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# Components of Design Thinking in Spatial Design Education and a Model Proposal

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## Abstract
Design thinking, defined in its simplest form as a creative problem-solving process, is interpreted in various ways in the literature, with differing models and components. This study, motivated by the need to identify gaps in existing approaches and to clarify the concept of design thinking, aims to define its key components within the context of spatial design education. To achieve this objective, the study employed qualitative research methods. To collect data, the study utilized both a literature review and content analysis techniques. By categorizing the collected data, it was concluded that design thinking consists of three fundamental components: cognitive-rational, emotional-intuitive, and practical. These components were elaborated upon with subcategories based on literature data, and a comprehensive model proposal for use in space design education was developed. The proposal put forward in this study is significant in clarifying the concept of design thinking and its constituent components. On the other hand, the potential of the proposed model to offer guiding alternatives for the problem-solving process in design studios at various levels and to make design thinking more explicit can be attributed to the pedagogical contributions of this study. From a practical perspective, the study is considered to have the potential to directly inform practice by proposing concrete and applicable steps that can be implemented within the design process. For future research based on this study, it is recommended that the potential contributions of the proposed model be explored through its application in actual design processes. Furthermore, expanding the theoretical scope by questioning different approaches to the components of design thinking is also suggested.

***Keywords:*** *Components of design thinking, Design education, Design process, Design thinking, Spatial design education*

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## INTRODUCTION

Thought is a set of mental processes and operations carried out in response to a problem. These processes may involve various actions such as reasoning, guessing, association, and imagination. Furthermore, activities related to knowing, thinking, and learning fall within the scope of cognitive science. When design is examined within the framework of cognitive science, discussions focus not only on methodical approaches in design but also on the definition of design thinking and how it emerges as a cognitive process (Koçkan, 2012).

Method movements in design initially emerged with the intention of making design more scientific. However, these efforts ultimately highlighted the fundamental differences between design and science. As a result, scientific design is considered as a blend of design methods grounded in scientific knowledge, incorporating both intuitive and non-intuitive processes (Cross, 1993). Consequently, design methodology encompasses the study of how designers think and work, the formulation of effective frameworks for the design process, the development of innovative techniques and methods, and their application to complex problems (Cross, 2001).



The need to make the design process open to examination and critical evaluation has encouraged the use of scientific methods in design (Lawson, 2005). As a result, scientific methodology has been used to study design activity, reflecting the evolving link between design and science (Akış, 2008). In this way, a new view of design thinking began to appear in the 1960s, focusing on cognitive and working processes, and it grew alongside design methodology (Cross, 2023).

Advances in computer and communication technologies have also significantly influenced both the act of designing and the methods employed. As a result, yet another layer was added to ongoing studies of design methods—many of which had yet to be fully explained—highlighting the need to approach design from a cognitive-scientific perspective (Bayazıt, 2004). Within the cognitive-scientific approach to design, the subjective nature of the design process has been acknowledged, and this perspective has focused on explaining the thought processes of designers (Lawson, 2004).Through studies executed within the framework of design research, designers' actions—such as thinking, perceiving, problem-solving, and conceptualization—have been examined (Uluoğlu, 2003).

Since the general structure of space design education—one of the key domains within design education—proceeds through problem-solving processes, the relationship between designers and their thought processes raises important questions and areas of inquiry (Carmel-Gilfilen & Portillo, 2010). Despite ongoing research and investigation, there remains no widely accepted or stable definition of design thinking. This ambiguity reflects the evolving nature of design thinking as an emerging discipline or field of knowledge (Jones, 2010). This research addresses these issues within the framework of space design education

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to contribute to the field. In this study, space design education refers to architecture and interior architecture programs, which are the focus. Space design serves as the core subject in these programs, varying in scale, scope, and detail.

A review of the literature on design thinking reveals ongoing calls for further research and development. For example, Badke-Schaub et al. (2010) emphasize the need to deepen research on design thinking to scientifically support designers and enhance knowledge and progress. Likewise, Lindbergh et al. (2010) highlight the importance of developing a comprehensive design thinking model to guide students through project-based learning courses. Building on these perspectives, Kurt Çavuş (2021) advocates for making design thinking more visible and integrating it into educational curricula. Together, these suggestions form the foundation and motivation for this study.

Another motivation for this study arises from the need to clearly understand the components and approaches that make up design thinking. This understanding is essential for effectively applying design thinking to problem-solving processes within space design education programs (Kurt Çavuş & Kaptan, 2022).



Based on the motivations identified in the literature and the review of existing studies, this research aims to elucidate design thinking and its constituent components within the context of space design education. In line with this objective, design thinking is approached in terms of the problem-solving steps, and a model is proposed for the methodological use of design thinking based on the analysis of relevant literature. Accordingly, the components of design thinking are categorized under three main dimensions: cognitive-rational, emotional-intuitive, and practical components.

## METHOD

This study, conducted within the context of space design education, was developed using a qualitative research method. According to Groat and Wang (2013), qualitative research involves an interpretive approach with a multifaceted focus, aiming to make sense of or interpret the meaning of data. In line with this approach, the study used literature review and content analysis as primary data collection techniques.

The main objective of content analysis is to identify concepts and relationships that help explain the collected data. This technique includes grouping similar data under specific themes and concepts. It also involves organizing and interpreting them in a way that is comprehensible to the reader (Yıldırım & Şimşek, 2006). As a qualitative research technique, content analysis focuses on coding the data based on the frequency and significance of particular words and concepts found in the reviewed sources. It aims to identify thematic areas and interpret the findings by systematically organizing the extracted data.

The data for this study were collected by conducting keyword searches using terms such as “design thinking and architecture,” “design

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thinking and interior architecture," "design thinking and space design education," and "components of design thinking" across both national and international databases, including Web of Science, Google Scholar, DergiPark, and ScienceDirect. No publication year restrictions were applied.

In line with the research objectives, inclusion and exclusion criteria were established to clarify the data selection process. Studies that explicitly discussed design thinking within the context of design education, architecture, or interior architecture, and provided conceptual or analytical insights into its components were included. Conversely, studies that lacked sufficient methodological detail or did not directly address the components of design thinking were excluded.

Within the scope of this study, the collected sources were examined through a content analysis method, and only those that included classifications related to the components of design thinking were incorporated into the research. During the data selection process, studies addressing the concept of design thinking in theoretical or pedagogical contexts were prioritized to maintain alignment with the research objectives.



In the studies reviewed, various approaches to defining the components of design thinking were examined. These approaches were then grouped according to existing classifications found in the literature. These classifications formed the foundation for the development of the proposed approach. Based on the generalizations derived from the literature the scope and sub-layers of the proposed model were defined. A new model was then proposed by synthesizing various approaches to design thinking and identifying their similarities, differences, advantages, and disadvantages. Since the study approaches design thinking in connection with the problem-solving process, the proposed model was developed based on frameworks aligned with this perspective. The data were further elaborated and expanded by adding subheadings under the main categories.

However, this study relies solely on secondary data, which constitutes one of its main limitations. The empirical validation of the model and the exploration of its potential contributions are therefore suggested as directions for future research.

## DESIGN THINKING AND COMPONENTS

The conceptual emergence of design thinking traces back to the late 20th century. Simon (1996) identify design thinking as the application of methodologies and sensitivities characteristic of designers to generate new ideas, choices, alternatives, and practical solutions that address stakeholder needs. Similarly, Rowe (1991), in his book Design Thinking, sought to develop a generalized understanding of the concept. His work aimed to explain the research focus, decision-making processes and internal dynamics involved in the act of designing.

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Visser (2006) offers a cognitive perspective on design thinking, emphasizing both internal (mental) and external (e.g., drawings, notes, and plans) dimensions of the design process. The term design thinking is also commonly used to describe an explicit, structured problem-solving approach employed by decision-makers to address real-world challenges (Melles et al., 2012). Simon (1996) further contributes to this discourse by suggesting that, apart from innate internal properties, all aspects of design are artificial—implying that design thinking can be learned and developed over time.

Over time, researchers have recognized that understanding design thinking is a preliminary step toward developing cognitive design tools that incorporate the problem-solving process and address mental activities (Görgün Göksu, 2022). The first Design Thinking Research Symposium marked an initial exploration into research on design and design methodology. Since then, several design thinking models have emerged, each grounded in distinct approaches to studying design situations. These models draw upon theories and frameworks from fields such as design methodology, psychology, education, and beyond (Dorst, 2011).

Design thinking is a mode of thinking and problem-solving that encompasses knowledge applicable to the creative problem-solving process. As such, design thinking and design education are closely intertwined concepts (Kurt Çavuş, 2021). However, despite this close relationship, Oxman (2004) notes that most design schools rarely address the cognitive processes underlying design thinking as explicit instructional content within studio environments.

In the literature, design thinking has been explored through various approaches. Among these, Kurt Çavuş and Kaptan (2022) examined the components of design thinking as regards individual characteristics such as values, principles, perspectives, and skills that a person adopts and utilizes to creatively solve design problems. Howard et al. (2015) address design thinking in a similar manner.

In other studies, researchers such as Börekçi (2015), Choi and Kim (2017), and Taimur and Onuki (2022) have approached design thinking as regards the tactics and strategies employed to generate ideas that embody this concept. In this study, the components of design thinking have examined as steps applicable within the problem-solving process. Accordingly, the approaches to design thinking are categorized under two main headings: (1) approaches that focus on the values, principles, perspectives, and skills acquired by the designer, and (2) approaches that emphasize the tactics and strategies employed by the designer. These two categories serve as the basis for the discussion and analysis presented in the study.



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**Approaches that Focus on the Values, Principles, Perspectives, and Skills Acquired by the Designer**

In this approach, design thinking is examined through the lens of the values, principles, and skills acquired by the designer, with inquiries structured accordingly. In line with this perspective, Kurt Çavuş and Kaptan (2022) discussed the components of design thinking under various headings, drawing upon data from the existing literature. These; human-orientedness, visualization skills, predisposition to multifunctionality, learning orientation, openness to interdisciplinary/multidisciplinary collaborations, openness to different perspectives and diversity, tendency to teamwork, critical questioning, empathy, reframing problems, willingness to make a difference, holistic perspective, avoidance of having to choose, risk-taking, passion for innovation, experimental intelligence/tendency to learning by doing, experience/ learning through error, creative thinking skills and self-confidence, using language as a tool, optimism and tolerance to uncertainty.



In the study by Howard et al. (2015) (Figure 1), the elements of design thinking are categorized under two main themes: design thinking as a way of life and design thinking as a way of working. Within this framework, key components such as collaboration, empathy, visualization, creative thinking, and prototyping are discussed. Additionally, attributes like optimism, curiosity, and holistic thinking have also been associated with design thinking.

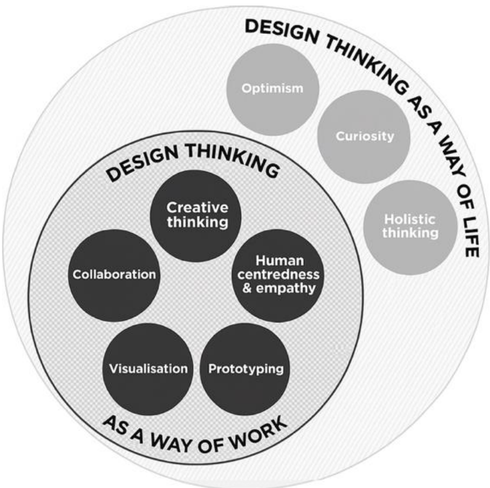


**Figure 1.** Design Thinking Components (Howard et al. 2015).

**Approaches that Emphasize the Tactics and Strategies Employed by the Designer**

Various studies in the literature adopt this approach, in which design thinking is addressed with regards to the tactics and strategies employed during the design process. This category is further divided into two subheadings, reflecting different dimensions of strategic and tactical implementation within the design process.

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Design thinking has been categorized in numerous ways in the literature (Cross, 2023; Kimbell, 2011; Johansson-Sköldberg et al., 2013). In this study, the data were classified based on the framework proposed by Johansson-Sköldberg et al. (2013), as it provides a categorization specific to design disciplines. However, the aspect of design thinking related to values acquired by students is not included in their classification; therefore, this study introduces it as an additional argument for expanding the categorization of design thinking. Based on Johansson-Sköldberg et al.'s framework, design thinking is divided into two subcategories: design thinking as a way of reasoning and making sense and design thinking as a problem-solving activity.

**Design thinking as a problem-solving activity**

Choi and Kim (2017) classified the components of design thinking into three levels: the design process level, the design strategy level, and the design representation level (Figure 2). At the design process level, subcategories include design activity, problem analysis, solution finding, evaluation, idea generation, detailing, and the creative leap. The design strategy level elaborates on strategic resources, which are categorized as knowledge-based and implicit reasoning methods. Finally, the design representation level encompasses both external and internal forms of representation.



| | | |
|---|---|---|
| **Design Process Level** | | |
| Design Activity | | |
| Problem Analysis | Analysing the given task | Problem space |
| | Establishing a new need | |
| Solution Finding | Gathering information | Solution space |
| | Developing conceptual design | |
| | Implementing designs | |
| Evaluation | Evaluating a proposed solution | |
| Idea Generation | | |
| Fluency | Proposal of a new idea | |
| Elaboration 1 | Development of a proposed idea | |
| Elaboration 2 | Rediscovery and redevelopment of a proposed idea | |
| Creative Leap | Making a leap by producing a creative idea | |
| Stuck | Being tied up by a problem | |
| **Design Strategy Level** | | |
| Strategy Resource | | |
| Information driven | Utilising the information collected during the problem analysis | |
| Knowledge driven | Utilising knowledge acquired previously | |
| Schema driven | Utilising existing experience | |
| Implicit | Unclear source | |
| Reasoning Method | | |
| Type | Analogy | |
| | Metaphor | |
| | None | |
| Period | Problem identification | |
| | Solution generation | |
| | Function finding | |
| | Explanation | |
| **Design Representation Level** | | |
| External representation | Transformation | |
| | Mutation | |
| | Conventional representation | |
| Internal representation | Collaborative discussion | |
| | Individual thinking | |

**Figure 2.** Design Thinking Components (Choi and Kim, 2017).

According to Katoppo and Sudradjat's model (Figure 3), the elements of design thinking include: understand, observe, point of view, idea generation(ideate), prototype and test.

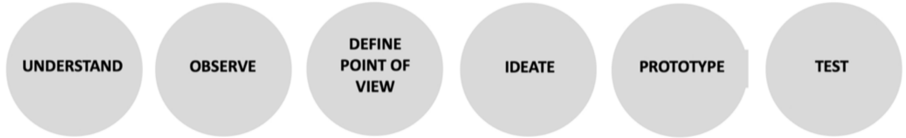


**Figure 3.** Design Thinking Components (Katoppo and Sudradjat, 2015).

Taimur and Onuki's approach (2022) includes five iterative phases; empathize, define, ideate, prototype, test. However, the test phase is handled in the form of transmission (Figure 4) as it is used in the context of design thinking education.


**Figure 4.** Stages of Design Thinking (Taimur and Onuki, 2022).

A similar approach (Figure 5) has also been proposed by the Stanford School. In this approach, the last stage transmission, has been replaced by the test title.




**Figure 5.** The Five Phases of Design Thinking Process (Standford School, 2025).

In the study conducted by Koçkan Özyıldız and Yıldız (2020), design thinking has explained through three main components: preparation, conceptualization, and spatialization (Figure 6).

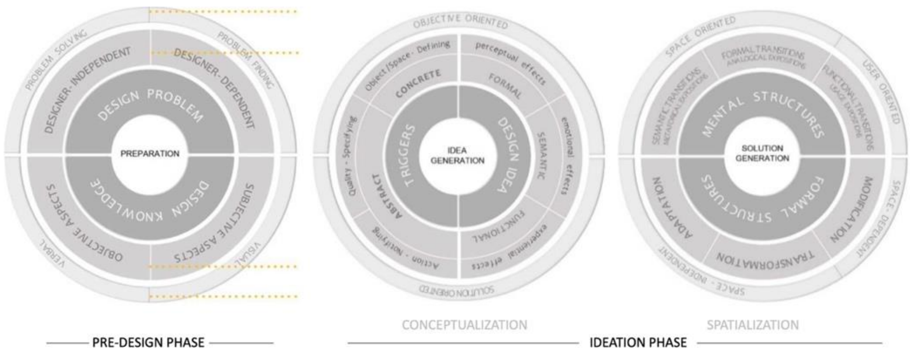


**Figure 6.** Infographic Model of the Design Thinking Process (Koçkan Özyıldız and Yıldız, 2020).

According to the model, design thinking includes two main stages: the pre-design stage and the ideation stage. The elements of the pre-design stage are defined as design problem and design information. The ideation stage is further divided into two sub-processes: idea generation and solution generation. In the conceptualization phase, the layers of triggering concepts or images, along with the main idea, are analyzed. In

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the subsequent spatialization phase, the focus shifts to the layers of mental and formal structures.

As stated the model, the definition of a design problem varies depending on how the designer approaches it. The designer's approach reveals the relationship between two fundamental styles: problem-solving and problem-finding. On the other hand, design knowledge varies depending on how the design problem is defined. The designer processes prior experiences, educational and professional background, and subjective tendencies together with fundamental information about the design problem. In other words, design knowledge and the design problem interactively initiate and shape the design process (Koçkan Özyıldız and Yıldız, 2020).

Akpınar et al. (2015) state that design thinking is not merely a model adapted from rational behaviors such as analysis, synthesis, evaluation, or formulation-synthesis-analysis. Rather, design—and by extension, design thinking—also encompasses intuitive thinking and reasoning processes. According to this approach, design thinking is addressed under several components: problem formulation, previous experiences, goal/target formulation, design thinking, avoidance logic, pragmatic maxim, development of design alternatives, and design implementation (Figure 7).



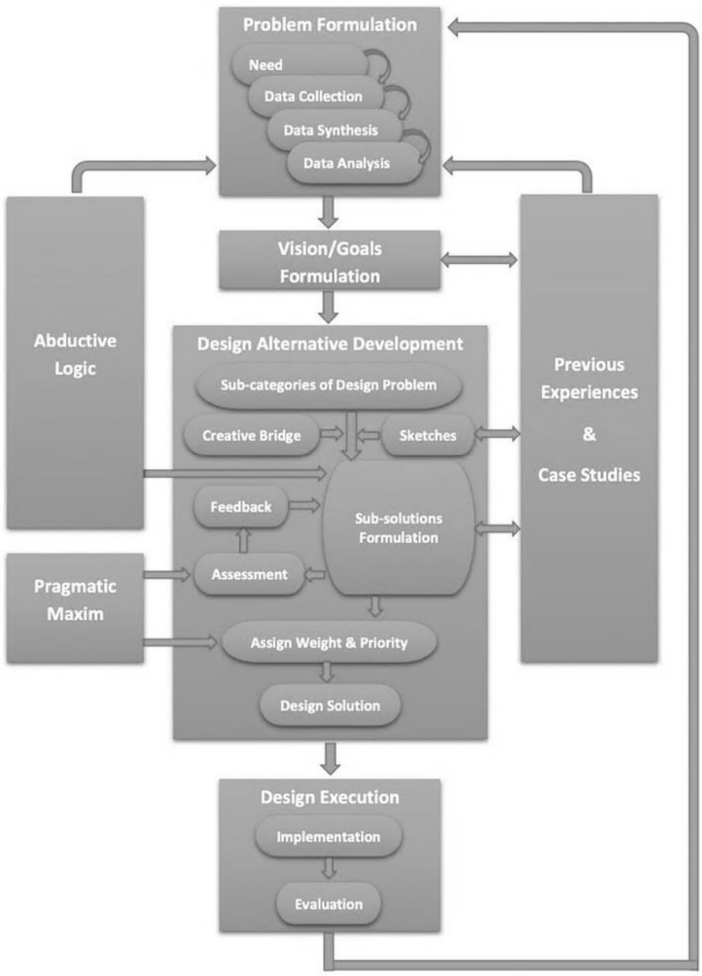


**Figure 7.** Design Thinking Model (Akpınar et al. 2015).

Lindberg et al. (2010) define the components of design thinking under the categories of exploring the problem area, discovering the solution space (Figure 8), and integrating these two areas. However, rather than presenting these as sequential process steps, the authors conceptualize them through modes of operation. These working modes include framing the design problem, comprehending external information, pooling information, synthesizing, selecting a path, generating ideas, defining concepts, and concretizing those concepts.

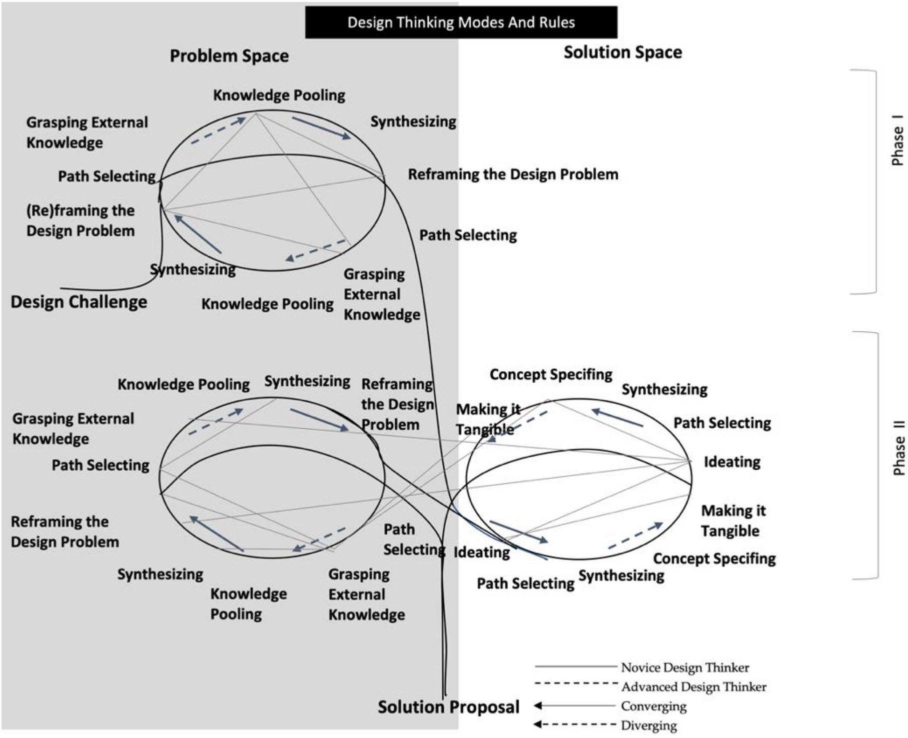


**Figure 8.** Adaptive Design Thinking Workflow Model (Lindberg, et al. 2010).

In the design thinking approach proposed by Howard and Davis (2011) (Figure 9), the elements of design thinking are categorized under the stages of defining the problem, researching, prototyping-testing, implementing, evaluating, and storytelling. In this model, the defining the problem stage emphasizes curiosity and is driven by asking "why" questions. During the research step, information is collected and synthesized through the literature of relevant disciplines.

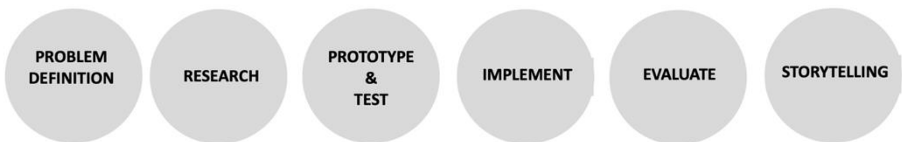


**Figure 9.** Design Thinking Model (Howard & Davis, 2011).

The incorporation of prototyping and hypothesizing in the model enables the use of creativity to generate potential solutions. The implementation and evaluation stages correspond to the rollout and review phases. According to Howard and Davis (2011), once the solutions



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are implemented and assessed, it is essential to communicate the design process and outcomes through both informal and formal storytelling.

Another approach links the higher-order thinking stages proposed by Bloom—an influential figure in educational psychology—with design thinking, and this association is reflected in relevant studies within the field of space design.

According to Bloom, thinking consists of three domains (Figure 10): cognitive, affective, and psychomotor. The cognitive component pertains to mental skills, while the affective domain involves emotional development and attitudes. The psychomotor domain, on the other hand, encompasses physical skills that require coordination betwixt the brain and muscles (Aslan, 2012).

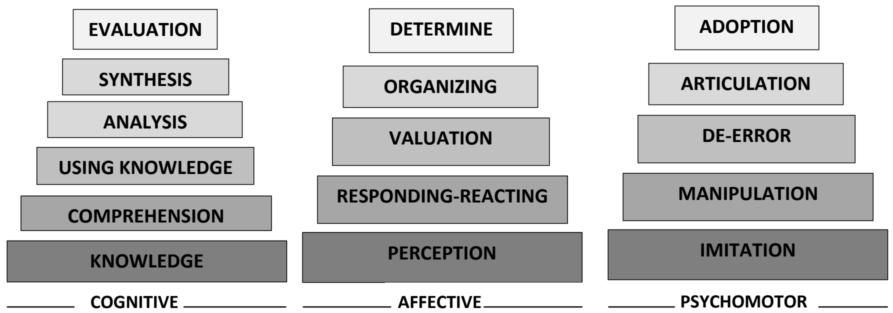


**Figure 10.** Phases of Thinking (Aslan, 2012).



In the study conducted by Yıldırım (2022), design thinking was examined through the lens of Bloom's taxonomy, categorizing it into cognitive, affective, and psychomotor components (Figure 11). According to this framework, the processes of problem definition and problem-solving are related with the cognitive component of design thinking. The affective component involves the internalization of the problem and its articulation through a subjective perspective. Finally, the psychomotor component encompasses the expression or transmission off all these processes.

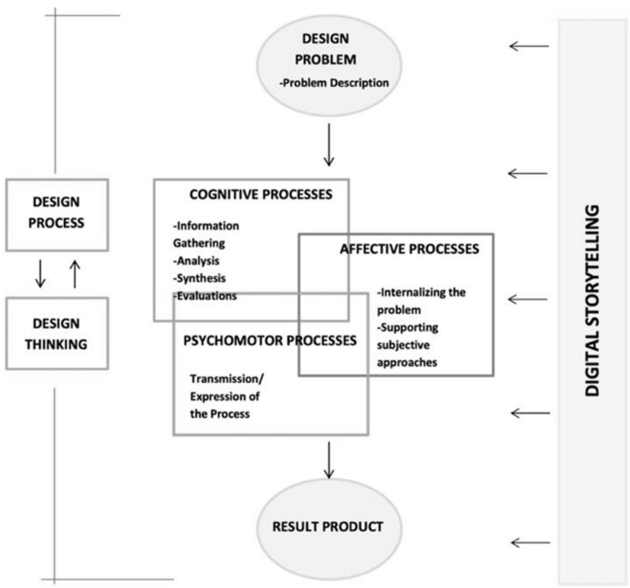


**Figure 11.** Design Thinking Components and Digital Storytelling (Yıldırım, 2022).

Wrigley et al. (2018) conceptualize the components of design thinking through the Design Education Ladder model (Figure 12). In this framework, the elements of design thinking are sequentially identified as understanding, application, analysis, synthesis, and evaluation. Within this model, understanding is regarded as a cognitive learning outcome, while application, analysis, and synthesis are categorized as skill-based learning outcomes. Evaluate, in turn, is interpreted as an affective learning outcome.

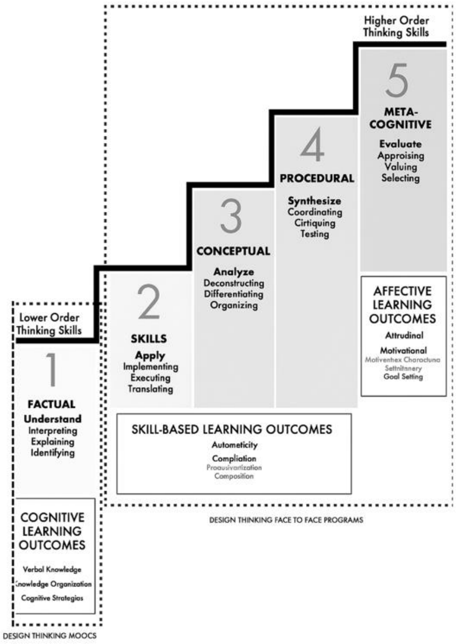


**Figure 12.** Design Education Ladder Model (Wrigley at al. 2018).



Avsec and Jagiello-Kowalczyk (2021) approached design thinking as a reflective process, linking it to the concept of metacognition, and proposed a model grounded in the Stanford School framework (Figure 13). In this model, design thinking is conceptualized as a cyclical process composed of the core components of empathize, define, ideate, prototype, and test. Surrounding these core components are broader elements such as learning activities, awareness, interpersonal skills, learning strategies, and evaluation, control, knowledge and monitoring.

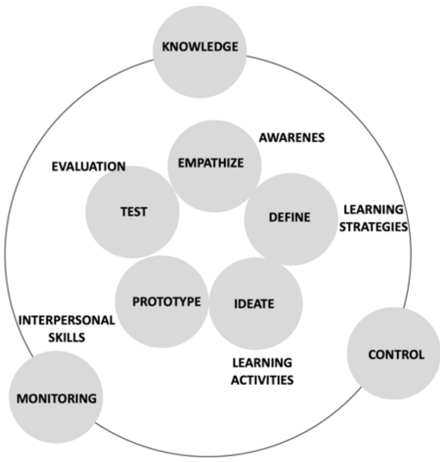


**Figure 13.** Metacognitive Design Thinking Model (Avsec & Jagiello-Kowalczyk, 2021).

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**Design thinking as a way of reasoning/making sense of things**

Börekçi (2015) conceptualized the components of design thinking through three main themes and twelve design thinking tactics. These tactics include incorporating personal experiences, accounting for user-based observations, the use of past experiences, the use of analogies, and the review of examples. During the solution-oriented analysis of the problem, emphasis is placed on exploring the user and the environment as well as examining similar ideas. Finally, the technical analysis of the summary involves reviewing project requirements, deviating from the design brief and providing technical information.

Dorst (2010) identifies the components of design thinking as grounded in five core activities: formulating, representing, transporting, evaluating, and managing design thinking carriers. According to this framework, formulation involves identifying the key issues within a problem space and reframing them in a novel and original manner. Within design disciplines, representation of both problems and solutions plays a critical role, as it enables designers to develop their ideas through an ongoing dialogue with these representations. The process of evaluation is also central to maintaining direction in a design project. Particularly in the early stages—when problems and solutions remain ambiguous—this evaluation tends to be subjective in nature, shaped by the designer's interpretations and insights.



Goldschmidt and Rodgers (2013) propose three key strategic components of design thinking that are widely applicable across various design disciplines. These components include adopting a broad systems approach to the problem, rather than adhering to narrowly defined problem criteria; framing the problem in a distinctive and original way; and designing from first principles.

Lawson (2006) identifies the central dimensions of design thinking as formal, symbolic, practical, and radical. According to this framework, formal constraints pertain to the aesthetic and compositional qualities of a design. Symbolic constraints influence the interpretive meanings embedded within the design. Practical constraints address the technical and construction-related aspects, including materials, mechanical systems, and technological requirements. Lastly, radical constraints relate to the core purpose or fundamental function of the designed object or system.

Given that design thinking is inherently oriented toward innovation, Brown (2008) outlines three key stages necessary for the innovation process to function effectively. The first stage is the inspiration area, which involves gathering insights and ideas that inform the problem-solving process. The other stage is the idea area, where these ideas begin to take shape through prototyping. The final stage is the application area, which focuses on developing a comprehensive production plan to bring the innovation to the intended user.

The fundamental concepts of design thinking across various design disciplines are often explored through studies on design cognition and design action. In this context, Howard (2013) emphasizes that design thinking arises from an equal integration of analytical and intuitive thinking (Figure 14).

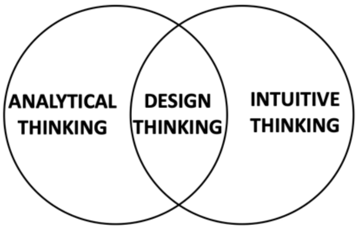


**Figure 14.** Design Thinking Working System (Howard, 2013).

Goldschmidt and Badke-Schaub (2010) conceptualize the components of design thinking under four key categories: search, mental image, evaluation, and structuring learning. In this framework, the process of search—which includes seeking information and generating potential solutions—contributes to the expansion of knowledge within the design context. Mental image is essential for constructing and adapting mental models in the face of complex problem-solving tasks. Furthermore, evaluation and structuring learning are critical for determining which ideas and information are advanced, organized, or discarded.



According to Jones (2010), design thinking is characterized as a trajectory involving kinesthetic, emotional, and mental movements, despite following a structured process. Consequently, he conceptualizes the components of design thinking under cognitive, emotional, and kinesthetic.

Smulders and Subrahmanian (2010) conceptualize the components of design thinking under three key headings: problem, system-principles, and integration. From this perspective, even when a problem appears well-defined initially, it is essential to treat problems or initial conditions as ill-defined to allow for novel integrations and innovative solutions. Addressing design challenges at more abstract and comprehensive levels (the system) or at more fundamental levels(principles) provides designers with strategies to challenge and potentially overcome existing assumptions. The development of specific design elements often occurs in line with the conceptualization of others; while one aspect is elaborated in detail, another may remain at a conceptual stage until integration becomes feasible. This dynamic interplay exemplifies integration.

Oxman (2004) explains design thinking and its conceptual structure through a method comprising three components: subject, concept, and form (Figure 15). In this framework, the subject component represents the connection to the problem. The concept component reflects a holistic or whole-oriented way of thinking. Finally, the form component embodies the formal or physical manifestation of the idea or thought.

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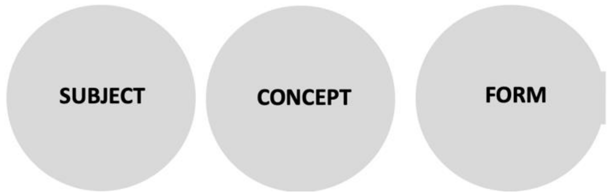


**Figure 15.** Design Thinking Components (Adapted from Oxman, 2004).

## FINDINGS

Based on the data obtained from the study, which aims to identify the components of design thinking within the context of space design education, it is evident that these components have been described in numerous ways in the literature. An overview of these descriptions is provided in Table 1.

**Table 1.** Studies in the literature on design thinking components.

| | |
|---|---|
| 1.Approaches that focus on the values, principles, perspectives, and skills acquired by the designer | |
| Kurt Çavuş & Kaptan (2022) | ▪ Human-orientedness,<br>▪ Visualization skills,<br>▪ Predisposition to multifunctionality, learning orientation,<br>▪ Openness to interdisciplinary/multidisciplinary collaborations,<br>▪ Openness to different perspectives and diversity,<br>▪ Tendency to teamwork,<br>▪ Critical questioning,<br>▪ Empathy,<br>▪ Reframing problems,<br>▪ Willingness to make a difference,<br>▪ Holistic perspective,<br>▪ Avoidance of having to choose,<br>▪ Risk-taking,<br>▪ Passion for innovation,<br>▪ Experimental intelligence/tendency to learning by doing,<br>▪ Experience/ learning through error,<br>▪ Creative thinking skills and self-confidence, using language as a tool,<br>▪ Optimism<br>▪ Tolerance to uncertainty. |
| Howard & Senova & Melles (2015) | ▪ Empathy,<br>▪ Collaboration,<br>▪ Creative thinking,<br>▪ Visualization,<br>▪ Prototyping<br>▪ Optimism,<br>▪ Curiosity,<br>▪ Holistic thinking |
| 2. Approaches that emphasize the tactics and strategies employed by the designer | |
| 2.1. Design thinking as a problem-solving activity | |
| Choi & Kim (2017) | ▪ Design process level,<br>▪ Design strategy level,<br>▪ Design representation level |
| Katoppo & Sudradjat (2015) | ▪ Understand,<br>▪ Observe,<br>▪ Point of view,<br>▪ Idea generation<br>▪ Prototype<br>▪ Test |
| Taimur & Onuki (2022) | ▪ Empathize,<br>▪ Define,<br>▪ Think,<br>▪ Prototype, |

| | |
|---|---|
| | ▪ Test/present |
| Koçkan Özyıldız & Yıldız (2020) | ▪ Preparation,<br>▪ Conceptualization<br>▪ Spatialization |
| Interaction Design Foundation | ▪ Emphatize<br>▪ Define<br>▪ Ideate<br>▪ Prototype<br>▪ Test |
| Akpınar & XU & Brooks (2015) | ▪ Problem formulation,<br>▪ Previous experiences,<br>▪ Goal-target formulation,<br>▪ Design thinking ,<br>▪ Avoidance logic,<br>▪ Pragmatic maxim,<br>▪ Design alternative development,<br>▪ Design implementation |
| Lindberg, Gumienny, Jobts & Meinel (2010) | ▪ Exploring the problem area,<br>▪ Discovering the solution space<br>▪ Integrating these two areas |
| Howard & Davis (2011) | ▪ Problem definition,<br>▪ Researching,<br>▪ Prototyping-testing,<br>▪ Implementing,<br>▪ Evaluating<br>▪ Storytelling |
| Aslan (2012), Savaş (2019) & Yıldırım (2022) based on Bloom | ▪ Cognitive process<br>▪ Affective process<br>▪ Psychomotor process |
| Wrigley & Mosely & Tomitsch (2018) | ▪ Understanding<br>▪ Application,<br>▪ Analysis,<br>▪ Synthesis<br>▪ Evaluation |
| Avsec & Jagiello-Kowalczyk ( 2021) | ▪ Emphatize<br>▪ Define<br>▪ Ideate<br>▪ Prototype<br>▪ Test<br>▪ Awareness<br>▪ Learning Strategies<br>▪ Learning Activities<br>▪ Interpersonel skills<br>▪ Evaluation<br>▪ Knowledge<br>▪ Control<br>▪ Monitoring |
| Koçkan Özyıldız & Yıldız (2020) | ▪ Preparation,<br>▪ Conceptualization<br>▪ Spatialization |
| 2.2 Design thinking as a way of reasoning/making sense of things | |
| Börekçi (2015) | ▪ The inclusion of personal experiences,<br>▪ Solution-oriented analysis of the problem,<br>▪ The technical analysis of the summary |
| Goldschmidt & Rodgers (2013) | ▪ Adopting a broad systems approach to the problem,<br>▪ To frame the problem in a distinctive<br>▪ To design from first principles. |
| Lawson (2006) | ▪ Formal,<br>▪ Symbolic,<br>▪ Practical,<br>▪ Radical |
| Brown (2008) | ▪ Inspiration area,<br>▪ Idea area,<br>▪ Application area |



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| | |
|---|---|
| Howard (2013) | ▪ Analytical thinking<br>▪ Intuitive thinking |
| Dorst (2010) | ▪ Formulating,<br>▪ Representing,<br>▪ Transporting,<br>▪ Evaluating<br>▪ Managing |
| Goldschmidt & Badke-Schaub (2010) | ▪ Search,<br>▪ Mental image,<br>▪ Evaluation,<br>▪ Structuring learning |
| Jones (2010) | ▪ Cognitive,<br>▪ Emotional<br>▪ Kinesthetic |
| Smulders & Subrahmanian (2010) | ▪ Problem,<br>▪ System-principles<br>▪ Integration |
| Oxman (2004) | ▪ Subject<br>▪ Concept<br>▪ Form |

The frequency of usage of the elements that constitute the concept of design thinking is presented in Figure 16.

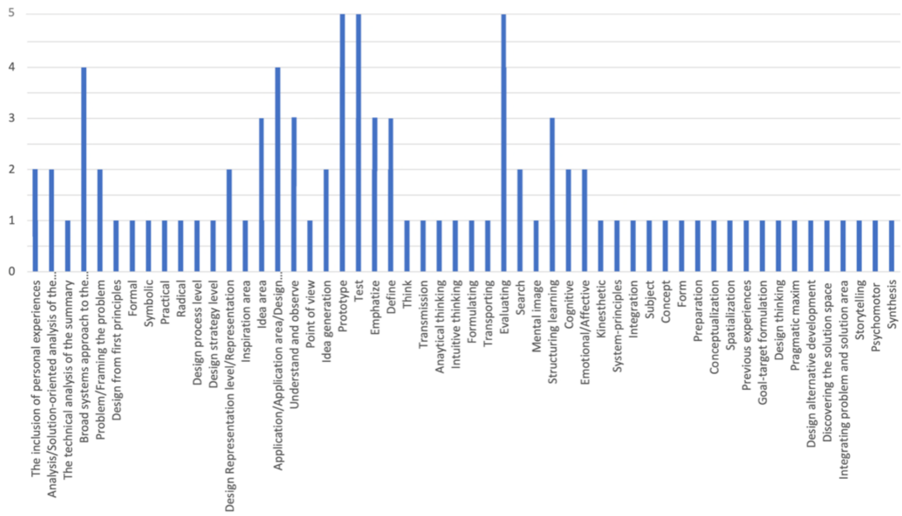


**Figure 16.** Design Thinking Components and Frequency of Use.

Accordingly, Börekçi's (2015) approach to the components of design thinking is structured as a guidance framework for problem-solving. Within this approach, various dimensions of design thinking are addressed through specific sub-headings, emphasizing both the incorporation of personal experiences and the analytical examination of the problem.

Goldschmidt and Rodgers (2013) propose redefining and narrowing the design problem by adopting a broader systems perspective and by encouraging designers to work from first principles. However, when evaluated within the context of space design education, this approach appears to be general, as it primarily concentrates on the nature of the problem and its formulation within the design process. It tends to overlook the subjective dimensions of design thinking, and the communication or expression of the design process.



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In the components of design thinking discussed by Choi and Kim (2017), the design process level encompasses elements such as analysis, synthesis, and evaluation, which correspond to the cognitive dimension of design thinking. While the strategy level aims to highlight the subjective aspect of design thinking—particularly in terms of reasoning—it is considered to remain ambiguous. Additionally, the representation level addresses the expression of ideas through various techniques, emphasizing the communicative aspect of design thinking. Although Choi and Kim's framework is both comprehensive and clearly structured, its applicability within the problem-solving processes of space design education remains uncertain and open to further investigation.

Although Brown (2008) addresses various dimensions of design thinking through the stages of inspiration, ideation, and implementation area, it is argued that the scope of these components and their adaptability to the design problem-solving process are not clearly articulated.

Although Katappo & Sudradjat (2015), Taimur & Onuki (2022), Dorst (2010), and Wrigley et al. (2018) define the elements of design thinking using similar terms—such as perspective, empathy, problem definition, ideation, prototyping, testing, and presentation—these elements are largely framed as sequential steps within a problem-solving process. However, this process-oriented perspective does not fully encompass all dimensions of design thinking.



In the design thinking model proposed by Howard and Davis (2011), the components include commonly recognized stages such as problem definition, research, prototyping and testing, implementation, and evaluation. However, a notable addition in their framework is storytelling, which sets it apart from other models. While the overall approach addresses the cognitive dimensions of design thinking—like analysis, synthesis, and iteration—storytelling introduces a subjective to the process.

Although Avsec & Jagiello-Kowalczyk (2021) address themes like other design thinking models, their approach is distinguished by its incorporation of sub-layers such as awareness, learning activities, and personal abilities. Moreover, while acknowledging the cognitive dimension of design thinking, their model also integrates its subjective and experiential aspects and framing the process as cyclical rather than linear.

Goldschmidt and Badke-Schaub (2010) identified the components of design thinking as research, mental imagery, evaluation, and the structuring of learning. Howard (2013), in contrast, argued that design thinking involves an equal integration of intuitive and analytical modes of thinking.

Jones (2010) states that design thinking encompasses cognitive, emotional, and kinesthetic components. Oxman (2004), on the other hand, describes design thinking and its conceptual structure through a

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method comprising the components of subject, concept, and form. While both approaches are valuable in addressing different dimensions of design thinking, they offer limited guidance for effectively engaging with the problem-solving process.

Lindberg et al. (2010) define the components of design thinking under the categories of exploring the problem space, exploring the solution space, and integrating these two domains. Moreover, design thinking is approached in terms of modes of operation rather than as a sequence of interdependent process steps. This perspective incorporates various components and stages intended to facilitate the application of design thinking. However, it is considered to involve complexities that may hinder its practical use in problem-solving processes.

In the study conducted by Koçkan Özyıldız and Yıldız (2020), design thinking is conceptualized through three main components: preparation, conceptualization, and spatialization. This model considers design thinking not only from a cognitive perspective but also from an affective standpoint, incorporating subjective dimensions. However, the final component—spatialization—raises questions regarding its content, particularly in relation to abstract outcomes typically associated with basic design studios. On the other hand, models based on Bloom's taxonomy support this study by offering a multidimensional and detailed framework for understanding design thinking.



The model proposed by Akpınar et al. (2015) is considered valuable for its acknowledgment of both the rational and intuitive dimensions of design thinking. However, the complexity of the model's sub-headings and the relationships among them presents challenges in terms of readability and adaptability to the problem-solving process.

When design thinking is understood in its simplest form as the generation of ideas and solutions during problem solving, the process can be seen as comprising a series of cognitive stages commonly associated with the design process—namely, problem identification, information gathering, analysis, synthesis, evaluation, and the development of a final product. However, it would be inaccurate to view this process as consisting solely of these stages. The problem-solving process also encompasses affective dimensions—subjective thoughts and the internal frameworks of the designer—which play a critical role in shaping outcomes. Furthermore, the forms of expression that emerge at the conclusion of this process are also components of the design thinking.

Within the study sample, some research (e.g., Katappo and Sudradjat, 2015; Taimur and Onuki, 2022; Dorst, 2010; Wigley et al., 2018; Howard and Darwis, 2011) outlined the components of design thinking in a broad manner, whereas others (e.g., Koçkan Özyıldız and Yıldız, 2020; Lindberg et al., 2010; Bloom) have provided more detailed discussions. Consequently, the examples examined in this study offer insights into various dimensions of design thinking. However, the complexity and level of detail in some models, as well as the difficulty in following certain procedural steps, raise questions about their applicability to problem-solving processes in space design education.

In this study, the components of design thinking were synthesized by drawing on themes identified in existing approaches. By examining the similarities, differences, strengths, and limitations of these approaches—as well as their potential contributions—the aim is to propose a model that is both inclusive and adaptable to the problem-solving process.

Since the model proposed in this article is intended to serve as a guide for the problem-solving process, it has been developed based on approaches that emphasize the tactics and strategies employed by the designer.

Based on the data acquired from the literature, common themes across all process models include subject component, formal component, inspiration area, formulation, comprehension, cognitive processes, problem/problem area, system approach to the problem, analytical thinking, rational thinking, understand/observe, design process level, preparation, concept development and empathy/definition. These elements are generally recognized as processes that encompass all or some of the essential steps involved in problem solving. As indicated in the reviewed studies, the initial components of design thinking typically follow a sequence involving problem definition, formulation, or exploration. In essence, this initial phase of design thinking encompasses steps such as understanding, defining, discovering, identifying, and addressing the problem. These steps can be collectively categorized as the cognitive-rational component.



In this classification, the second generalizability can be addressed under headings such as: concept, idea area/generation, mental image, emotional, solution area, system/principles, framing the problem, intuitive thinking, point of view definition, design strategy level, conceptualization, awareness, learning strategies, learning activities, interpersonel skills, emotional-situational component and thinking. When the components are generalized, it becomes evident that they also encompass subjective approaches to the problem. This indicates that another key component of design thinking involves its subjective, emotional, and intuitive dimensions.

Considering that design thinking is fundamentally a problem-solving process, it is natural for it to incorporate both objective and subjective approaches. The inclusion of this component in most of the studies reviewed in the literature shows that another component that constitutes design thinking is the emotional-intuitive component.

According to Table 1, when the components that constitute design thinking are generalized, another common approach refers to the transmission, representation and externalization dimension of the problem-solving process (design thinking). Although these approaches are referred to by various terms—such as form, practical/radical, application area, representation, evaluation, kinesthetic, integration, prototype, design representation level, spatialization, application,

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psychomotor component, test, and control—they all reflect the externalization aspect of the process. Therefore, another component in the proposed model is the practical component, which constitutes the representational dimension of design thinking.

Based on these generalizations, it is considered that the initial components of design thinking are grounded in rational processes, as they encompass the fundamental stages of problem solving—commonly referred to as cognitive processes—and do not involve the subjective values of the designer. Accordingly, this first component of design thinking is termed the cognitive-rational component. The second component of design thinking has identified as the emotional-intuitive component, as it encompasses elements that reflect the designer's subjective approaches. Finally, in most studies, a component grouping related to the transmission and externalization of the entire process has been observed. This tendency indicates that another essential component of design thinking is the practical component.

The subheadings in the proposed model have identified by drawing on the subheadings found in the literature that represent design thinking components, while also considering their relevance to the three categories (cognitive-rational, emotional-intuitive, practical) established in this study.



## CONCLUSION

This study addresses the lack of a stable consensus regarding design thinking and its components within space design education. Accordingly, its objective is to identify and clarify the key elements that constitute design thinking in this context. Based on an analysis of data gathered from international literature, three primary components of design thinking have been identified: the cognitive-rational component, the emotional-intuitive component, and the practical component.

On the other hand, these three main components were further elaborated based on the obtained data. They were divided into sub-layers, and the suggestion model/approach in Figure 17 was created. Accordingly, while the primary components of design thinking are cognitive-rational, emotional-intuitive, and practical, the subheadings that constitute the cognitive-rational component are identified as problem, comprehending and understanding, framing the problem-producing new problems, using information (prior knowledge-design knowledge), analysis, synthesis and evaluation. The subheadings that constitute the emotional-intuitive component are identified as perception, responding-reacting, point of view identification, valuation (sensory-mental-spiritual), identification-characterization (main idea-concept-conceptualization). Finally, the practical component is defined to include the subcategories of application, transmission, imitation, manipulation, and transformation.

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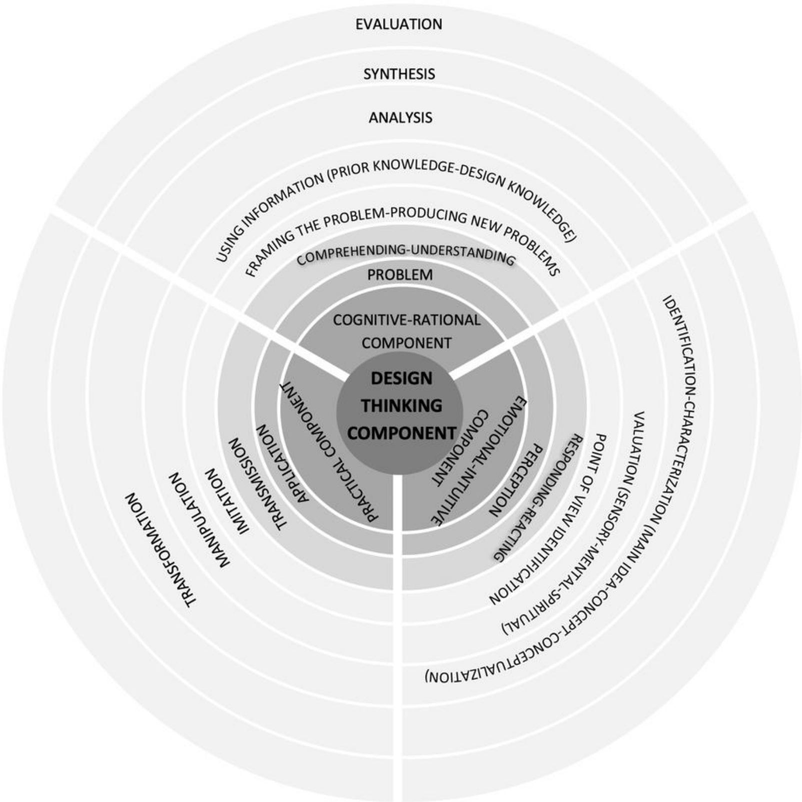


**Figure 17.** Design Thinking Components Suggestion Model.



The subheadings that comprise the cognitive-rational component basically refer to the problem-solving process. They encompass all the stages the designer experiences. These include comprehending and understanding the problem, limiting the problem accordingly (solving the existing problem) or defining a new problem (finding a problem), using the information (prior knowledge-design knowledge), analyzing the obtained data in ways that contribute to problem resolution, synthesizing these analyses meaningfully for problem solving, Finally, an evaluation step assesses the product's potential to address the initial problem.

The emotional-intuitive component enables the designer to seek meaning in the problem. In other words, it involves identifying a design purpose or selecting a starting point using information the designer has obtained. This sub-component represents one of the most critical stages of design thinking. It marks the moment when subjective and internal processes begin to be expressed and externalized. To facilitate the externalization of these implicit and intuitive processes, the designer needs triggers, such as concepts and images related to the problem.

The emotional-intuitive component covers subjective aspects of design thinking. It is characterized by subheadings such as perceiving, responding or reacting, defining a point of view, valuation (sensory, mental, spiritual), and determining or characterizing the main idea or concept. Subjectivity begins with how the student perceives the problem. This perception leads to initial responses or reactions. Defining a viewpoint is the stage where the first concrete data about the problem

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appear. Valuation involves further developing and assessing this information. Finally, identification-characterization mark when these subjective approaches form the main idea or concept and are reflected in the study.

The practical component is the phase for shaping the idea and expressing the process. It includes subheadings: application, transmission, imitation, manipulation, and transformation. Application means implementing the proposed process, solution, or creating an archetype. Transmission is expressing or representing the process. Imitation is abstracting a concrete form as a starting point, or adapting methods found through the internet or digital media. Manipulation means applying skills or steps by following instructions. Transformation is changing the visual features of the design concept or main idea. These subheadings are included because the practical component consists of several approaches and techniques.

In the space design education problem-solving process, the student must identify a situation, phenomenon, event, or problem, generate information to resolve it through definitions they construct, and ensure the development of the information is traceable. This entire progression constitutes design thinking and its components. While many studies treat these stages as linear (Choi and Kim, 2017; Howard & Davis, 2011; Katoppo and Sudradjat, 2015; Taimur and Onuki, 2022), they are in fact cyclical and interdependent. Therefore, the model presented in this study was developed holistically, represented as a single circle.



The studies by Koçkan Özyıldız and Yıldız (2020) and Akpınar et al. (2015) contributed to the development of the model proposed in this study by addressing the intuitive and rational dimensions of design thinking. However, the proposed model expands the scope of the subject by differing from existing approaches. It addresses the components of design thinking in a holistic manner, incorporates stages that can support the problem-solving process, and establishes theoretical connections with the emotional–intuitive and practical dimensions, which have been relatively underrepresented in the literature. These characteristics demonstrate the model's originality and comprehensive structure.

On the other hand, the model's potential to be integrated into design studios at different levels—offering alternative pathways to guide the problem-solving process and enabling the visualization of the components that constitute design thinking—is associated with the pedagogical contributions of the study. The practical contribution, in turn, lies in the model's potential to provide direct guidance for design practice by proposing concrete, applicable steps to be employed within the design process.

For future research grounded on this study, it is recommended to use the proposed model as an analytical tool in the design process and investigate its potential contributions to the field and to integrate it with space design education studio environments.

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The integration of this model into studio environments can be implemented as follows: The model can be introduced to students from the very beginning of a project. Students can use the model both as a guiding framework and as a structure supporting their problem-solving processes. At each stage, the ideas and proposals they develop are linked to the model's core components, explained, and justified. In this way, the implementation of the model not only assists students in addressing complex design challenges but also provides an opportunity to evaluate its effectiveness and contributions within the studio context. Moreover, this process also helps to make design thinking and its components more visible.

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## Resume

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