *Designing for growth: A design thinking tool kit for managers*. Columbia Business School Publishing.

Liedtka, J., Rosen, R., & Wiltbank, R. (2009). *The catalyst: How you can become an extraordinary growth leader*. Crown Business.

Lindberg, T., Meinel, C., & Wagner, R. (2011). Design thinking: A fruitful concept for IT development? *Design Thinking*, 3-18. https://doi.org/10.1007/978-3-642-13757-0_1

Liu, W., Bakker, A. B., Tse, B. T., & Van der Linden, D. (2022). Does playful work design 'lead to' more creativity? A diary study on the role of flow. *European Journal of Work and Organizational Psychology*, *32*(1), 107-117. https://doi.org/10.1080/1359432x.2022.2104716

Liu, X., Ye, J., & Zhang, Y. (2023). Multimodal neurophysiological representations of high school students' situational interest: A machine learning approach. *Journal of Educational Technology Development and Exchange*, *16*(2), 108-125. https://doi.org/10.18785/jetde.1602.07

Lottrup, L., Stigsdotter, U. K., Meilby, H., & Claudi, A. G. (2013). The Workplace Window View: A Determinant of Office Workers' Work Ability and Job Satisfaction. *Landscape Research*, *40*(1), 57-75. https://doi.org/10.1080/01426397.2013.829806

Magadley, W., & Birdi, K. (2009). Innovation labs: An examination into the use of physical spaces to enhance organizational creativity. *Creativity and Innovation Management, 18*(4), 315-325. https://doi.org/10.1111/j.1467-8691.2009.00540.x

Mania, K. (2001). Connections between lighting impressions and presence in real and virtual environments: An experimental study. *Proceedings of the 1st International Conference on Computer Graphics, Virtual Reality and Visualization - AFRIGRAPH '01*, 119–123.

Martens, Y. (2011). Creative workplace: instrumental and symbolic support for creativity. *Facilities*, *29*(1/2), 63–79. https://doi.org/10.1108/02632771111101331

Matthews, G., Campbell, S. E., Falconer, S., Joyner, L. A., Huggins, J., Gilliland, K., Grier, R., & Warm, J. S. (2002). Fundamental dimensions of subjective state in performance settings: Task engagement, distress, and worry. *Emotion (Washington, D.C.)*, *2*(4), 315–340. https://doi.org/10.1037/1528-3542.2.4.315

Mayer, L., Mayer, S., Hölzle, K., Bönke, N., & Meinel, C. (2023). Design thinking transfer gap: Differences between knowledge and application of design thinking in the organizational environment. *Understanding Innovation*, 359-382. https://doi.org/10.1007/978-3-031-36103-6_17

McCoy, J. M., & Evans, G. W. (2002). The potential role of the physical environment in fostering creativity. *Creativity Research Journal*, *14*(3-4), 409-426. https://doi.org/10.1207/s15326934crj1434_11

Meinel, M., Maier, L., Wagner, T. F., & Voigt, K. I. (2017). Designing Creativity-Enhancing Workspaces: A Critical Look at Empirical Evidence. *Journal of Technology and Innovation Management*, *1*(1), 1-12. https://ssrn.com/abstract=3051058

Newport, C. (2016). Deep work: Rules for focused success in a distracted world. *Choice Reviews Online*, *53*(12), 53-5309-53-5309. https://doi.org/10.5860/choice.197480

Nye, C. D. (2022). Assessing interests in the twenty-first-century workforce: Building on a century of interest measurement. *Annual Review of Organizational Psychology and Organizational Behavior*, *9*(1), 415-440. https://doi.org/10.1146/annurev-orgpsych-012420-083120

Oksanen, K., & Ståhle, P. (2013). Physical environment as a source for innovation: Investigating the attributes of innovative space. *Journal of Knowledge Management*, *17*(6), 815-827. https://doi.org/10.1108/jkm-04-2013-0136

Palmiero, M., Nori, R., Piccardi, L., & D'Amico, S. (2020). Divergent Thinking: The Role of Decision-Making Styles. *Creativity Research Journal*, *32*(4), 323-332. https://doi.org/10.1080/10400419.2020.1817700

Peng, C., Yuan, G., Xie, M., Zhu, L., & Mao, Y. (2024). The impact of daily flow on employees' daily innovative behavior: disentangling the within-level mediation effect of job involvement and the cross-level moderation effect of person-organization fit. *Current Psychology (New Brunswick, N.J.)*, *43*(29), 24332–24345. https://doi.org/10.1007/s12144-024-06086-2

Pitchforth, J., Nelson-White, E., Van den Helder, M., & Oosting, W. (2020). The work environment pilot: An experiment to determine the optimal office design for a technology company. *PLOS ONE*, *15*(5), e0232943. https://doi.org/10.1371/journal.pone.0232943

Pittaway, L., Aissaoui, R., Ferrier, M., & Mass, P. (2019). University spaces for entrepreneurship: a process model. *International Journal of Entrepreneurial Behaviour & Research*, *26*(5), 911–936. https://doi.org/10.1108/ijebr-09-2018-0584

Pizzolante, M., Bartolotta, S., Sarcinella, E. D., Chirico, A., & Gaggioli, A. (2024). Virtual vs. real: Exploring perceptual, cognitive and affective dimensions in design product experiences. *BMC Psychology*, *12*(1), 1-12. https://doi.org/10.1186/s40359-023-01497-5

Primus, D. J., & Sonnenburg, S. (2018). Flow experience in design thinking and practical synergies with Lego serious play. *Creativity Research Journal*, *30*(1), 104-112. https://doi.org/10.1080/10400419.2018.1411574

Renninger, K. A., & Hidi, S. (2016). *The power of interest for motivation and engagement*. Routledge.

Renninger, K. A., Hidi, S., Krapp, A., & Renninger, A. (2014). *The role of interest in learning and development*. Psychology Press.

Rhodes, M. (1961). An Analysis of Creativity. *The Phi Delta Kappan*, *42*(7), 305-310. https://www.jstor.org/stable/20342603

Rotgans, J. I. (2015). Validation study of a general subject-matter interest measure: The individual interest questionnaire (IIQ). *Health Professions Education*, *1*(1), 67–75. https://doi.org/10.1016/j.hpe.2015.11.009

Rotgans, J. I., & Schmidt, H. G. (2014). Situational interest and learning: Thirst for knowledge. *Learning and Instruction*, *32*, 37-50. https://doi.org/10.1016/j.learninstruc.2014.01.002

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal*, *24*(1), 66-75. https://doi.org/10.1080/10400419.2012.652929

Schmidt, S., & Brinks, V. (2017). Open creative labs: Spatial settings at the intersection of communities and organizations. *Creativity and Innovation Management*, *26*(3), 291–299. https://doi.org/10.1111/caim.12220

Schubert, T. W. (2003). The sense of presence in virtual environments: A three-component scale measuring spatial presence, involvement, and realness. *Zeitschrift für Medienpsychologie*, *15*(2), 69–71. https://doi.org/10.1026//1617-6383.15.2.69

Schüler, J. (2007). Arousal of flow experience in a learning setting and its effects on exam performance and affect. *Zeitschrift für Pädagogische Psychologie*, *21*(3/4), 217-227. https://doi.org/10.1024/1010-0652.21.3.217

Scritchfield, M. (1999). *The creative person, product, process, and press: The 4P's.* Retrieved June, 25, 2004.

Silvia, P. J. (2008). Interest—The curious emotion. *Current Directions in Psychological Science*, *17*(1), 57-60. https://doi.org/10.1111/j.1467-8721.2008.00548.x

Slater, M., Usoh, M., & Steed, A. (1995). Taking steps. *ACM Transactions on Computer-Human Interaction*, *2*(3), 201-219. https://doi.org/10.1145/210079.210084

Soriano, A., Kozusznik, M. W., Peiró, J. M., & Demerouti, E. (2021). Employees' work patterns–office type fit and the dynamic relationship between flow and performance. *Applied Psychology*, *70*(2), 759-787. https://doi.org/10.1111/apps.12251

Staiano, F. (2022). *Designing and Prototyping interfaces with Figma: Learn essential UX/UI design principles by creating interactive prototypes for mobile, tablet, and desktop*. Packt Publishing.

Stevens, J. A., & Kincaid, J. P. (2015). The Relationship between Presence and Performance in Virtual Simulation Training. *Open Journal of Modelling and Simulation*, *3*(2), 41-48. https://doi.org/10.4236/ojmsi.2015.32005

Stollberger, J., & Debus, M. E. (2019). Go with the flow, but keep it stable? The role of flow variability in the context of daily flow experiences and daily creative performance. *Work & Stress*, *34*(4), 342-358. https://doi.org/10.1080/02678373.2019.1695293

Storvang, P., & Nguyen, B. (2020). The next frontier: using space as management strategy - an exploratory study. *The Bottom Line Managing Library Finances*, *33*(3), 217–229. https://doi.org/10.1108/bl-01-2020-0009

Su, R. (2020). The three faces of interests: An integrative review of interest research in vocational, organizational, and educational psychology. *Journal of Vocational Behavior*, *116*, 103240. https://doi.org/10.1016/j.jvb.2018.10.016

Thigpen, N. N., Kappenman, E. S., & Keil, A. (2017). Assessing the internal consistency of the event-related potential: An example analysis. *Psychophysiology*, *54*(1), 123-138. https://doi.org/10.1111/psyp.12629

Thompson, L. (2003). Improving the creativity of organizational work groups. *Academy of Management Perspectives*, *17*(1), 96-109. https://doi.org/10.5465/ame.2003.9474814

Thomson, P., & Jaque, S. V. (2023). Creativity and flow: Not a simple relationship. *The Journal of Creative Behavior, 57*(3), 397-408. https://doi.org/10.1002/jocb.586

Thoring, K.C., Gonçalves, M., Mueller, Roland M., Desmet, P.M.A., K., Gonçalves, M., Mueller, R., Desmet, P., & Badke-Schaub, P. (2021). The Architecture of Creativity: Toward a Causal Theory of Creative Workspace Design. *International Journal of Design*, *15*(2), 17-36.

Thoring, K., Mueller, R. M., Desmet, P., & Badke-Schaub, P. (2020). Spatial design factors associated with creative work: A systematic literature review. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, *34*(3), 300-314. https://doi.org/10.1017/s0890060420000232

Tordet, C., Erhel, S., Wodey, E., Jamet, E., Nardi, N., & Gonthier, C. (2021). The flow observational grid: An observation-based solution to assess flow states. *Journal of Happiness Studies*, *22*(7), 3069-3089. https://doi.org/10.1007/s10902-021-00356-7

Usoh, M., Catena, E., Arman, S., & Slater, M. (2000). Using presence questionnaires in reality. *Presence: Teleoperators and Virtual Environments*, *9*(5), 497-503. https://doi.org/10.1162/105474600566989

Van de Ven, A. H., Polley, D. E., Garud, R., & Vankataraman, S. (1999). *The innovation journey*. Oxford University Press.

Van der Linden, D., Tops, M., & Bakker, A. B. (2020). Go with the flow: A neuroscientific view on being fully engaged. *European Journal of Neuroscience*, *53*(4), 947-963. https://doi.org/10.1111/ejn.15014

Van Hooijdonk, M., Ritter, S. M., Linka, M., & Kroesbergen, E. (2022). Creativity and change of context: The influence of object-context (in)congruency on cognitive flexibility. *Thinking Skills and Creativity*, *45*, 101044. https://doi.org/10.1016/j.tsc.2022.101044

Verstijnen, I., Van Leeuwen, C., Goldschmidt, G., Hamel, R., & Hennessey, J. (1998). Sketching and creative discovery. *Design Studies*, *19*(4), 519-546. https://doi.org/10.1016/s0142-694x(98)00017-9

Wagner, M., & Growe, A. (2020). Creativity-enhancing work environments: Eventisation through an inspiring work atmosphere in temporary proximity. *Raumforschung und Raumordnung | Spatial Research and Planning*, *78*(1), 53-70. https://doi.org/10.2478/rara-2019-0039

Wallas, G. (1926). *The Art of Thought*. Harcourt, Brace and Company.

Wanqing, S., Tianyu, Z., Zhichong, Z., Jian, K., & Jianhua, S. (2020). A grounded theory approach to the understanding of creativity in common spaces of universities. *Interactive Learning Environments*, *28*(6), 744-761. https://doi.org/10.1080/10494820.2018.1542319

Weibel, D., & Wissmath, B. (2011). Immersion in computer games: The role of spatial presence and flow. *International Journal of Computer Games Technology*, *2011*, 1-14. https://doi.org/10.1155/2011/282345

Weintraub, J., Cassell, D., & DePatie, T. P. (2021). Nudging flow through 'SMART' goal setting to decrease stress, increase engagement, and increase performance at work. *Journal of Occupational and Organizational Psychology*, *94*(2), 230-258. https://doi.org/10.1111/joop.12347

Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). Toward a Theory of Organizational Creativity. *The Academy of Management Review*, *18*(2), 293-321. https://doi.org/10.2307/258761

Wu, Y., Lu, C., Yan, J., Chu, X., Wu, M., & Yang, Z. (2021). Rounded or angular? How the physical work environment in makerspaces influences makers' creativity. *Journal of Environmental Psychology*, *73*, 101546. https://doi.org/10.1016/j.jenvp.2020.101546

Yang, S., & Zhang, W. (2022). Presence and flow in the context of virtual reality storytelling: What influences enjoyment in virtual environments? *Cyberpsychology, Behavior, and Social Networking*, *25*(2), 101-109. https://doi.org/10.1089/cyber.2021.0037

Yekanialibeiglou, S., Demirkan, H., & Denti, L. (2021). Enhancing creativity in activity-based offices: A critical incident study of knowledge workers. *Creativity and Innovation Management*, *30*(4), 763-782. https://doi.org/10.1111/caim.12464

Zahorik, P., & Jenison, R. L. (1998). Presence as being-in-the-world. *Presence: Teleoperators and Virtual Environments*, *7*(1), 78-89. https://doi.org/10.1162/105474698565541

Zhou, N., Kisselburgh, L., Chandrasegaran, S., Badam, S. K., Elmqvist, N., & Ramani, K. (2020). Using social interaction trace data and context to predict collaboration quality and creative fluency in collaborative design learning

environments. *International Journal of Human-Computer Studies, 136*, 102378. https://doi.org/10.1016/j.ijhcs.2019.102378

APPENDICES

APPENDIX A. Participant Consent Form

Purpose

This study examines the direct impact of open and private creative spaces on the design thinking process, specifically divergent and convergent thinking. As a participant, you are only responsible for being in the open creative space (setting 1) or the private creative space (setting 2). Please note that students who have the potential of being graded by the investigators during or following the semester(s) in which the study is being carried out will not be able to participate in this study. In this study, undergraduate and graduate students over 18 years old from Bilkent University will join the experiment.

Participation

Your participation in this experiment is entirely voluntary. You can skip any questions you do not wish to answer, and you may withdraw from the experiment anytime, or you can be excluded from the research if necessary. If you choose to withdraw, your relationship with Bilkent University will not be affected.

Procedure

If you agree to participate in this study, you will be asked to complete the following:

1. Fill out a survey about your demographic information (age, gender, occupation, etc.)
2. Perform two divergent thinking activities in Figma displayed on a Windows PC.
3. Fill out a survey rating your experience based on flow state and situational interest.
4. Perform two convergent thinking activities in Figma displayed on a Windows PC.
5. Fill out a survey rating your experience based on flow state and situational interest.

Risks and Benefits

Your participation in this study does not pose any foreseeable risks to you. While you will not receive any direct benefits, your participation will contribute to gaining knowledge of how physical creative spaces influence the design thinking process, specifically divergent and convergent thinking.

Compensation

If you choose to participate in the study, you will not receive any compensation, course credits, or monetary rewards.

Confidentiality

Your responses as a participant will be kept confidential, and your identity will remain anonymous. Research records will be securely stored in a locked file for two years and only be accessed by the researcher.

Questions and Concerns

Please ask any questions you have now regarding this research. If you have questions regarding the research later, contact the researcher or her supervisor. Questions or concerns about institutional approval should be directed to Bilkent University Local Ethics Committee.

Statement of Consent: *I have read the above information. I have asked all the questions I had about the experimental procedure, and I am satisfied with the answers. I consent to participate in this study.*

Name of the Participant: _____

_____	_____
Participant's Signature	Date

_____	_____
Researcher's Signature	Date

_____	_____
Advisor's Signature	Date

Information about the Investigator:

Zena Taleb Yousef Alshawa,
MFA student at Bilkent University
Department of Interior Architecture and Environmental Design
E-mail: zena.taleb@bilkent.edu.tr

Information about the Advisor:

Prof. Dr. Halime Demirkan,
Department of Interior Architecture and Environmental Design
E-mail: demirkan@bilkent.edu.tr

APPENDIX B. Approval by Bilkent University Local Ethics Committee

Bilkent Üniversitesi
Akademik İşler Rektör Yardımcılığı

Tarih : 21 Mayıs 2024

Gönderilen : Zena Alshawa

Danışman : Halime Demirkan

Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı

Konu : *"The Influence of ..."* çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 21 Mayıs 2024 tarihli görüşme sonucu, *"The Influence of Creative Space Types on the Design Thinking Process of Design PractitionersCreative Space Types on the Design Thinking Process of Design Practitioners"* isimli çalışmanız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

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

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

Etik Kurul Üyeleri:

Ünvan / İsim	**Bölüm / Uzmanlık**	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Haldun Özaktaş	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Ayşen Ürgen	Psikoloji	Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Üye
Prof. Dr. Özgür Ulusoy	Bilgisayar Mühendisliği	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özçelik	Hukuk	Yedek Üye

Kurul karar/toplantı No: 2024_05_21_01 Başvuru No: 558

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

Bilkent Üniversitesi İnsan Araştırmaları Etik Kurulu Hakkında:

- Kurul aşağıda ünvan, isim, uzmanlık alanı/bölümü belirtilen 5 asli ve 2 yedek üyeden oluşur:

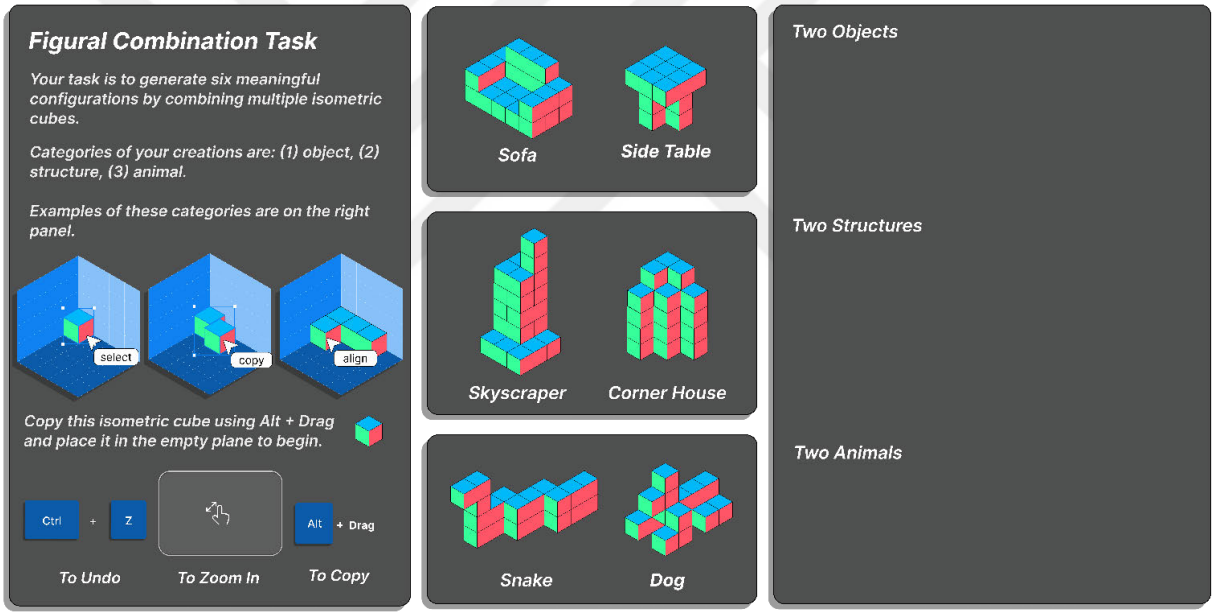
  Prof.Dr. H. Altay Güvenir (Başkan), Bilgisayar Mühendisliği
  Prof.Dr. Haldun Özaktaş, Elektrik ve Elektronik Mühendisliği
  Doç.Dr. Işık Yuluğ, Moleküler Biyoloji ve Genetik
  Dr.Öğr. Üyesi Burcu Ayşen Ürgen, Psikoloji
  Dr.Öğr. Üyesi Arif Barış Özbilen, Hukuk
  Prof. Dr. Özgür Ulusoy (Yedek Üye), Bilgisayar Mühendisliği
  Dr.Öğr. Üyesi Barış Özçelik (Yedek Üye), Hukuk

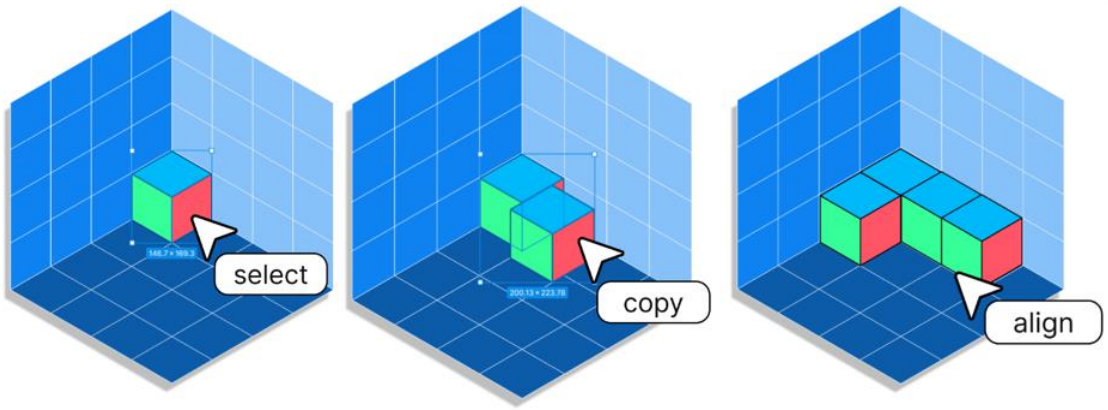
- Kurul toplantılarına katılamayan asli üyelerin yerine yedek üyeler görevlendirilir.
- Kurul en az 3 üye ile toplanabilir.
- Bir başvurunun onay alması konusunda olumsuz oy kullanan üyeler bunu onay belgesindeki isimlerinin yanına muhalefet notu düşerek belirtirler.
- Bir başvurunun onay alabilmesi için en az 3 üyenin olumlu oy kullanması gerekir. Onay belgesinde isimlerinin yanında muhalefet notu bulunmaması, o üyelerin olumlu oy kullandıkları anlamına gelir.

APPENDIX C. Brief of the “Poly-cube Figural Combination Task”

Poly-cube Figural Combination Task

A *poly-cube* is a solid figure formed by combining one or more equal cubes face to face. In this activity, your task is to create six poly-cube creations by combining several isometric cubes. Your creations should represent the following categories: (1) object, (2) structure, (3) animal. Examples of each category are provided in the middle panels. To begin your creations, copy the isometric cube seen below using *Alt + Drag* and place it in the provided empty plane. Please label your creations. There are no right or wrong answers.

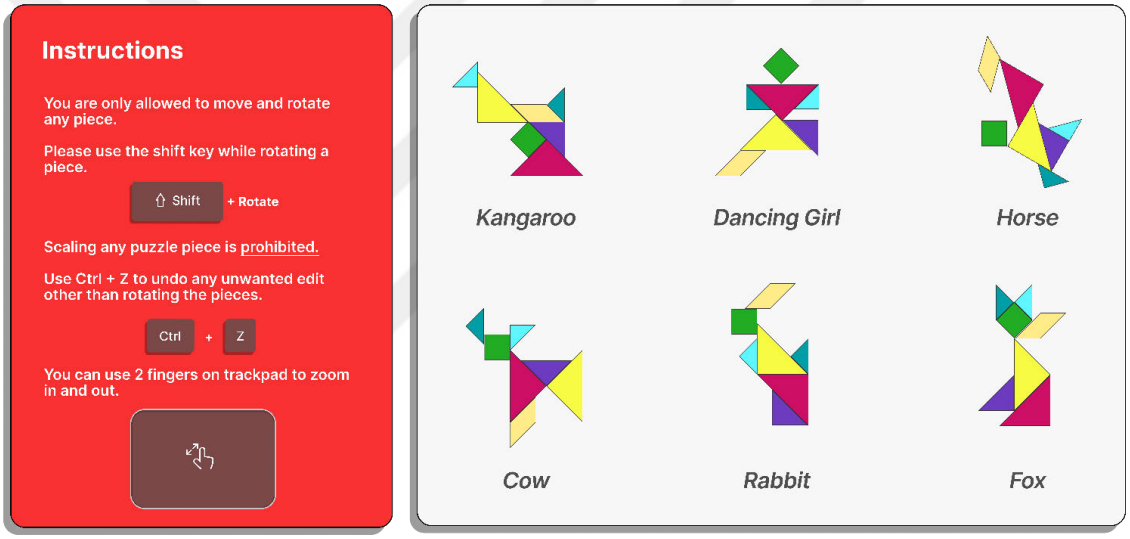




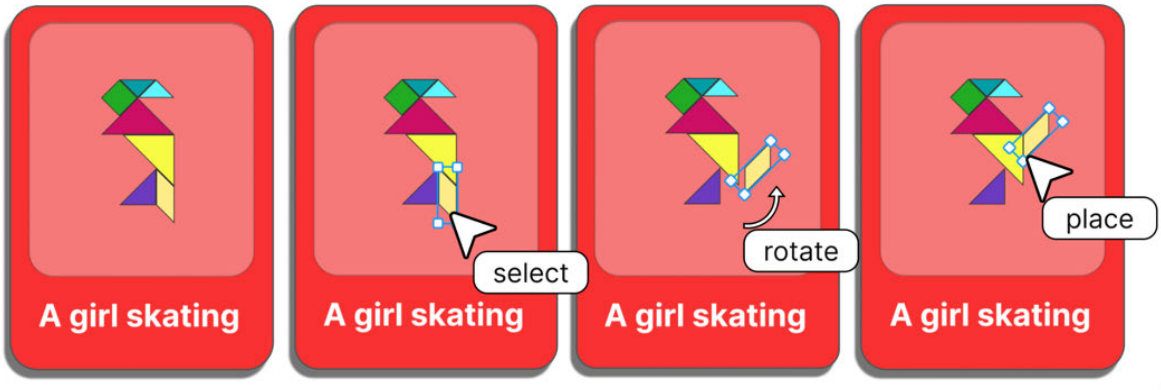
APPENDIX D. Brief of the “Modify Figures Task”

Modify Figures Task

There are six ambiguous figures, each formed by seven geometric pieces. These dissected figures need improvement to match the phrases below each figure. Your task is to simply modify the figures by rotating, shifting, or moving any of the pieces. Your modifications should be an improved depiction of the phrases. There are no correct or incorrect answers.



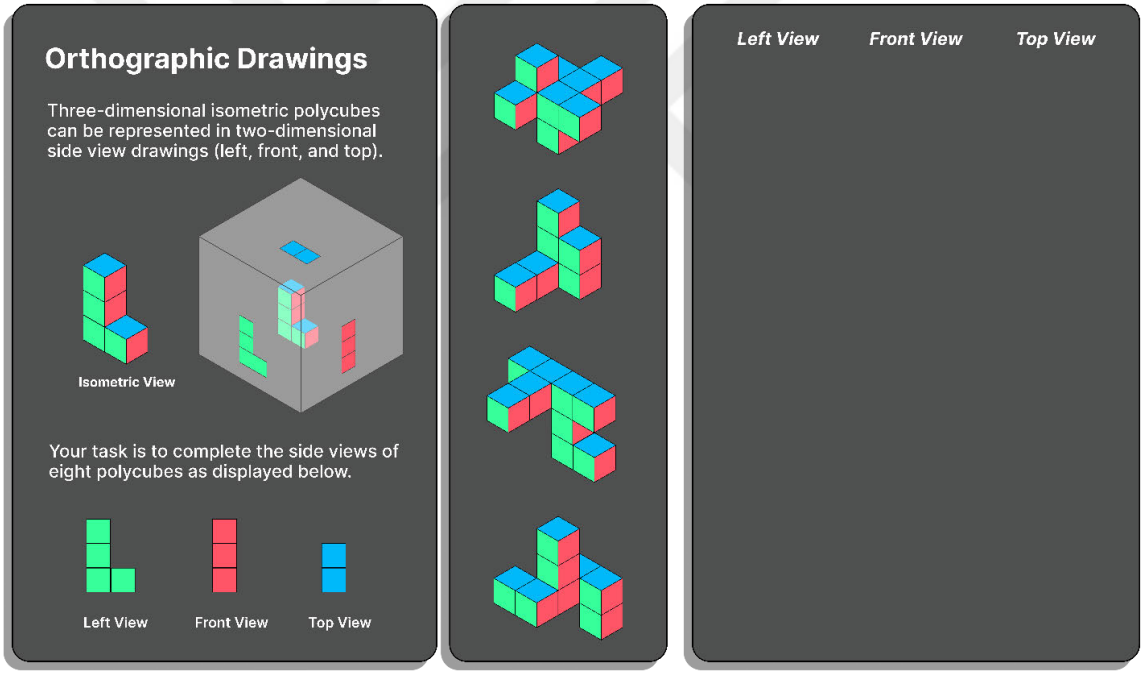
There are no right or wrong answers.

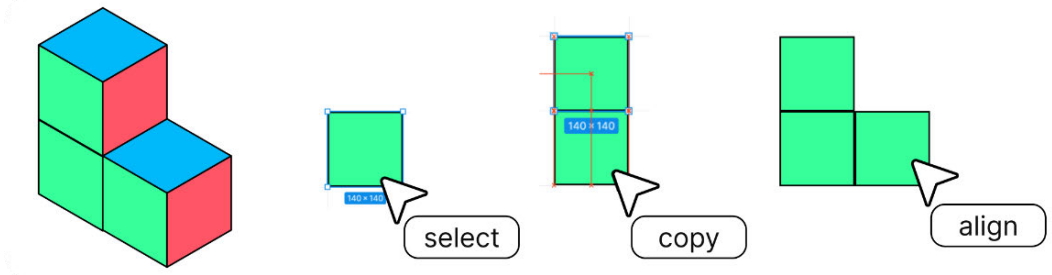


APPENDIX E. Brief of the “Orthographic Projections Task”

Orthographic Projections Task

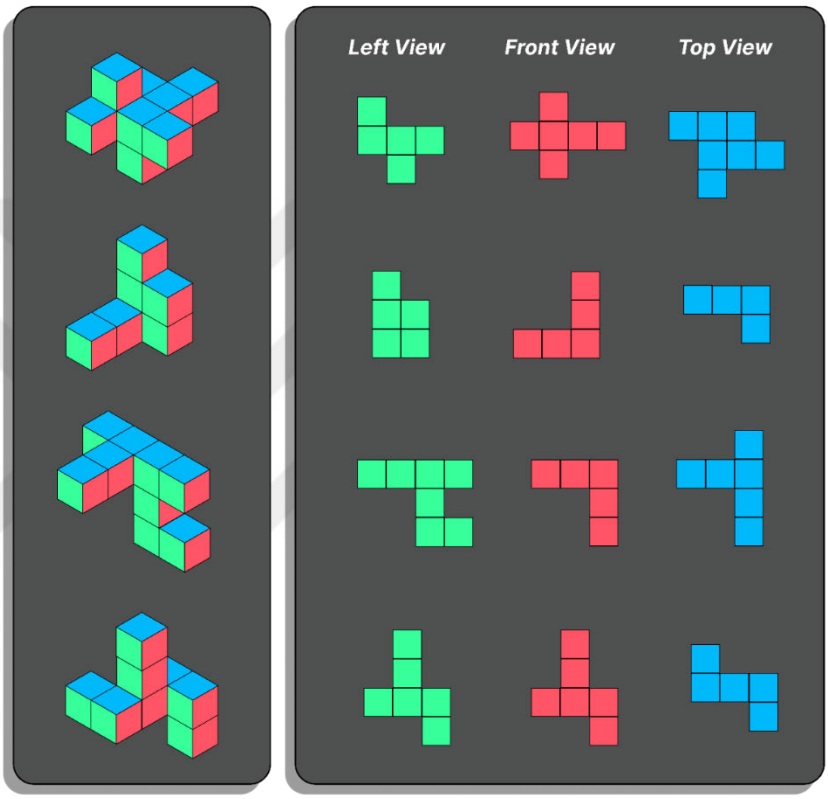
Three-dimensional isometric poly-cubes can be represented in two-dimensional side-view drawings, including left, front, and top views. You will find eight isometric poly-cubes below. Your task is to complete the two-dimensional side-view drawings of these poly-cubes. To start, please copy the two-dimensional squares below using Alt + Drag. Green squares represent the left-side view of a poly-cube, pink squares represent front-side views, and blue squares represent top-side views of a poly-cube.





APPENDIX E. (Cont'd)

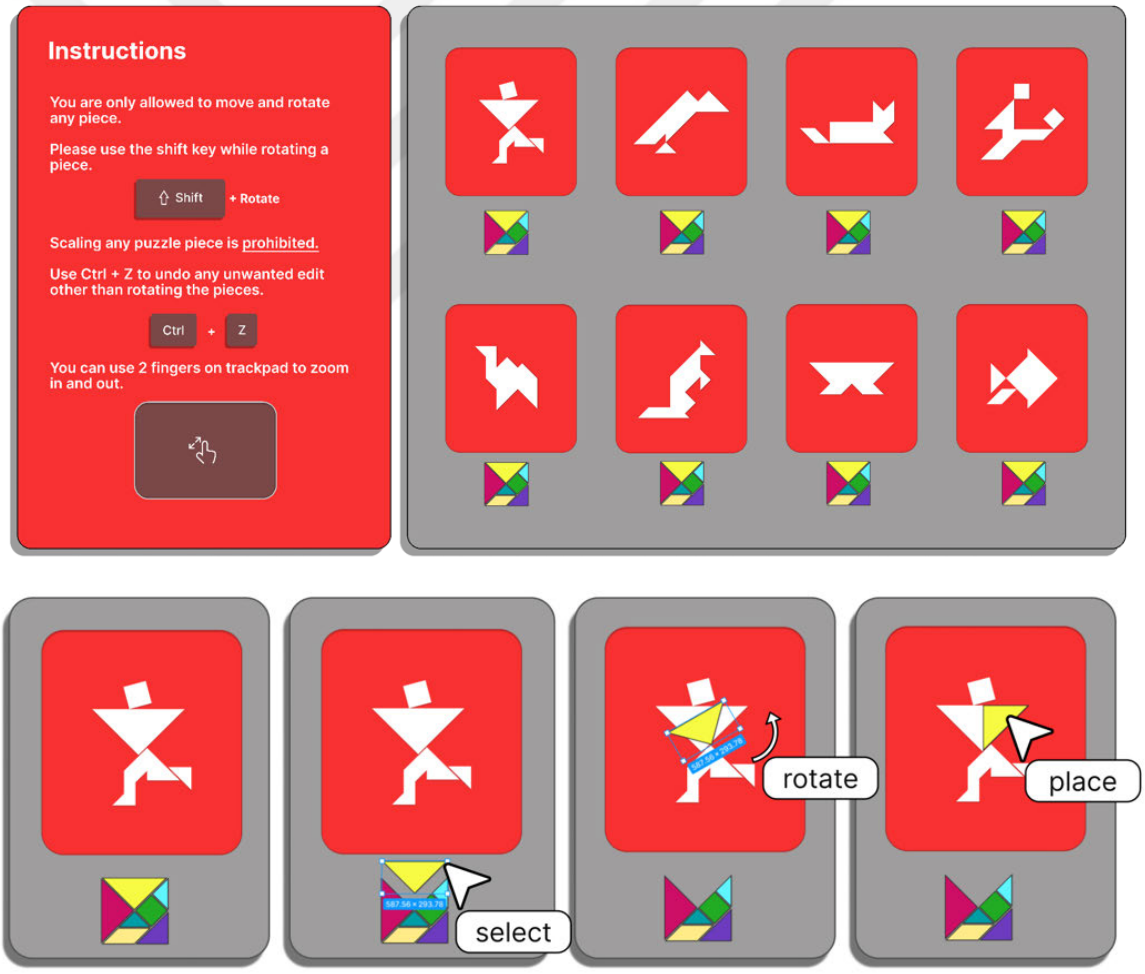
Orthographic Projections Answer Key



APPENDIX F. Brief of the “Tangram Puzzle Task”

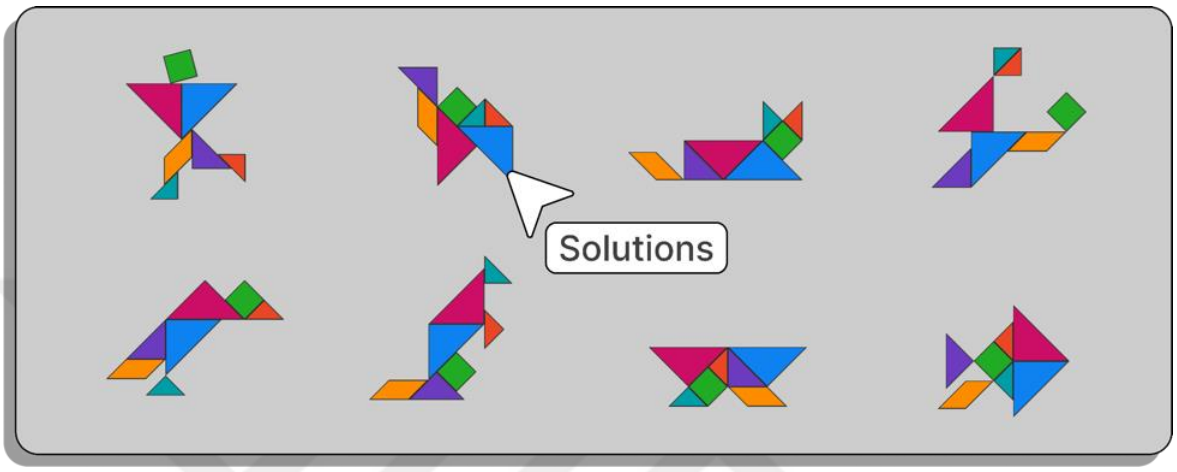
Tangram Puzzle Task

There are eight empty Tangram figures and seven geometric pieces. Your task is to solve the Tangram puzzle by filling the empty figure with all seven geometric pieces. You may move, rotate, or shift the pieces to complete the empty Tangram figure. You are not allowed to change the scale or size of any piece. All seven pieces are found under the empty Tangram figures.



APPENDIX F. (Cont'd)

Tangram Task Answer Key



APPENDIX G. Demographic Questionnaire

Participant Code #

Experimental Setting

O Private Creative Space O Open Creative Space

Kindly respond to the following questions about your socio-demographic variables and subjective preference for creative spaces.

Demographic Variables

1. Age _____
2. Gender O Male O Female
3. Department _____
4. Education Level O Masters O Ph.D. O Undergraduate

Subjective Preference for Creative Spaces

1. I prefer browsing for inspiration and brainstorming new ideas for a new project in:
   - ○ A secluded space with partitions to withdraw myself from distractions.
   - ○ An open workstation where I can see and interact with my colleagues.
   - ○ None of the above

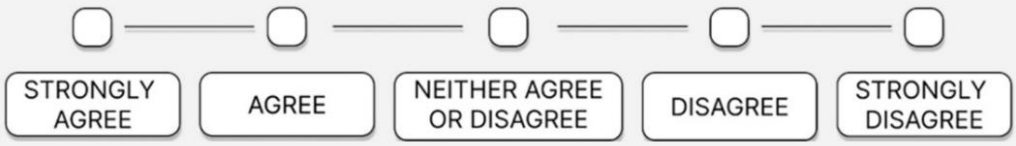
2. I prefer structuring my ideas into categories and eliminating ambiguous ones in:
   - ○ A secluded space with partitions to withdraw myself from distractions.
   - ○ An open workstation where I can see and interact with my colleagues.
   - ○ None of the above

APPENDIX H. Preference for Ideation and Evaluation Scale

Adapted from Basadur & Finkbeiner (1985).

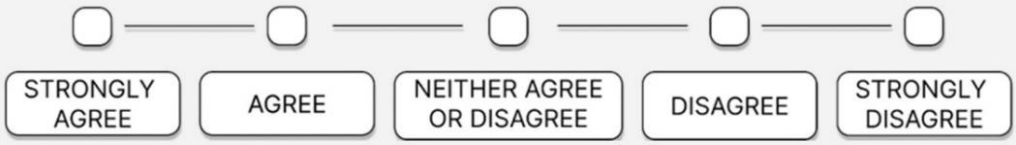
Kindly evaluate the extent to which you agree with each statement.

Q1. I should make some prejudgment of my ideas before telling them to others.



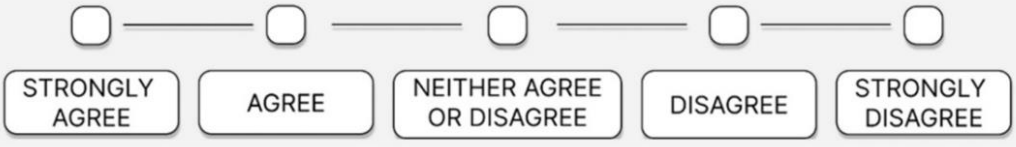
Q2. We should cut down ideas when they get ridiculous and get on with it.

Q3. I feel that people at work ought to be encouraged to share all their ideas, because you never know when a crazy sounding one might turn out to be the best.

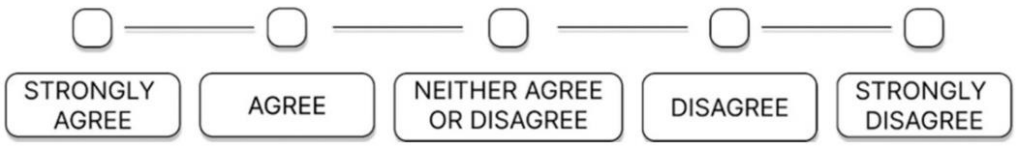


Q4. One new idea is worth ten old ones.

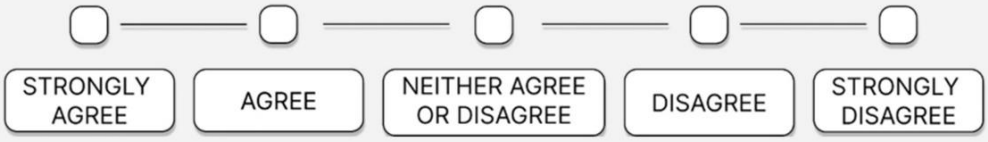
Q5. Quality is a lot more important than quantity in generating ideas.



Q6. A group must be focused and on track to produce worthwhile ideas.

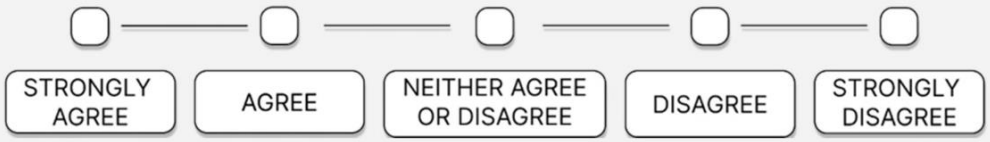


Q7. Lots of time can be wasted on wild ideas.



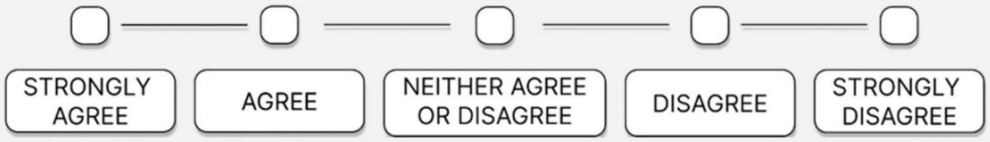
Q8. I think everyone should say whatever pops into their head whenever possible.

Q9. I like to listen to other people's crazy ideas since even the wackiest often leads to the best solution.

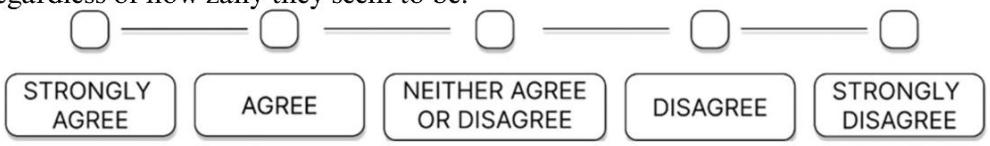


Q10. Judgment is necessary during idea generation to ensure that only quality ideas are developed.

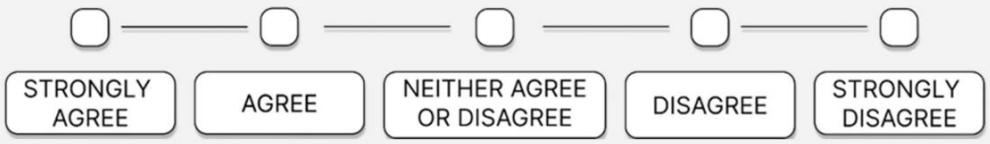
Q11. You need to be able to recognize and eliminate wild ideas during idea generation.



Q12. I feel that all ideas should be given equal time and listened to with an open mind, regardless of how zany they seem to be.



Q13. The best way to generate new ideas is to listen to others then tailgate or add on.



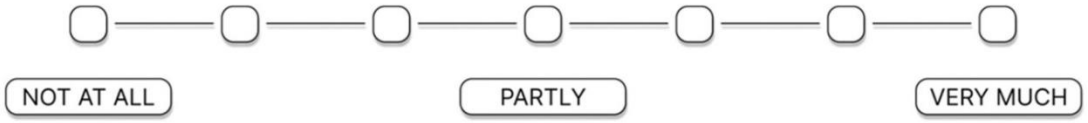
Q14. I wish people would think about whether an idea is practical or not before they open their mouth.

APPENDIX I. Flow Short Scale

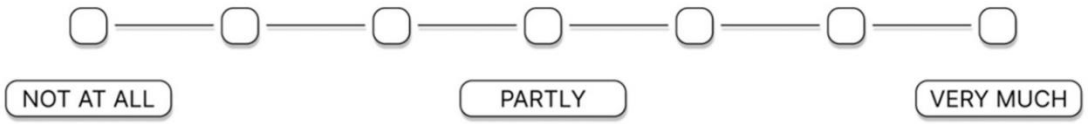
Flow Short Scale (FSS) adapted from Engeser and Rheinberg (2008).

Kindly think of the activities you just completed as you evaluate each statement.

Q1. The activities felt just the right amount of challenge.



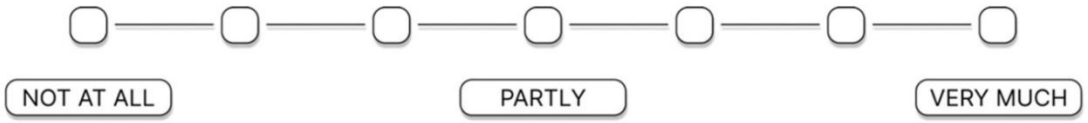
Q2. My thoughts/activities ran fluidly and smoothly.



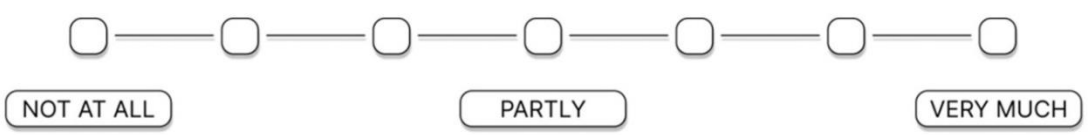
Q3. I did not notice the time passing.

Q4. I had no difficulty concentrating.

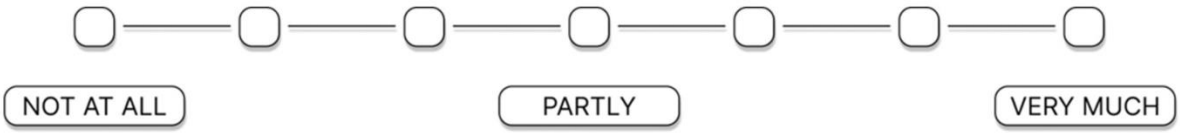
Q5. My mind was completely clear.



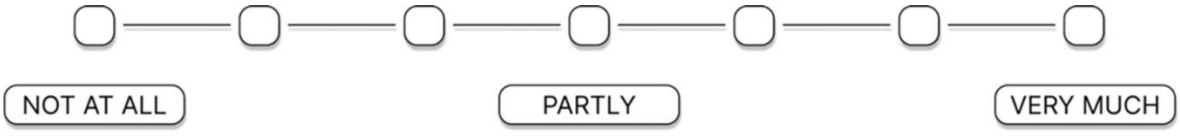
Q6. I was totally absorbed in what I was doing.



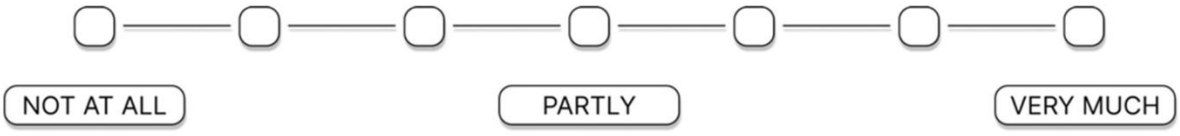
Q7. The right thoughts/movements occurred of their own accord.



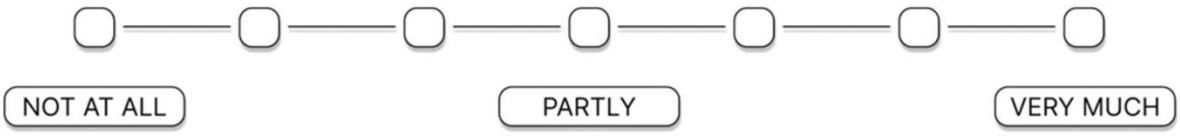
Q8. I knew what I had to do at each step of the activities.



Q9. I felt that I had everything under control.



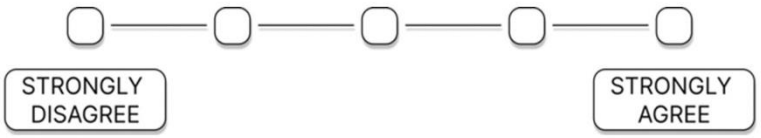
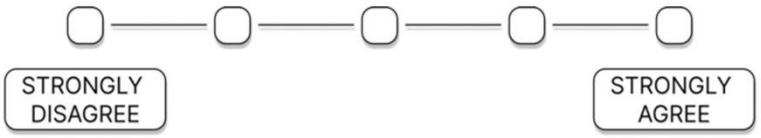
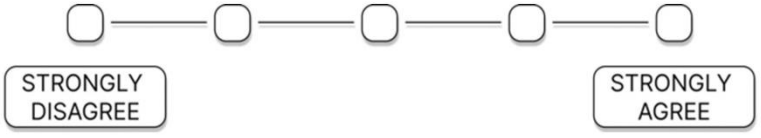
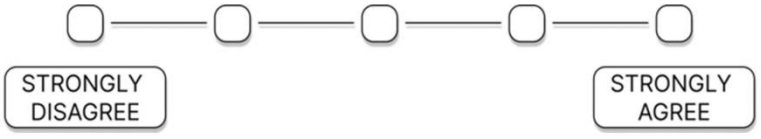
Q10. I was completely lost in thought.

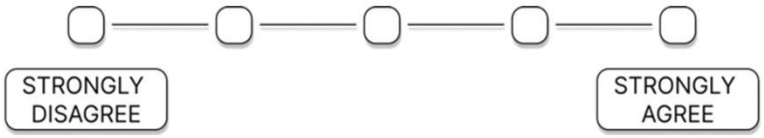
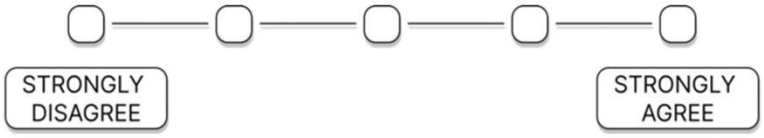
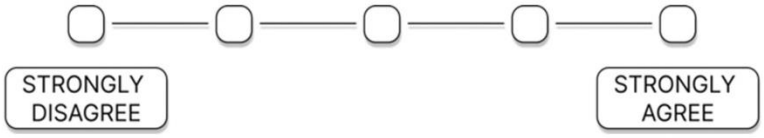
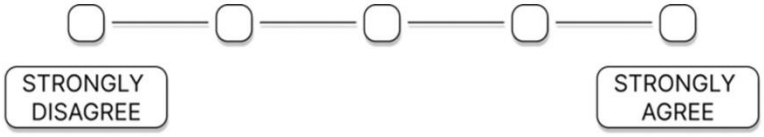
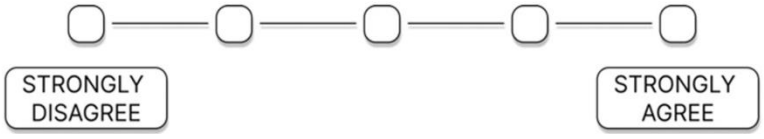


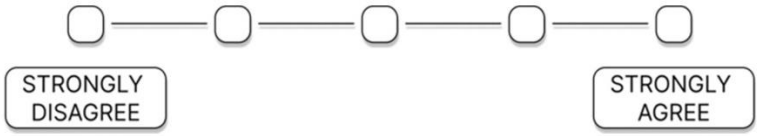
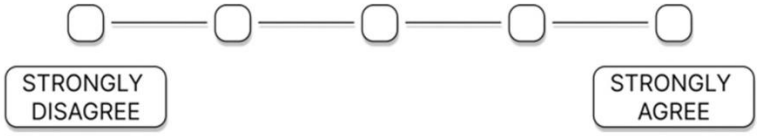
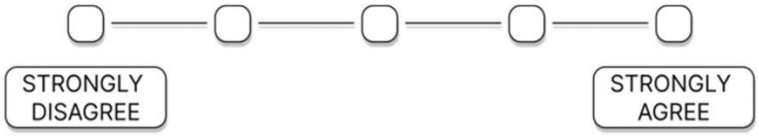
APPENDIX J. Situational Interest Scale

Situational Interest Scale (SIS) adapted from Chen et al. (1999).

Kindly think of the activities you just completed as you evaluate each statement.

Q1. These activities were exciting.	
Q2. These activities were new to me.	
Q3. These activities were complicated.	
Q4. My attention was high.	
Q5. I wanted to find out more about how to do these activities.	
Q6. They were complex activities.	
Q7. These activities were fresh.	
Q8. I wanted to analyze these activities or have a grasp on them.	

Q9. These activities were interesting.	
Q10. It was hard for me to do these activities.	
Q11. The activities inspired me to participate.	
Q12. These activities were appealing to me.	
Q13. It was fun for me to try these activities.	
Q14. I wanted to inquire into the details of how to do these activities.	
Q15. These were exceptional activities.	
Q16. I was very attentive all the time.	
Q17. I was focused.	
Q18. These activities seemed fun to me.	

Q19. These were interesting activities for me to complete.	
Q20. I wanted to discover all the tricks of these activities.	
Q21. These were new-fashioned activities for me to do.	
Q22. These activities were demanding tasks.	
Q23. They were enjoyable activities for me.	
Q24. I concentrated.	

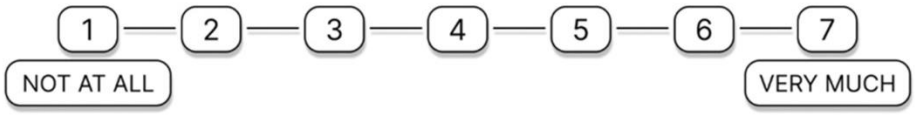
APPENDIX K. Slater-Usoh-Steed Presence Questionnaire

Slater-Usoh-Steed Presence Questionnaire (SUS-PQ) adapted from Slater et al. (1995).

Kindly think of the space you just completed the activities in as you evaluate the following statements.

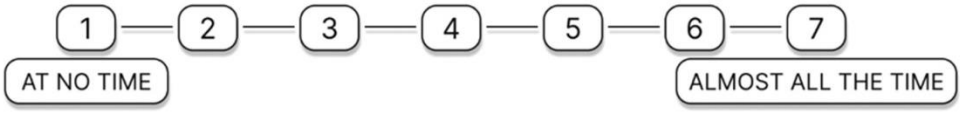
Q1. Please rate your sense of being in the assigned space, being (1) Not at all to (7) Very much.

I had a sense of "being there" in the assigned space.



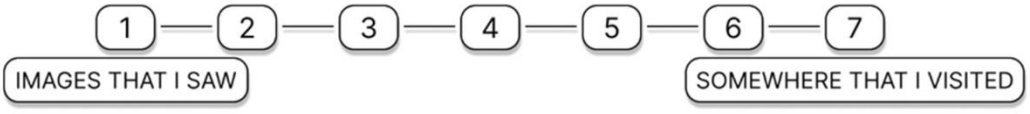
Q2. To what extent were there times during the experience when the assigned space was the reality for you?

There were times during the experience when this space was the reality for me...



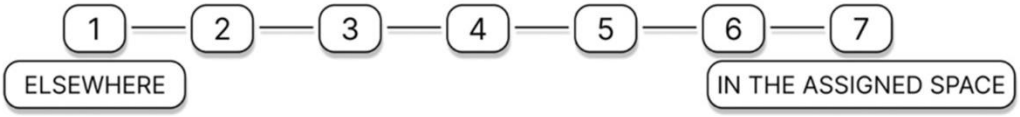
Q3. When you think back about your experience, do you think of the assigned space more as images that you saw, or more as somewhere that you visited?

This space seems to me to be more like...



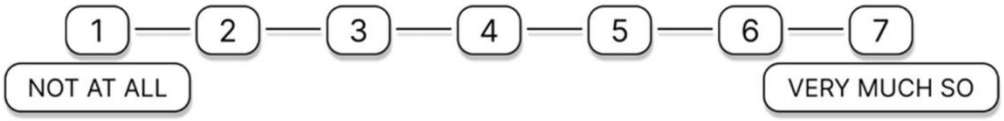
Q4. During the time of the experience, which was strongest overall, your sense of being in the assigned space, or of being elsewhere?

I had a stronger sense of being…



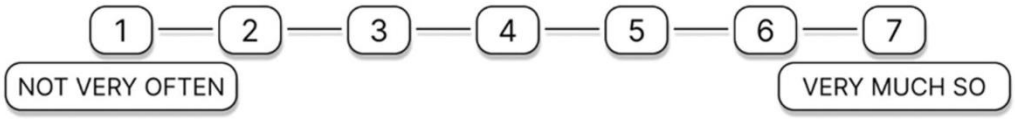
Q5. Consider your memory of being in the assigned space. How similar in terms of the structure of the memory is this to the structure of the memory of other places you have been today?
By 'structure of the memory' consider things like the extent to which you have a visual memory of this space, whether that memory is in color, the extent to which the memory seems vivid or realistic, its size, location in your imagination, the extent to which it is panoramic in your imagination, and other structural elements.

I think of the assigned space as a place in a way similar to other places that I've been today...



Q6. During the time of the experience, did you often think to yourself that you were in the assigned space?

During the experience, I often thought that I was really positioned in this space.

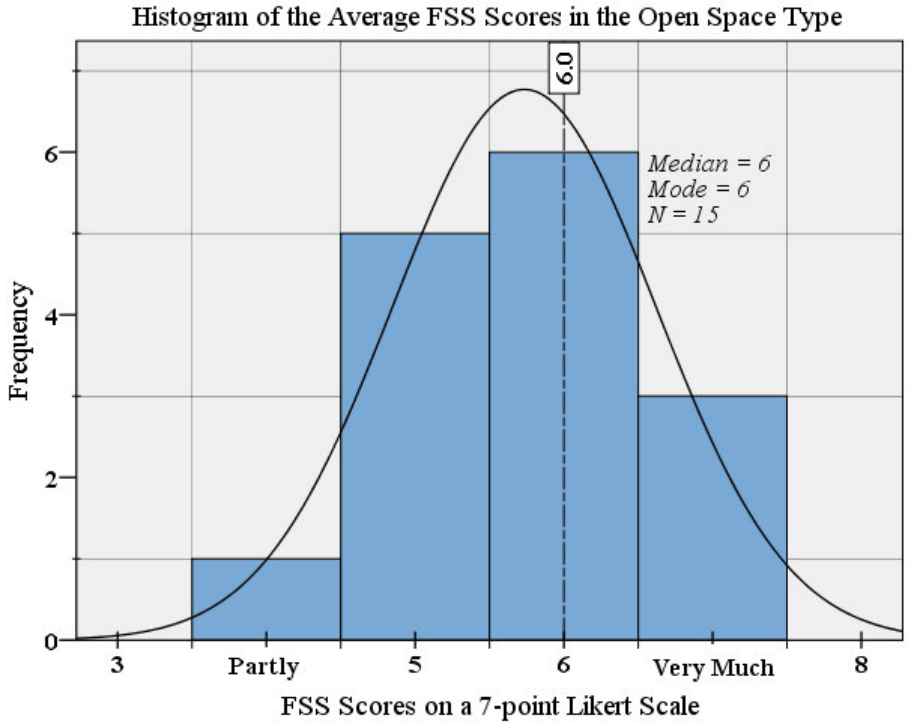


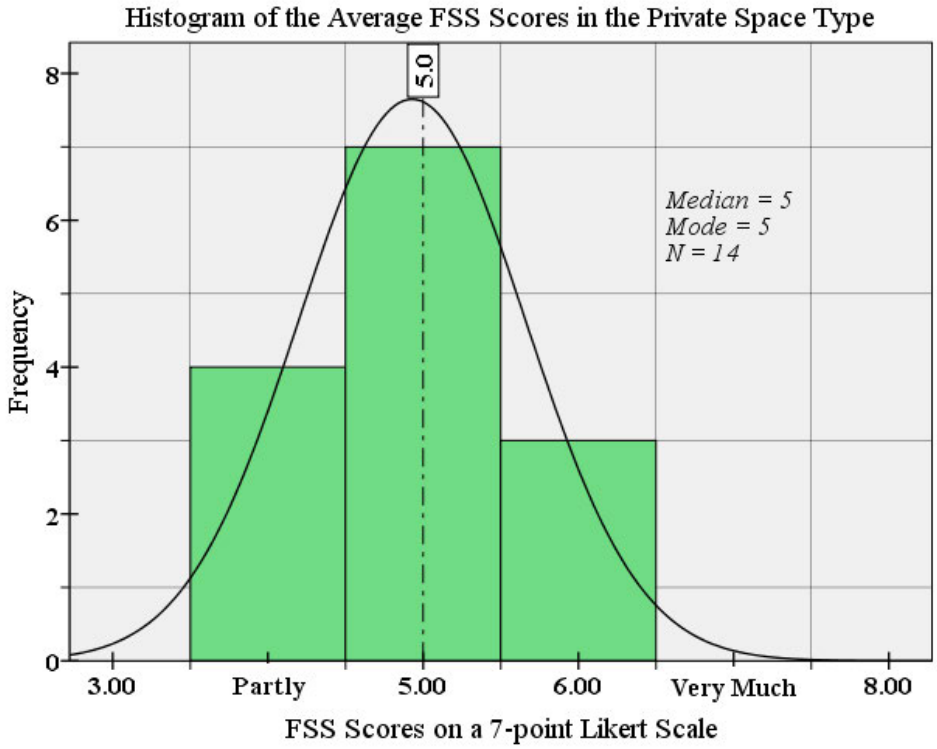
Please write down any further comments that you wish to make about your experience. In particular, what things helped to give you a sense of 'really being' in the assigned space, and what things acted to 'pull you out' of the assigned space?

Q7. What things helped to give you a sense of 'really being' in the assigned space?

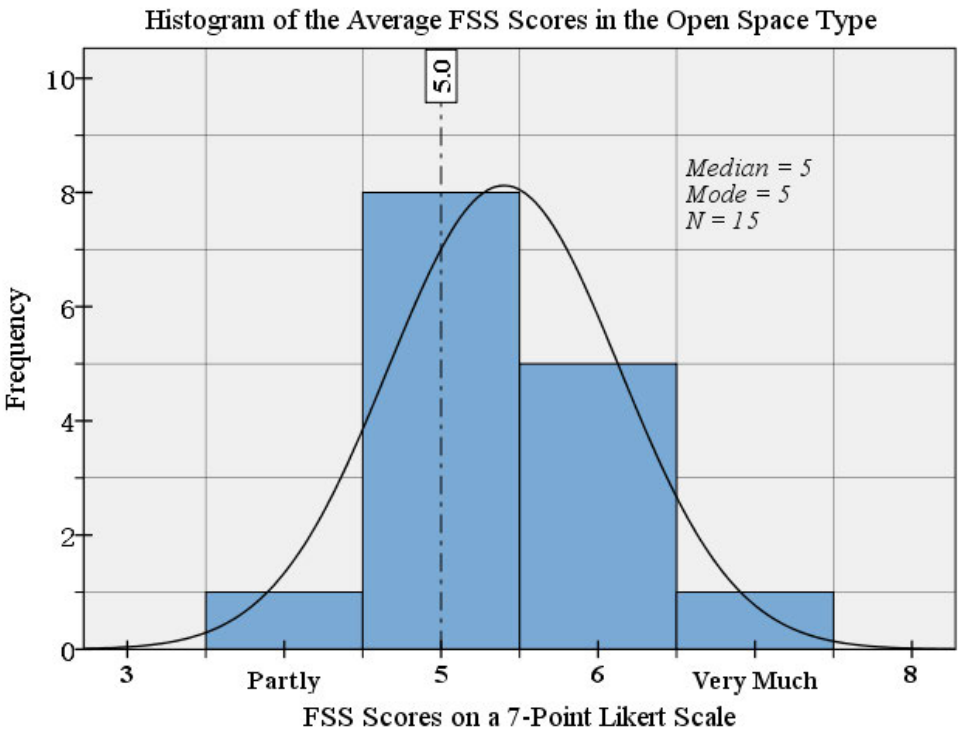
Q8. What things acted to 'pull you out' of the assigned space?

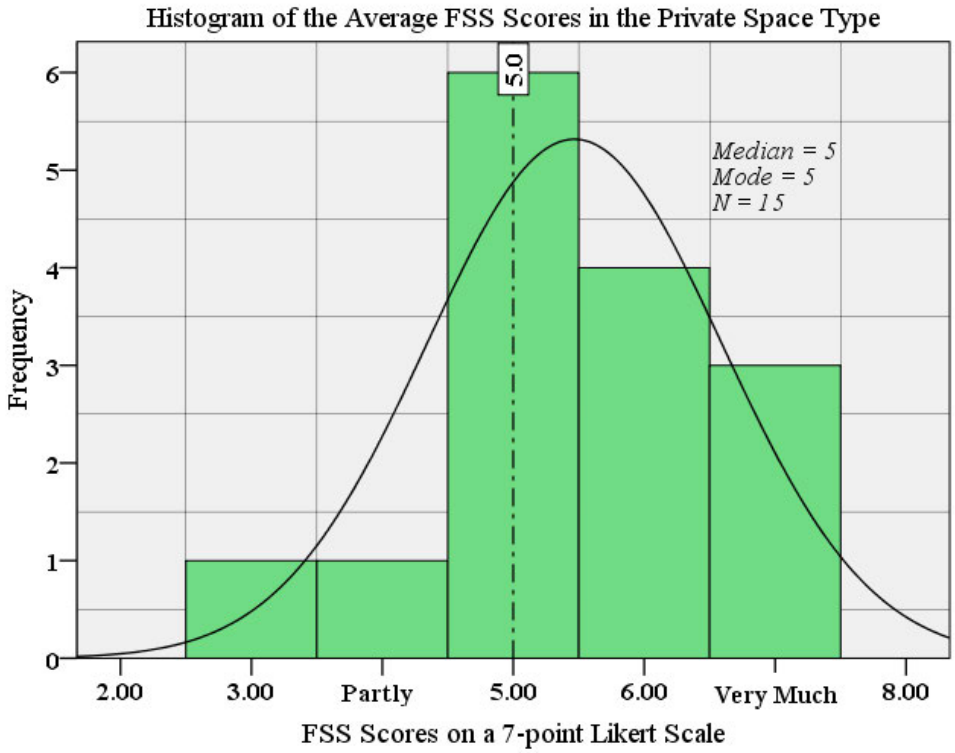
APPENDIX L. FSS Scores During Divergent Tasks in Both Space Types



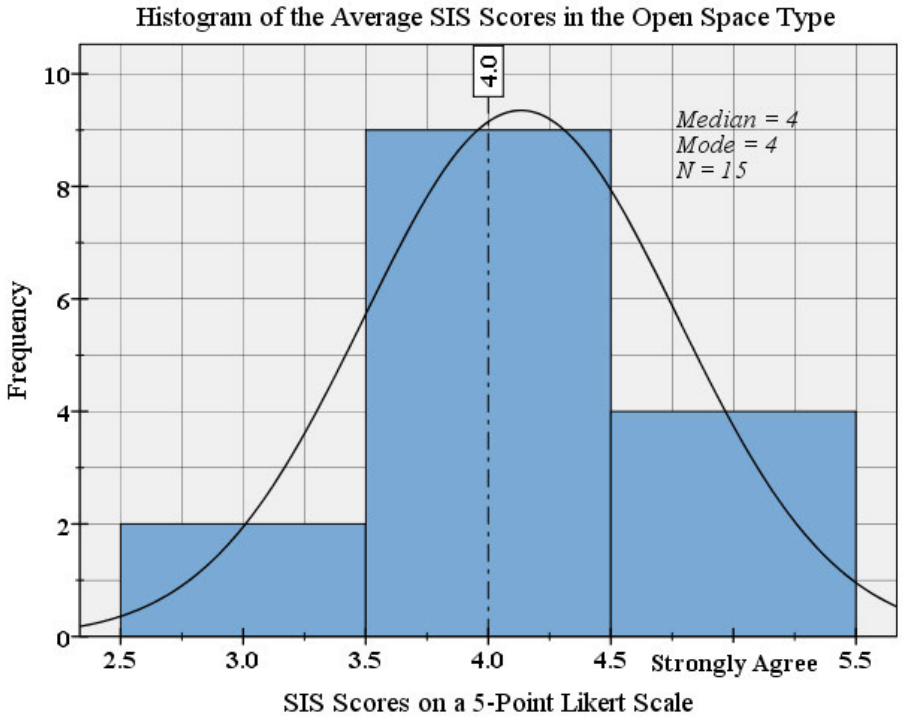


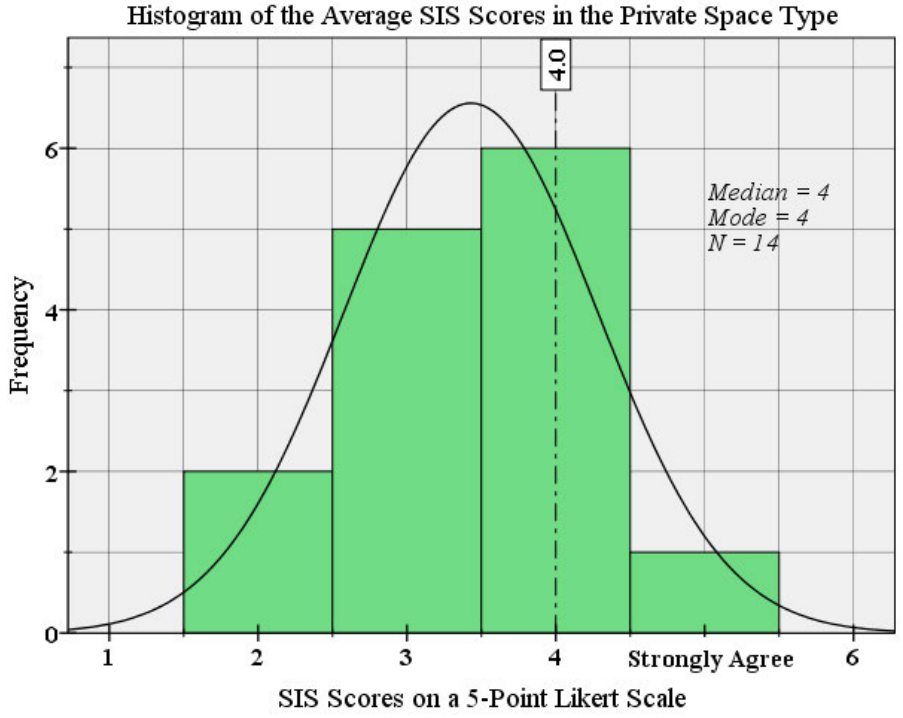
APPENDIX M. FSS Scores During Convergent Tasks in Both Space Types



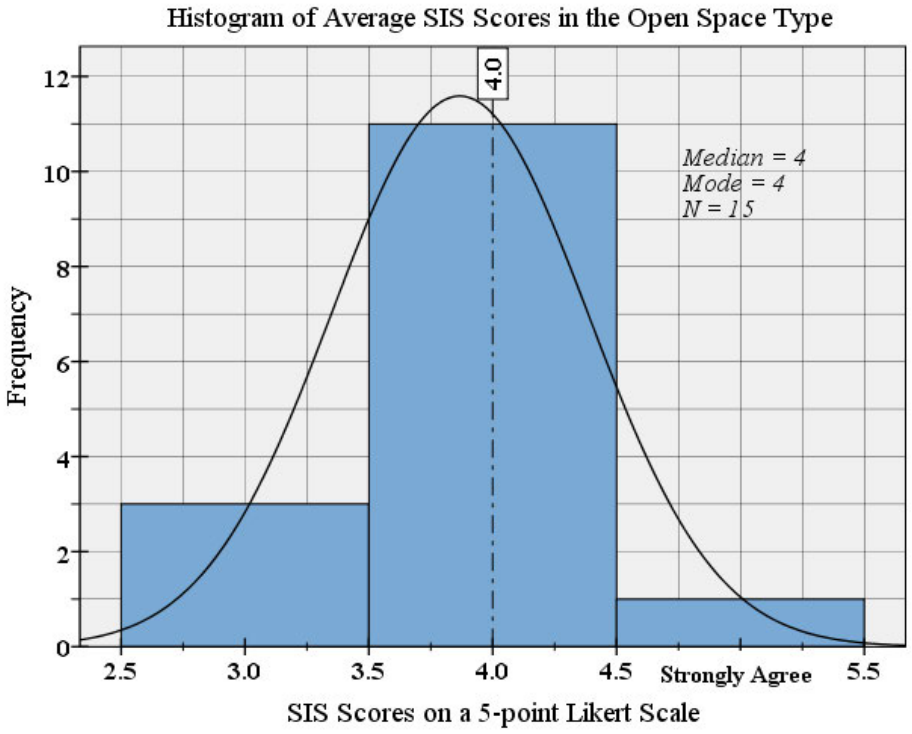


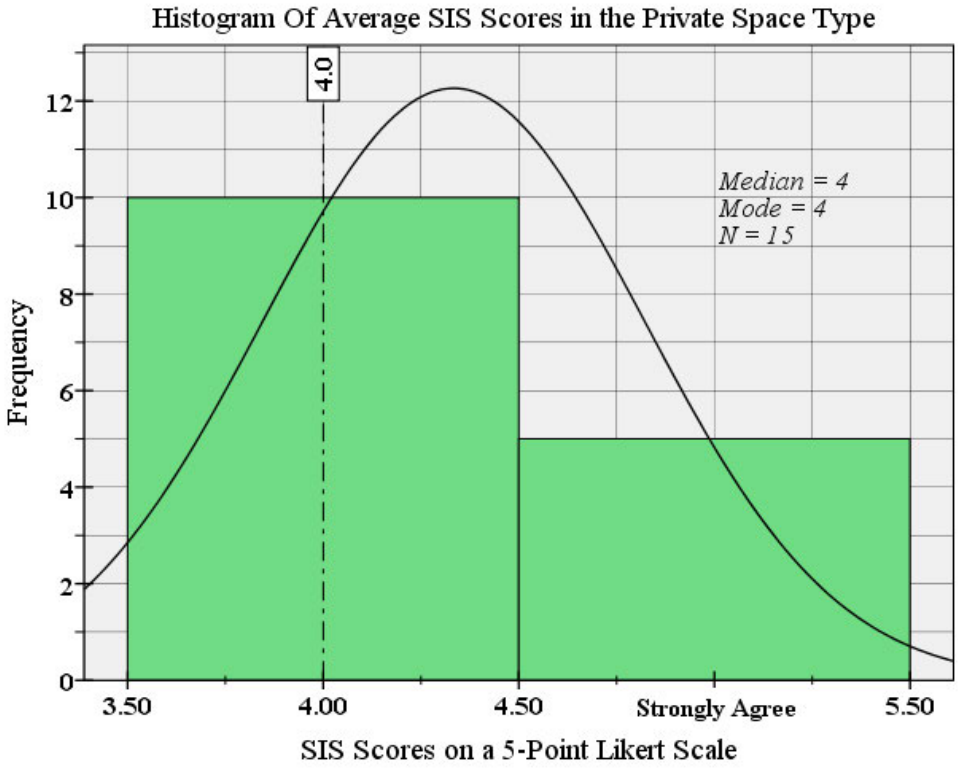
APPENDIX N. SIS Scores During Divergent Tasks in Both Space Types



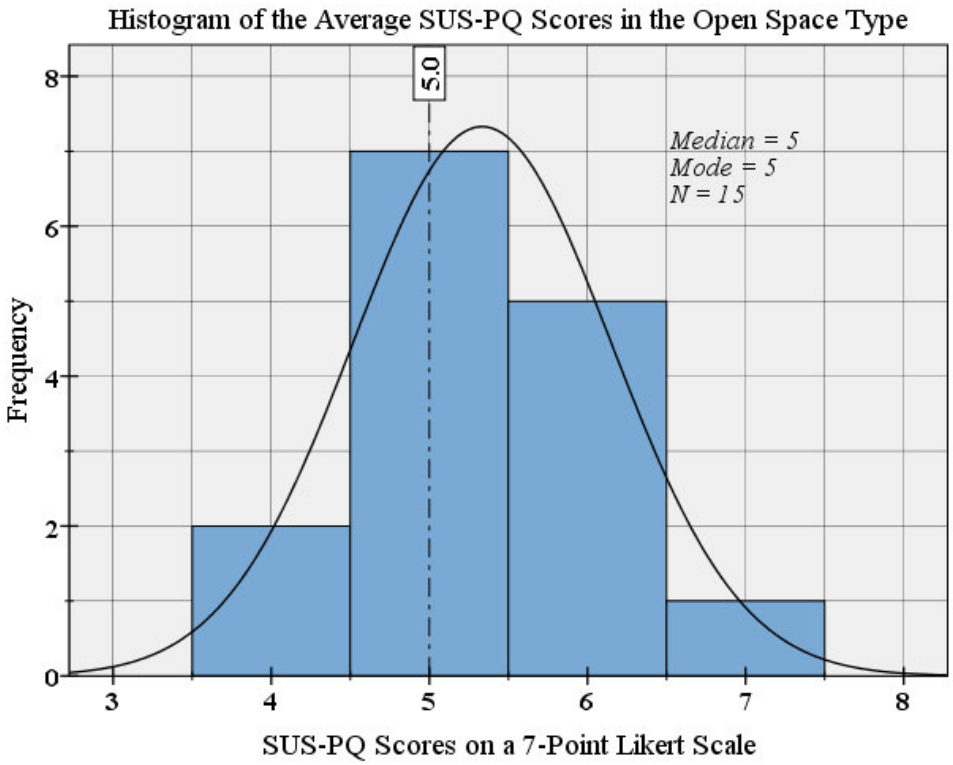


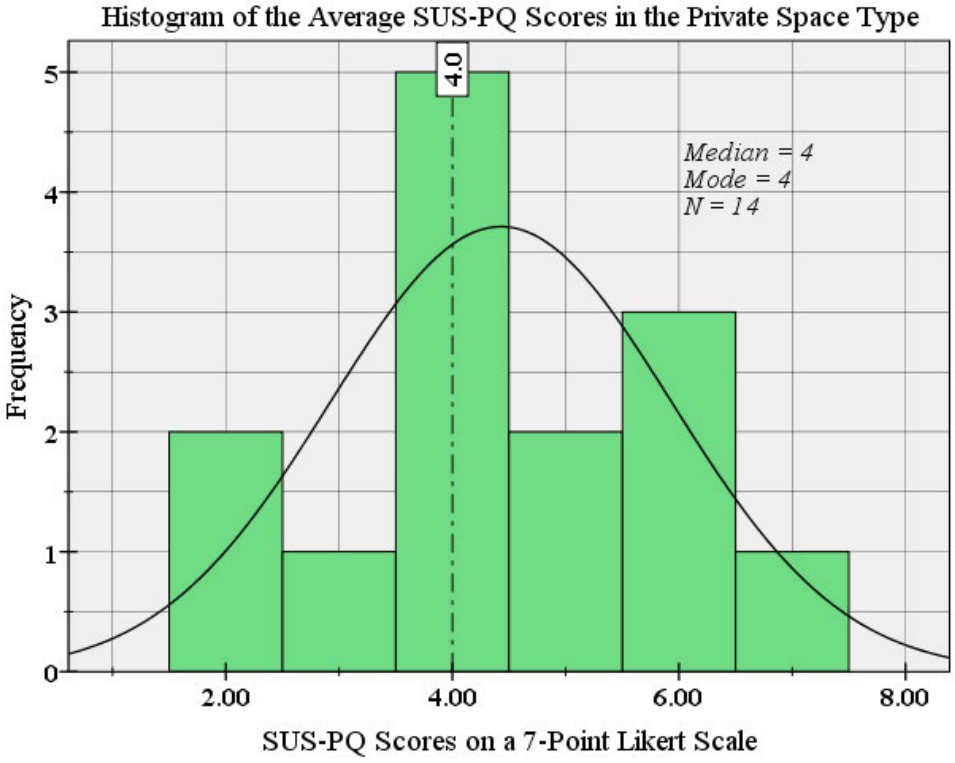
APPENDIX O. SIS Scores During Convergent Tasks in Both Space Types





APPENDIX P. SUS-PQ Scores During Divergent Tasks in Both Space Types





APPENDIX Q. SUS-PQ Scores During Convergent Tasks in Both Space Types