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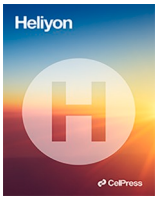

Research article

Developing positive design with innovative thinking framework: A design pedagogical approach to enhance subjective well-being

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ABSTRACT

Design thinking is the foundation of professional design education, and the shift from zero to professional design skill involves the completion of the transition from single-mindedness to independent and innovative thinking. In this exploratory study on design teaching, we build a novel teaching model by drawing on the connection between students' self-transcendent knowledge and formal knowledge in design thinking. Based on the Design for Happiness framework (DfH), this study uses Positive Emotional Granularity cards (PEG) to stimulate students to identify and categorize various positive emotions. We matched 15 furniture-related positive emotion keywords, summarized the corresponding design strategies, and subsequently generated Design for Happy Furniture cards (DfHF). We looked at new structural reorganizations of design teaching resources and effective teaching models and examples that might be used in course delivery. This study used the USE scale for quantitative analysis and triangulation for qualitative data analysis. The results indicate that this method is crucial for making it easier to convert design ideas into practice and for enhancing the efficiency of instructional techniques in a specific design procedure. The bottom-up approach is beneficial for creating sets of cards and design strategies, as well as for utilizing the cards in innovative ways to enhance students' creativity, engagement, and self-efficacy. DfHF cards are a valuable tool for promoting motivation and facilitating the constructive learning of creative skills. They not only improve students' creative thinking abilities but also expedite the design decision-making process and prioritize emotional integration and user well-being.

1. Introduction

The actual measure of progress is the happiness of the people [1], which is a unique and vital state of affairs and an important emotional experience that everyone craves [2]. Happiness is measurable and comparable among persons [3]. Interest in the feeling of happiness has expanded dramatically in recent decades [4], and policymakers around the world have come to see it as an essential objective of public policy. Encouraged by the Organisation for Economic Co-operation and Development (OECD), practically all

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member states now evaluate the happiness of their citizens on an annual basis, and the European Union (EU) has pushed its member states to place well-being at the core of their policy design [1].

In the discipline of 'positive psychology,' subjective well-being is defined as a positive appreciation of life, a sense that life is good, important and worthy, and the sensation of joy, happiness and contentment [5,6]. Design has been increasingly involved with health and well-being. Design not only provides form and function, but it also produces sensations that affect our state of well-being, and all the created products, services, settings or systems around us affect our health and well-being in one way or another [7,8]. This design-induced sensation of well-being is not incidental but rather the outcome of the designers' conscious pursuit in developing these environments and products. The strength of design rests in its potential to create environments, objects and experiences that inspire happiness and contentment. The subject of 'positive emotions' or 'positive experiences' in terms of perception, thought, conduct, and, by extension, improved well-being has been included in design theory and methodology, and its relationship to the influence on well-being is a prominent theme in positive emotion design [9,10].

The Positive Design framework promotes the incorporation of emotion regulation into the design process as a means to enhance well-being. This involves considering emotions as a backdrop for emotional experiences that not only impact sensory pleasure but also contribute to overall happiness and functionality [8,11,12]. Positive emotions are associated with two physiological systems: the arousal and drive system and the affiliation and soothing system [13]. These systems are inherently connected to individuals' well-being. Positive emotions are closely connected to neurotransmitters, hormones, brain networks, and cognitive functions in relation to emotions. Experiencing positive emotions has numerous beneficial effects on various elements of mental and physical health [14]. How might design enhance well-being and facilitate individuals in their pursuit of leading complete and gratifying lives? This inquiry raises the possibility that we need to reevaluate both what design is and how it might intentionally improve people's quality of life [15]. Designers consistently strive to create designs that evoke appropriate emotions. The successful integration of emotions not only enhances the user experience but also prolongs the lifespan of the product. The integration of design emotion decoding and the utilization of design emotion language should be pervasive across the entirety of the design process [16]. In this setting, innovative thinking has emerged as a crucial catalyst in the realm of design. Innovative thinking arises from a significant amalgamation of several modes of thought, particularly divergent, convergent, and recombinant thinking. The necessity for designers to employ many approaches, explore various angles, resolve issues from several viewpoints, articulate and deconstruct objectives, and get knowledge or resources from various outlets underscores the inherent multi-perspective characteristic of thinking in the design process [17].

The combination of design, health, and well-being forms a beneficial trio that enhances the overall quality of individuals' lives and positively influences their experiences, expectations, and perceptions while engaging with various products and services [8]. The design programs provided by universities are a direct reaction to the strategic landscape of design practice and education. They also serve as a kind of activism in addressing the learning needs brought about by industry and societal challenges [18,19]. Thus, design research and discourse today are focused on the shifts, struggles, and stabilization of instruction [20]. Teachers should prioritize the development of creative literacy by focusing on the content and providing clear interventions rather than solely creating an atmosphere and engaging in innovative activities. Develop a task scenario that promotes the demonstration and production of innovative literacy. Design specific activity tasks and offer prompt and effective assistance throughout the task execution process [21]. Design educational tasks that are aligned with the fundamental subject matter, grounded in authentic scenarios, promote interdisciplinary connections, and prioritize the development of students' cognitive abilities. Emphasizing the external aspects of overall innovative approaches and field-specific problem-solving concepts to improve the development of innovative literacy efficiently [22].

2. Background

2.1. Pedagogical approaches

Innovative talents encompass a set of abilities focused on innovative thinking, which refers to the cognitive process of creating novel or substantially enhanced ideas [23]. The skills encompassed in this category consist of flexibility, fluency, creative thinking, the capacity to identify issues, and the ability to formulate hypotheses. It is crucial for designers to engage in lifelong learning in order to obtain new domain-specific knowledge on technical breakthroughs, given the rapid changes in the world and the shift towards Industry 4.0 [24,25]. Unleashing the creative potential of pupils is a crucial objective in university education. The enhancement of students' innovative thinking abilities relies on the integration of education with science and production [26]. Design thinking enables the creative solution of intricate challenges [27]. The practice of design innovation has evolved into a systematic and intricate research and problem-solving process characterized by the application of design innovation thinking to comprehend and excel in problem definition, the discovery of innovation opportunities, and the integration of resources. This outcome is achieved through the harmonious development of diverse modes of thinking and their combination. The design problem is complex due to the presence of multi-disciplinary, cross-complex system characteristics. In practical terms, design innovation thinking refers to the approach and paradigm of interdisciplinary, integrated innovation practice. It is a process that prioritizes the development of an empathetic understanding, problem insight, prototype creation, test iteration, and final solution formation. Understanding and incorporating diverse views is crucial for holistically comprehending difficult issues. Additionally, bridging the gap in innovative thinking caused by cognitive disparities among disciplines, individuals, or organizations is essential for interdisciplinary, integrated innovation and tackling complicated design problems.

Creativity is a multifaceted construct that encompasses both divergent and convergent thinking [28]. Divergent thinking expands the range of representative research, while convergent thinking is employed to determine the most optimal ideas for the given task

[29]. Designers have the ability to transition between the two types of thinking based on the specific demands of the task at hand, and the alternating sequences of divergent and convergent thinking constitute the creative process [30]. Design thinking is a problem-oriented, integrated creative thinking process, regardless of the thinking concept or specific thinking methodologies and procedures. The initial step in the design thinking process is to precisely articulate the problem and approach it from the perspective of the designer's mindset. The entire process involves multiple stages of concentration, divergence, iteration, and validation, ensuring that the solutions obtained are both innovative and rational in terms of their breadth and depth. Fig. 1 depicts the flowchart illustrating the innovative thinking process employed in this research.

In the realm of design education, a toolkit refers to a compilation of tools that help students acquire knowledge and hone their skills in the field of innovative design. It may encompass educational resources like as teaching materials, tutorials, case studies, and other materials that aid students in comprehending, mastering, and applying the principles and abilities of creative design. A toolkit may also comprise an extensive variety of inventive instruments, such as idea cards and design thinking tools, to direct students towards thinking outside conventional boundaries, provoke innovative thinking and creative inspiration, and motivate them to generate original design solutions. Certain toolkits may also encompass interdisciplinary content, fostering students' ability to establish links across many domains of knowledge and fostering integrated thinking in inventive creation. Table 1 shows several design methods that have been incorporated into toolkits in recent years [12,15,31–42].

These toolkits offer a comprehensive resource for designing curricula and have exhibited exceptional pedagogical outcomes. Nevertheless, certain topics warrant an in-depth look at the discipline of design education. For instance, the disparity between theory and practice can lead to students' incapacity to proficiently amalgamate the theoretical information they have acquired with practical design. Moreover, the conventional system of dividing disciplines and focusing on test-based education could hinder the incorporation of affective design since it overly prioritizes the transfer of knowledge while disregarding students' emotional expression. Hence, it is imperative to adopt an interdisciplinary and integrated approach that advocates for a learning and innovation design framework. This framework encourages students to anticipate and apply theoretical knowledge in practical settings, enhances the formation and growth of cognitive structures, reinforces students' capacity for innovative thinking, and facilitates the development of advanced cognitive abilities.

Das earlier proposed Design Heuristics for Furniture Design (DHfFD) [43]. However, the toolset for furniture design has yet to be developed. This study is centered around a design thinking curriculum that specifically emphasizes positive design for subjective well-being, with an emphasis on nurturing mental well-being and enhancing emotional regulation. The Design for Happiness framework (DfH) advocated by Escobar-Tello urges designers to address the functional and emotional requirements of consumers with the aim of crafting a user experience that is more profound and pleasurable [44,45]. Utilizing the principles of DfH and positive design, we have decided to concentrate on the creation of furniture that promotes feelings of happiness and positive emotions. The perceived emotions attributed to furniture are actually a manifestation of consumers' "empathy", whereby they project their feelings onto the inanimate furniture in order to enhance the innovation and positive experiences associated with furniture design. The Design Thinking course emphasizes the cultivation of students' capacity to see and comprehend diverse forms of positive emotions. To facilitate this, we employ the Positive Mood Granularity Card (PEG) devised by Desmet. The purpose of this tool is to facilitate an emotion-centric design process by aiding designers in comprehending the intricacies of positive emotions [46]. The PEG will be employed to encourage students to recognise and classify diverse forms of positive emotions and apply distinct positive emotions to the creation of well-being furniture designs.

The process of innovation can be categorized into two distinct stages, wherein the initial stage is characterized by divergent thinking and the subsequent stage is characterized by convergent thinking. During the idea generation stage, designers primarily employ divergent thinking to generate a multitude of abstract ideas, forms, and design solutions [47]. Imagination stimulates and cultivates an individual's creativity [48]. Divergent thinking is the fundamental process of generating creative ideas, which is a crucial

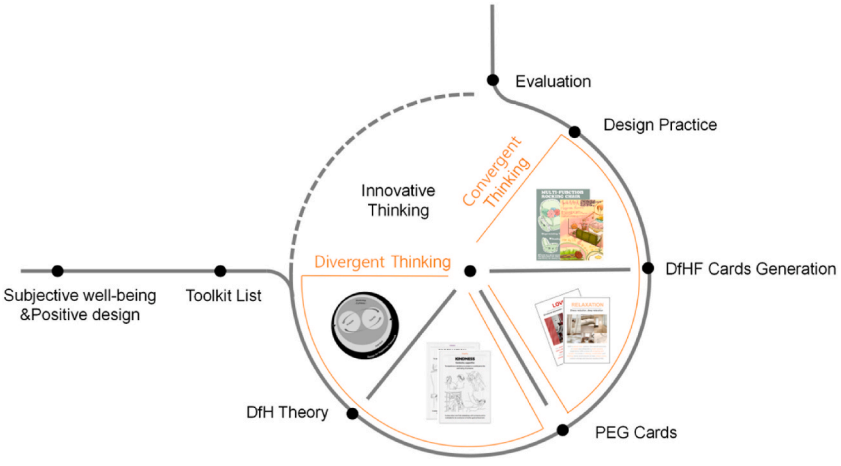


Fig. 1. Innovation thinking process.

Table 1
Summary of toolkits in recent years.

Author	Design tool
Desmet (2003,2008).	The three evaluation types, usefulness, pleasure, and justification, correspond to goals, attitudes, and standards, creating a framework of nine sources of product emotions based on product-human relationship levels.
Desmet (2010).	The framework of product emotion sources can be used to design three levels of emotional appeals, including self-appeals, activity appeals, and product appeals.
Pohlmeyer (2013).	The Design Well-Being Matrix illustrates the range of subjective well-being touchpoints in design, encompassing both the roles design can play and the dimensions of subjective well-being.
Desme & Pohlmeyer (2013).	The Positive Design framework has three components: design for pleasure, design for personal meaning, and design for virtue.
Calvo & Peters (2014).	Three general approaches designed for well-being, namely the preventive approach, the proactive approach and the specialized approach.
Brey (2015).	Four directions for designing for well-being, the affective design approach, the competency approach, life-based design, and the positive psychology approach.
Desmet, Vastenburg & Romero (2016).	Pick-A-Mood is a drawing tool for expressing and measuring eight emotional states across four categories: excited/happy, irritated/tense, relaxed/calm, and bored/sad.
Casais, Mugge, & Desmet (2016).	The positive design framework includes user values, personal fit, and commitment to design success. The SIM card toolkit helps designers understand six symbolic categories of happiness and sixteen design directions for creating symbolic designs that enhance user happiness.
Desmet & Sääksjärvi (2016).	The design impact on behavioral intervention techniques (BITs) was explored through a user-centered process, creating brightly colored keychain coins for self-managed interventions.
Xue, Desmet & Fokkinga (2020).	The overall typology of the 20 emotional states covers six broad categories: subjective feelings, perceptions, reactions, tendencies, likes and dislikes.
Desmet, Fokkinga, Ozkaramanli & Yoon (2021).	Seven Emotional Principles in Design: (1) Emotions are subjective, (2) Design evokes micro-emotions, (3) Humans have basic needs, (4) Design triggers varied emotions, (5) Negative emotions can be pleasant, (6) Emotions reveal motivations, (7) Emotions stem from dilemmas.
Desmet, Xue, Xin & Liu (2022).	Emotion-driven design (EDD) involves manipulating emotions in the creative process and refers to approaches that target and predetermine users' emotions through design.
Huang & Desmet (2023).	Expanding on the 13 basic design-centered need types, this fine-grained vocabulary supports human-centered design research and practice, aiding in discussions across diverse backgrounds.

component of creativity, and the ability to think divergently increases over time [49,50]. By analyzing the relationship between the DfH and the PEG, students will explore the connotations, meanings, and roles of each dimension in promoting overall well-being. Divergent thinking encourages students to explore several avenues of thought, approach problem-solving from multiple viewpoints, and elevate their creations to a more advanced level. During the idea review step, designers primarily employ convergent thinking to assess these ideas and determine solutions that must be both innovative and viable. This level necessitates a cognitive approach focused on specific tasks and the seamless integration of related knowledge [51,52]. During the process of restructuring their thoughts, students give priority to the significance of well-being and establish strong connections between highly relevant parts to create new content.

2.2. Theoretical framework: DfH framework and PEG cards

Escobar-Tello introduces the Design for Happiness framework (DfH), a design process that is based on three distinct foundations. Design Methodology, Design Process, and Toolkit. (Escobar-Tello, 2016). The DfH employs workshop scenarios to create sustainable products, services, or systems that encourage sustainable lifestyles and foster happier societies. Designers serve as 'facilitators' in these workshops, fostering collaboration among participants from different disciplines and promoting active involvement in the development of collective and cohesive design solutions. The DfH aims to address social disparities in design and create groundbreaking solutions that promote both happiness and sustainability by implementing comprehensive changes at the systemic level. One of its primary advantages is its ability to question and criticize conventional design processes and approaches. Furthermore, by adopting a human-centric approach, we can redefine the conventional connection between objects and individuals, so influencing our material culture to promote a contented and environmentally conscious way of living. In addition, the design process and toolkit can incorporate DfH into practical applications. The DfH analyzes the notion of happiness and defines its connection to a society that can be maintained throughout time. It explores the role of happiness in sustainable design and converts it into a specialized 'design language.' [45].

Within the framework of DfH, happiness is defined as 'a state of profound contentment with one's life,' arising from the interplay of three factors: experiencing positive emotions, overall life satisfaction, and genetic predisposition [44]. It is activated and discovered in activities that align with an individual's inherent values and in which they can participate. Moreover, due to its shared attributes with a sustainable society, it possesses the significant potential to influence behaviour towards sustainable lifestyles [53]. DfH capitalizes on this by utilizing happiness as a tool to approach design in a comprehensive manner: addressing and altering the urgent requirements of the present world, identifying prospects for innovation, and facilitating the creation of sustainable objects that involve individuals in matters that are 'bigger-than-self' [45].

The design process of the Design for Happiness framework has six stages, with the initial stage being Insight—Download. In this stage, the focus lies on attaining a comprehensive grasp of the concepts of 'happiness' and 'sustainable social qualities.' The second

stage, known as Preparation—Incubation, stimulates participants' senses and imagination, encouraging them to explore novel approaches to problem-solving, particularly during talks. It fosters a fresh, comprehensive, and sustainable perspective on the issues being addressed. The subsequent phase, Incubation Part 2—Presence, introduces novel design concepts that are seamlessly integrated into the fabric of a joyful and environmentally friendly society. Stage 4, Illumination and Reflection—Let come, focuses on deriving design solutions from the original thoughts developed in Stage 3. Stage 5, Illumination and Reflection Part 2—Co-design and Co-creation, marks the completion of the design idea generation process. Stage 6, Evaluation, focuses on assessing the outcomes of the discussions at the end of the process [45].

In general, DfH can facilitate innovative discourse between designers and diverse stakeholders when investigating novel design resolutions. Additionally, it prompts designers to not only fulfill practical requirements but also comprehend and meet the affective needs of users, thereby engendering more significant and pleasurable user experiences. This notion has extensive potential applications across several design disciplines, encompassing product design, service design, environmental design, and digital experience design. Furthermore, Ann et al. have introduced the Designing for Home Happiness framework (DfHH). DfHH is an innovative methodology and workshop format that specifically aims to generate service designs for enhancing home happiness and promoting sustainable product-service systems (PSS). It aligns with DfH's enduring view on happiness while also incorporating Seligman's theory of "authentic happiness" [45,54]. The concept of DfH posits that enduring happiness is comprised of three levels: pleasure, engagement, and meaning, which often manifest in sequential order. Embracing this concept enables the creation of designs that foster pleasure and well-being by encouraging actions related to happiness, engagement, and significance. DfHH places a premium on the family because of its significant influence on the overall well-being of individuals, impacting several aspects of life, such as social participation, security, and quality of sleep. Petermans and Cain elaborated on the concepts of DfH and DfHH by incorporating additional elements such as tools, processes, and related concepts of well-being. They also guided how to integrate these concepts into the application and final design.

Card-based design tools have gained popularity as a method for sharing and using insights from design research in the design process [46]. Desmet has created the Positive Emotional Granularity (PEG) cards to aid designers in developing a detailed comprehension of positive emotions during the emotion-centered design process. The deck comprises 25 cards, with each card expressing a distinct positive emotion. The deck comprises definitions of emotion labels, elicitation conditions, and graphics that depict behavioral manifestations. The utilization of PEG cards centers around the process of incorporating the nuances of positive feelings, elucidating emotional purpose, and producing concepts for products [9,46]. The PEG is highly utilitarian, as it allows for various benefits such as understanding the user's emotional state, determining the emotional effect of a product, enhancing support within an organization, ensuring consistent emotional intent in communication, promoting innovative design, improving emotional coherence, and managing emotions within product development teams [46]. Over time, emotional granularity can be influenced and gradually enhanced through multiple methods [55]. Long-term interventions can enhance individuals' emotional distinction by improving their PEG [56]. Designers can utilize design tools to modify the degree of detail adaptively and so successfully consider positive emotions. Furthermore, the cultural subtleties of positive emotions are encompassed alongside the consideration of content appropriateness. Hence, it is imperative for tools to not only direct designers towards prioritizing the user's emotional reaction but also assist them in examining possible user apprehensions and culturally significant contextual elements in their entirety [10], while there may be variations in a designer's proficiency in utilizing PEG cards. The PEG possesses the capacity to precisely and definitively interpret and articulate positive emotional experiences [46]. The fundamental driving force behind positive emotion design has been the advantageous impact of positive emotions on users [10].

2.3. Generation of DfHF cards

Within the present landscape of design education, particularly in the realm of furniture well-being design, there is a pressing requirement for a novel toolkit that can facilitate the evolution of students' design cognition. This toolkit incorporates elements of emotional design, sustainability principles, and user requirements research, with a particular emphasis on the emotional bond between furniture and users. As a result, the Design for Happy Furniture cards (DfHF) were developed. During this instructional procedure, we amalgamate DfH and PEG to create a novel pedagogical approach known as DfHF. This study substitutes the DfH toolkit with the PEG, which is employed in the classroom alongside the emphasis on the utilization of PEG cards. The objective is to investigate how the designer's PEG can be employed to generate a product and how it can elicit a variety of positive emotions during the usage process. The outcome is the creation of delightful furniture designs that enhance the user's well-being. The DfHF is an innovative teaching method and an original set of tools specifically centered around the design of furniture that promotes well-being. This new toolkit aims to assist students in comprehending the principles of emotional design and methodically implementing design strategies. It emphasizes the consideration of the product life cycle, material selection, and environmental sustainability. By bridging the gap between theory and practice, it encourages students to foster innovation and experimentation. Additionally, it introduces interdisciplinary content and promotes integrative, innovative thinking. The toolkit also provides inspirational design case studies to enable students to apply their acquired knowledge more flexibly and thoughtfully to real design projects and a more thoughtful implementation of their acquired knowledge. Ultimately, we will assess this study by using the USE scale to examine the usability, ease of use, ease of learning and satisfaction of the design strategies.

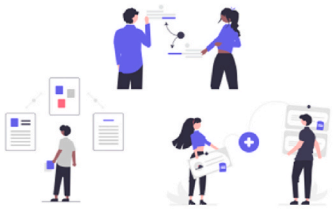
Integrating DfH with the PEG cards can enhance the design process by adding greater complexity and specificity. The process begins by refining the emotional specifics. The PEG cards consist of 25 distinct positive emotions, each accompanied by its distinct definition, conditions for elicitation, and visualization. We will thoughtfully select the most appropriate 15 positive emotions that promote well-being in furniture design, then integrate these emotions with DfH's concepts to assist designers in accurately

1.Understanding DFH Theory

Focus at this stage

- What is **happiness**
- The **relationship** between design and happiness
- How to enhance people's happiness **through design**

2.Problem Definition



Focus at this stage

- The **furniture case** for the relationship between well-being and environment, product and experience
- How to **apply DfH theory** to practical furniture design
- **Context and challenges** of furniture design for dappiness

3.Solution Generation

Focus at this stage

- **Keywords** and **picture collection** for happiness furniture design
- Introducing **PEG Cards** to help students recognize the nuances of positive emotions
- **Matching DfHF keywords** from **PEG Cards** that are suitable as happiness furniture designs
- **Summarize design strategies** based on keywords to generate **DfHF Cards**

4.Design practice

Focus at this stage

- Clarify specific **design projects**
- Use **DFHF Cards** for happiness furniture design

5.Evaluation

Focus at this stage

- Using the **USE scale** to assess students' use of the DFHF cards
- Analyze the data and draw **final conclusions**

Fig. 2. Course flowchart.

understanding users' needs, determining the appropriate design direction, and creating emotionally impactful design works. In the context of furniture design, this involves selecting materials, shapes, colours, and other design elements that can evoke various emotions, such as comfort, warmth, and pleasure. Furthermore, it is an emotionally orientated design. The DfH highlights the objective of enhancing the user's well-being. Meanwhile, the PEG aids designers in comprehensively understanding and acknowledging the emotional experience. This understanding enables designers to accurately identify the user's requirements, guide the emotional direction of the design, and determine the appropriate design orientation by recognizing the range of positive emotions that users may encounter while interacting with furniture. In the realm of furniture design, this entails the ability to choose design components such as materials, shapes, and colours to evoke specific emotions, such as feelings of comfort, warmth, and enjoyment. This enables designers to develop products, services, or experiences that are extremely attractive and have a positive impact, thus improving the user's overall sense of well-being. The integration of theory and methodology offers a comprehensive framework for design instruction, enabling students to gain a deeper comprehension of theories and effectively apply them in practical design scenarios.

During this process, designers must establish strong connections between dispersion and reorganization of innovative thinking to create a cohesive whole, ensuring that these elements are closely intertwined in the design of furniture that promotes well-being, which is crucial for achieving internal coherence in the design. For instance, the method of highlighting particular pleasant feelings by utilizing a blend of forms, hues, and substances. In the process of reorganizing thinking, the designer must redefine the DfHF framework to ensure that it is not simply a stacking of the original framework. Instead, it should involve integrating and reorganizing the elements at a higher level, which may include renaming, reframing, and repositioning the roles of each element. Fig. 2 depicts the flowchart representing the structure of this course.

3. Methodology

The study was carried out in a design thinking course specifically designed for design students. A total of 30 students, who possessed a strong background in design, actively participated in the course. The training was structured into three distinct phases: sample collection, sample screening, and sample analysis.

During the sample collection stage, the class, consisting of 30 students, was divided into five groups of six. Each individual in the group was responsible for gathering 20 photographs of furniture related to happiness and then selecting five images to present to the group leader. This stage resulted in a total of 30 images per group. Afterward, each group engaged in group discussions centered around the 30 cards that were examined. They identified the keywords representing the happiness elements present in the furniture design concepts on each card, then organized the furniture with similar elements to be showcased together in a single image. Finally, they created small cards that included the product name, its effects, and other relevant descriptions. The objective of creating the cards was to provide utmost clarity, enabling the participants to swiftly and effortlessly comprehend the product samples. Every group contributed ten emotion keywords cards, resulting in a total of 50 cards for the entire class. These cards were then uploaded to the online workgroup.

During the initial screening phase, the keywords from a collection of 50 furniture product sample cards were compared to a set of 25 emotions from the PEG cards. The overlapping words were identified, and the top 15 words with the highest overlap rate were

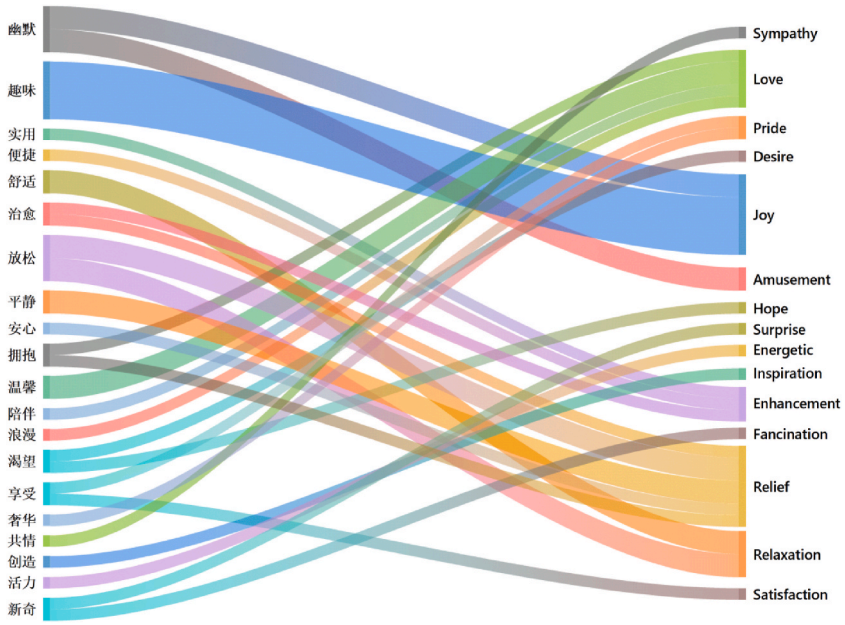


Fig. 3. Keyword matching chart.

selected. The product samples associated with each word were then gathered for further analysis in the next step.

During the sample analysis stage, the entire class was invited to participate. Each student was given 15 keyword cards. After understanding the content on each card, participants were asked to analyze product samples. Specifically, they were asked to identify commonalities in vocabulary design practices and their potential impact on well-being based on the product samples. The goal was to distil the design strategies represented by each keyword and generate new cards. This task aimed to train students to conceptualize creative solutions for furniture products using the well-being furniture keyword cards. The next step was to transform these ideas into design creations and establish a matrix for thinking about furniture design associations. Finally, the designs were evaluated to provide pathways for generating innovative designs.

4. Program development

4.1. Keyword matching and strategy

Innovative thinking refers to the cognitive process of uncovering novel concepts, devising original approaches, and resolving unfamiliar challenges through individual experiential knowledge. Utilizing creative cards, such as PEG cards, is a prevalent and efficient approach employed to foster inventive thinking in students. The clear benefit of this approach is that it stimulates students'

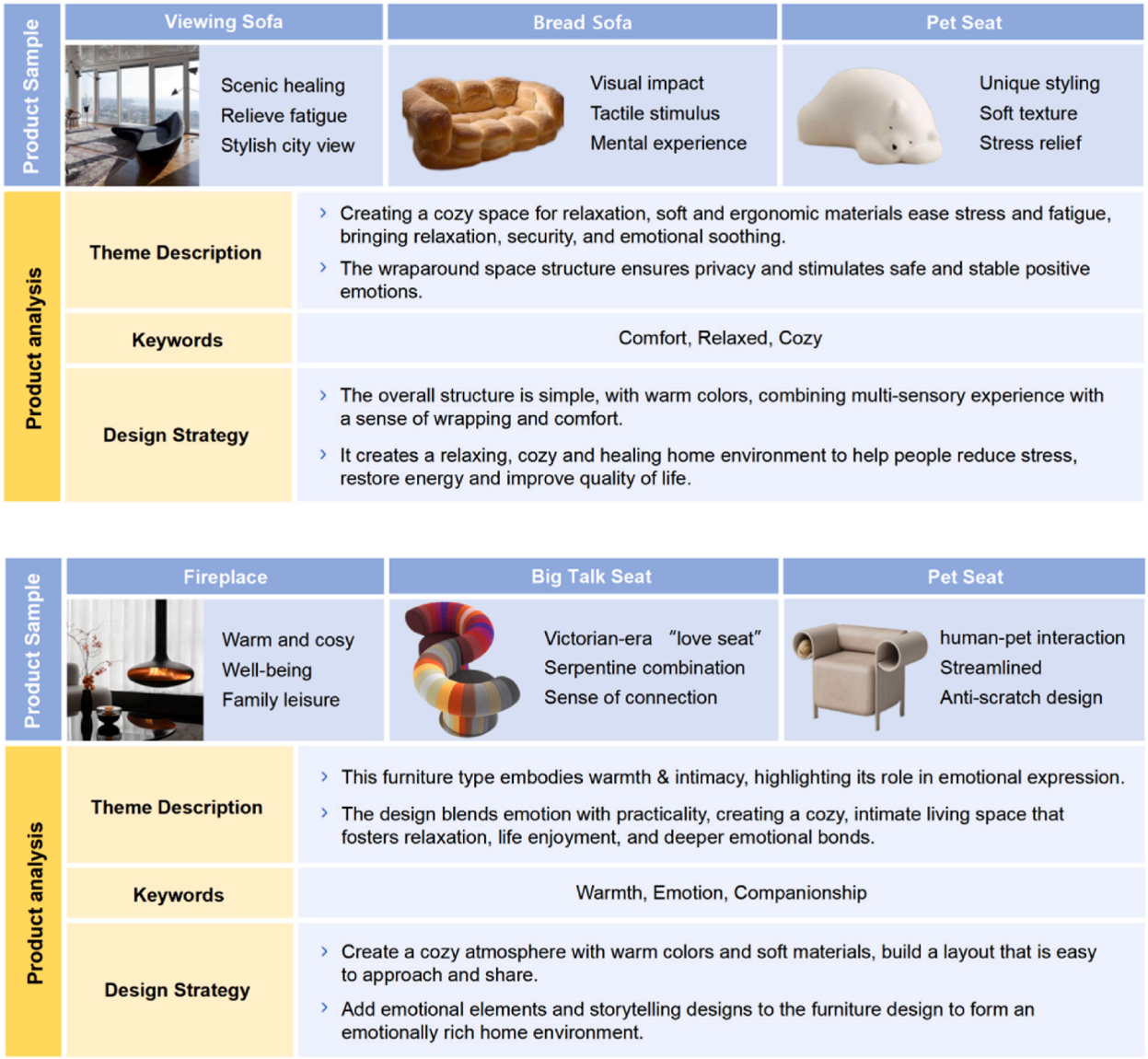


Fig. 4. Students' analyses of the keywords 'Love' and 'Relaxation' and the generation of design strategies.

cognitive processes by utilizing the elements or concepts shown on the cards, so facilitating the divergence and convergence of thoughts, ultimately leading to the generation of novel ideas.

Statistically, students gathered a significant number of furniture examples by utilizing different search engines like Baidu and Google. Prior to submitting them, students had already labelled the phrases representing the happiness characteristics of each product. The image displays a comprehensive list of gathered sample keywords and the 25 emotions of PEG. We conducted a comparison between the keywords and descriptions on the cards, connecting words that share the same or similar meanings. Fig. 3 is the keyword matching chart. Consequently, we identified 15 keywords that have a significant degree of overlap. These keywords include *Sympathy, Love, Pride, Desire, Joy, Amusement, Hope, Surprise, Energetic, Inspiration, Enhancement, Fascination, Relief, Relaxation, and Satisfaction.*

Using a combination of PEG and DfH, we rearranged the gathered keywords to create groundbreaking DfHF keywords. This phase of the design process involves more than just matching and combining words. It also entails assigning new meanings and connotations to the words within the theoretical framework of emotional design. Additionally, it involves delving into the emotional significance of each keyword, offering students a more comprehensive understanding during the subsequent sample analysis and ultimately leading to creative transformation.

Throughout the sample analysis phase, the group of 30 students actively engaged in meticulously correlating the DfHF keywords with each product sample. The adoption of this collaborative method enhanced the breadth and accuracy of the analyses by

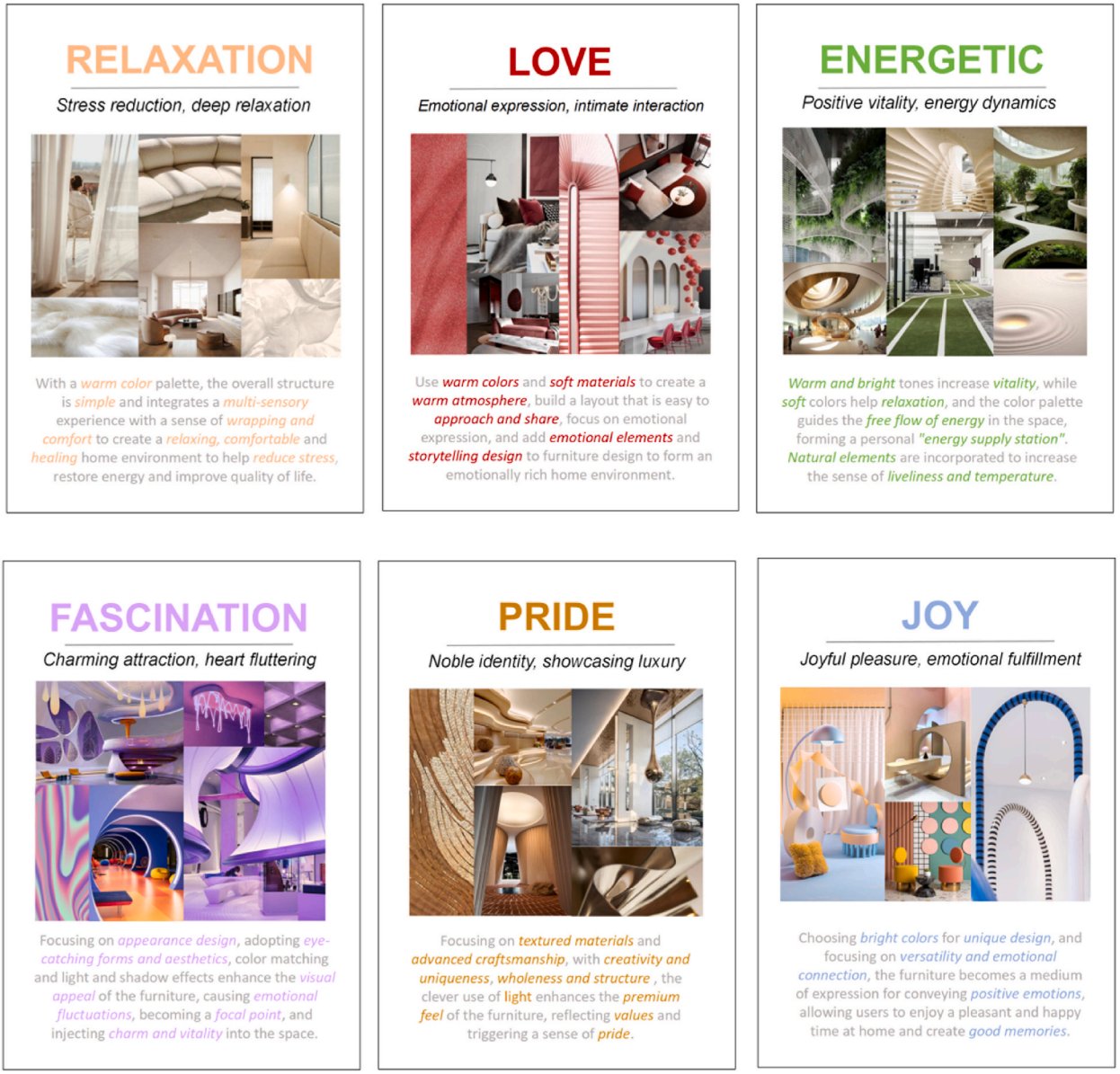


Fig. 5. DfHF cards display.

incorporating diverse perspectives and ensuring a wide range of samples. The students achieved success by establishing connections between each keyword and the samples, enabling them to generalize the shared characteristics of each keyword in relation to furniture design approaches, as well as the possible influence these design strategies have on well-being. The analysis process encompasses both theoretical contemplations on the design of furniture for enhancing well-being and a practical endeavour for students to apply their acquired theories through convergent thinking. Fig. 4 depicts the student's analytical approach and the creation of design strategies.

By following DfH's direction and doing sample analysis, students discovered the shared characteristics of different furniture design practices. They gained an understanding of how these practices might impact the well-being of users and established a theoretical foundation for improving design techniques. The process of refining design strategies is a crucial component of the overall study and a pivotal stage in consolidating students' thoughts. The efficacy of associating each phrase with the shared characteristics of design methodologies resides in the conversion of theoretical concepts into tangible design principles, empowering students to implement these methods more precisely in their actual designs.

We have successfully produced 15 DfHF cards that feature keywords integrated with images, design strategies, and corresponding descriptions. Fig. 5 displays six of these samples. The design of each card was meticulously crafted, taking into consideration the selection of theme colours and the alignment of keywords. This visual representation effectively communicated the significance of the keywords and their connection to the larger framework, thus enhancing the viewer's understanding and offering a more intuitive and thorough experience. The graphics shown on the cards have been meticulously chosen. The furniture samples exhibit diverse design styles and forms, while the assortment of options and combinations of fabrics, materials, and colours underscore the intricate complexity of the design.

The PEG cards are utilized specifically in three design activities: (1) comprehending the nuances of positive emotions, (2) elucidating emotional purpose, and (3) producing ideas for products (Yoon et al., 2016). The guidelines for the use of DfHF cards are more precise and focused on (1) accurately identifying positive emotions that are relevant to furniture design and understanding the corresponding design directions, (2) clarifying design elements and objectives based on the selected design strategy, and (3) generating creative furniture designs that are emotionally adaptable and promote positive emotional sustainability. Regarding sustainability, our focus extends beyond society's sustainability, encompassing environmentally friendly materials, to also include the furniture's impact on personal well-being.

Designers can reap numerous advantages by possessing a diverse array of positive emotions and being aware of their subtle distinctions. Firstly, it facilitates the accurate identification of design intent, which can guide the product towards the desired emotional impact. Furthermore, articulating emotional states using detailed emotional terminology facilitates consistent communication during the design process. Additionally, exploring various positive emotional reactions from the user can stimulate diverse design approaches, as each emotion is influenced by distinct triggering factors [46].

During the production of the DfHF design strategy card, the combination of innovative thinking and design philosophy is not a mere overlay but a profound integration that necessitates designers to go beyond superficial aspects and consider the comprehension of human existence and a forward-looking perspective on the future of society that underlies the design. This type of complex contemplation raises the status of design to a philosophical plane. Instead of being merely a tangible product or experience, it becomes a profound introspection on human well-being and the fundamental purpose of existence. These reflections encompass an in-depth understanding of the concept, consideration of the current circumstances, amalgamation of inventive components, pioneering design approaches, optimization of user experience, utilization of technology and materials, integration of culture and society, and ongoing refinement in implementation.

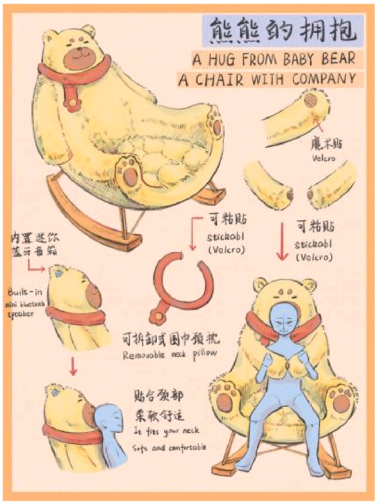
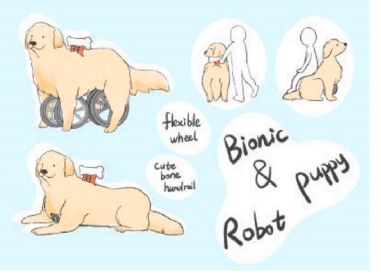
4.2. Use of DfHF cards

In order to further substantiate the demonstration of how to implement the 15 strategies to design furniture that promotes well-being during the conceptual design phase, we explored the instructional use of the tool cards, specifically the stage where the cards are applied to the students. The objective of this phase was to evaluate the students' comprehension and utilization of the DfHF cards, with a specific emphasis on their grasp of design strategies, the development of the concept of creative thinking, and their ability to apply the DfHF cards in design exercises effectively. Once the students had acquired a thorough comprehension of DfHF cards, we tasked them with coursework centered around the design object 'Sitting.' The subsequent designs presented by the students were focused on the design strategy of the keyword 'Relaxation.' The outcomes of the students' designs are displayed in Table 2.

The students have exhibited adeptness in utilizing DfHF cards to convert intangible emotional design principles into tangible and aesthetically appealing furniture pieces. The DfHF cards were instrumental in connecting the students' theoretical understanding with their practical application. They demonstrated their understanding of emotional experiences by selecting appropriate colours and shapes, and they also considered the user's needs by designing functional solutions for real-life scenarios. Through the utilization of these cards, students were able to engage in a systematic thought process on the incorporation of positive emotions into furniture design. Consequently, they were able to communicate their thoughts in a nuanced way, so enhancing the depth and experiential aspect of the design.

At first, the student's selection of colours and forms demonstrated a distinctive comprehension of emotional perception. For instance, the Lollipop Sofa effectively communicates a feeling of youthful enjoyment and comfort with its distinctive lollipop design and plush velvet fabric. The deliberate selection of colours and shapes skillfully elicits a delightful emotional response. Furthermore, the students showed exceptional proficiency in functional design. The multifunctional Rocking Chair showcased in the piece has exceptional functionality and innovative design. The chair's selection of hues and incorporation of floral-adorned pillowcases imbue it with a rejuvenating and delightful ambience, effectively evoking feelings of gratification and reassurance. In addition, the designers

Table 2
The outcomes of the students' designs.

Students' works		
		
Semi-closed Air Bed	Bear's Hug	Multifunctional Rocking Chair
		
Companion Cradle	Food Suite	Lollipop Sofa
		
Virtual Experience Warehouse	Cloud Sofa	PUPbot

astutely included charging ports and mobile phone holders into the armrests of the chair, enhancing its usability and exemplifying the students' meticulousness. The Virtual Experience Warehouse, created by students, stands out for its incorporation of 5D audio, projector, and VR equipment, along with an automatic telescopic desktop. This combination of technology and design showcases the students' innovative mindset towards the future lifestyle.

In summary, the students displayed innovative thinking during the design process, explored new possibilities and connections, and effectively incorporated the concept of happiness furniture design into practical creations using DfHF cards. The impact of these cards was clearly evident in the series of works produced. Adopting a design approach that prioritizes the user's emotional experience transforms furniture into more than just a functional object. It becomes a lifelong companion that has the potential to elevate the user's overall sense of well-being. The cards have a crucial function in prompting students to contemplate happiness design, rendering these creations a genuine "happiness choice" within the domestic setting. Simultaneously, they introduce novel design strategies and teaching approaches into the discipline of furniture design, offering a fresh trajectory for the future development of creative design and talent cultivation.

4.3. Evaluation

The final evaluation entails a meticulous assessment and contemplation of the entire study process. To evaluate the students' experience of using the cards scientifically and systematically, we conducted a questionnaire study evaluation. We collected usage feedback using the USE scale developed by Arnie Lund. The USE scale is a commonly employed instrument in the domains of design, user research, and human-computer interaction [57]. It is utilized to evaluate and measure the quality of the user experience for a product, system, or interface. The scale encompasses four aspects: Usability, Ease of use, Ease of Learning and Satisfaction. These dimensions serve as a comprehensive foundation for designers, researchers, and development teams. The primary objective of the USE scale is to enhance the design of a product or system by more effectively fulfilling user requirements and expectations, hence augmenting user acceptance. Initially, we selected all the students in this class as the research participants and collectively examined the

Table 3
USE scale results.

Use	Mean Value (SD) n = 30
Total Score	5.23 (0.83)
Usefulness	5.40 (0.84)
It helps me be more effective.	5.33 (1.12)
It helps me be more productive.	5.70 (0.75)
It is useful.	5.37 (1.25)
It gives me more control over the activities in my life.	5.17 (0.95)
It makes the things I want to accomplish easier to get done.	5.37 (1.10)
It saves me time when I use it.	5.40 (1.30)
It meets my needs.	5.50 (1.14)
Ese of Use	5.10 (0.89)
It does everything I would expect it to do.	4.80 (1.40)
It is easy to use.	5.40 (1.07)
It is simple to use.	5.37 (1.03)
It is user friendly.	5.37 (1.10)
It requires the fewest steps possible to accomplish what I want to do with it.	5.30 (1.02)
It is flexible.	5.30 (1.06)
Using it is effortless.	5.07 (1.20)
I can use it without written instructions.	4.57 (1.33)
I don't notice any inconsistencies as I use it.	4.87 (1.31)
Both occasional and regular users would like it.	4.97 (1.30)
I can recover from mistakes quickly and easily.	5.07 (1.36)
I can use it successfully every time.	5.10 (1.16)
Ese of Learning	5.21 (1.02)
I learned to use it quickly.	5.20 (1.16)
I easily remember how to use it.	5.10 (1.13)
It is easy to learn to use it.	5.17 (1.29)
I quickly became skillful with it.	5.37 (1.10)
Satisfaction	5.31 (0.93)
I am satisfied with it.	5.17 (1.23)
I would recommend it to a friend.	5.33 (1.32)
It is fun to use.	5.20 (1.19)
It works the way I want it to work.	5.33 (1.12)
It is wonderful.	5.13 (1.20)
I feel I need to have it.	5.47 (0.97)
It is pleasant to use.	5.53 (0.94)

design framework. Subsequently, the students utilized the USE scale to assess and evaluate the DfHF cards in four dimensions using the Likert 7-point scale method, which necessitates the students to evaluate their feelings towards the cards. The findings from the assessment of the USE scale are presented in Table 3. The Cronbach's alpha coefficient is 0.966.

Based on the results from the USE questionnaire in Table 3, the participants showed a strong inclination towards accepting the DfHF cards. The cards demonstrated substantial outcomes across the four crucial aspects, indicating the effectiveness of this instructional tool in practical application.

From the perspective of usefulness and ease of use, students unanimously acknowledged the DfHF cards as a highly effective training platform for enhancing their creative thinking abilities. The cards proved to be an intuitive and efficient tool, as revealed by their ability to facilitate seamless integration into the learning process, reduce obstacles to learning, and foster the stimulation of innovative thinking. Consequently, students were able to exhibit greater adaptability in applying the principles of expressive design to their actual creations. This achievement represents an outstanding accomplishment in the pursuit of enhancing student's creative thinking skills. Regarding the ease of learning, students reported a favorable experience with the DfHF cards, indicating that the card design facilitated the learning process by making it more effortless and motivating. The students generally acknowledged that the layout of the cards and the presentation of information effectively provided them with a straightforward framework to comprehend and implement the principles of expressive design. The positive feedback on satisfaction further underscores the positive influence of the DfHF cards in teaching practice. The significant level of student satisfaction with the cards indicates their recognition of the cards' value in fostering innovative thinking.

Fig. 6 presents the distribution of student ratings across four key metrics, and the ratings are predominantly concentrated in the higher range, suggesting that students generally have a positive overall experience with the cards. The median rating for 'Usefulness' is 5.39, with a narrow spread, indicating that the cards' practicality is widely acknowledged. The median rating for 'Ease of Use' is 5.1, with some variability, but it still reflects a strongly positive assessment of the cards' ease of operation. The median ratings for 'Ease of Learning' and 'Satisfaction' are 5.2 and 5.32, respectively, suggesting that the cards are easy to learn and that students are highly satisfied overall. These data demonstrate that the cards perform well across all key metrics, particularly in 'Usefulness' and 'Satisfaction,' highlighting their successful design and functionality.

This result is encouraging for educators, as it indicates that the DfHF cards were designed to meet students' expectations and deliver a fulfilling learning experience. Overall, This research paradigm prioritizes the integration of theoretical knowledge and practical application, offering a novel approach to enhancing design education.

5. Universality verification

To thoroughly examine the variations in students' use of DfHF cards when performing inventive tasks and to verify their influence on innovative thinking, this study additionally conducted focus groups for a representative case study. This phase employed triangulation [58,59], which refers to the utilization of several methods or the aggregation of data sources to assess the accuracy and reliability of a study during the research process. The triangulation in this study encompassed the observation of the design process, analysis of student work, and conducting semi-structured interviews. This resulted in the collection of extensive data for analysis, which can be utilized to supplement and bolster the initial findings obtained in the classroom. This approach enhances the credibility and strength of the findings. At this stage of the project, the following research questions were generated to accomplish these objectives: (i). Do students' fluency, flexibility, and creativity vary before and after using DfHF cards? (iii). To what degree did the students exhibit innovative concepts? (iii). What were the students' opinions or understandings of the solution process that was developed during the design process?

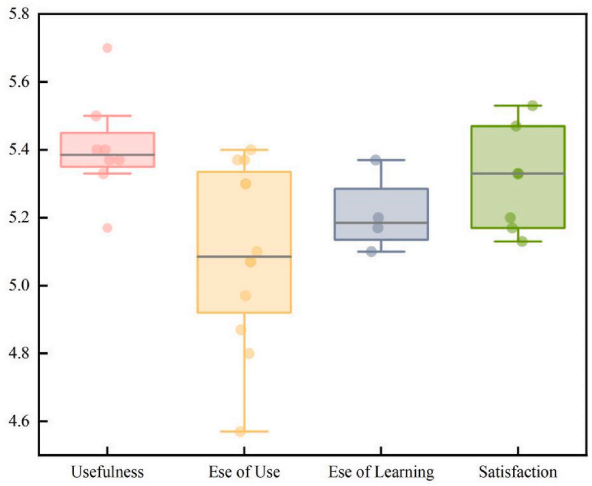


Fig. 6. Further analysis of the four aspects.

5.1. Process

The focus group comprised three male and five female students aged between 21 and 24 years. Each interview lasts approximately 20 min and takes place in the classroom. The University Human Research Ethics Committee approved the study. The focus group participants, in contrast to the students who used the DfHF cards in the classroom, had no prior exposure to these cards. As a result, their responses to the cards and the design process offered an unbiased and novel perspective for this study. The researcher collected the participants' genuine feedback on the use of the cards and the design process through observations, recordings, and interviews, which was accomplished by comparing the focus group participants' responses to the cards. Through performing a comparative analysis of the design process and outcomes of the focus group members prior to and following the use of the cards, the efficacy of the cards in diverse settings can be more effectively showcased. The four characteristics of creativity [60], namely design thinking fluency, flexibility, originality, and elaboration, were the main focus. The result allowed for the assessment of the DfHF cards' practical utility in facilitating innovative thinking while confirming their breadth and reliability.

5.2. Semi-structured interviews

The interviews aimed to get an extensive understanding of how the DfHF cards influenced the students' design methodologies and processes in the context of creative thinking. Prior to the interviews, informal conversation was established to develop a friendly relationship, and the interview questions were formulated using clear and simple language. This included asking a variety of open-ended questions to enable the students to fully comprehend the topics and provide thoughtful responses. The researcher initially created the semi-structured interview guide. To ensure that the questions in the interviews were relevant and appropriate for the study, the researcher sought feedback from three pedagogical experts who specialize in educational technology. The ultimate semi-structured interview form comprised of the subsequent three inquiries.

(i). What is your opinion on this instructional approach that utilizes DfHF cards? For what reason?
(ii). What obstacles did you face when utilizing the DfHF cards and implementing inventive thinking into the design? What impact did these obstacles have on your approach to design thinking?
(iii). Kindly elucidate your creative methodology prior to and subsequent to employing the DfHF cards. Did the cards alter your design cognition or approach? How did they facilitate your ability to think creatively and produce innovative ideas?

5.3. Data analysis

The on-site design process, student's work, and the content of semi-structured interviews were used as sources of data. The data was analyzed through two parts, descriptive analysis and content analysis, with reference to the four elements of creativity.

The first part employed descriptive analysis to scrutinize the students' design process and design work. Effective problem-solving necessitates students to exhibit fluency in generating many solutions, flexibility in proposing several sorts of solutions, originality in presenting distinctive and innovative solutions, and elaboration on the detailed nature of the design program. Hence, the researcher evaluated the students' work by assessing the number of varied designs they created, the level of intricacy in their design work, and the frequency with which they employed descriptive analysis to present their solutions.

The second part included content analysis to examine the descriptions, complemented by semi-structured interviews to validate the findings of the descriptive analysis and participant interactions to foster the recognition and exchange of diverse viewpoints on the subject matter. The interviews were taped and transcribed into text for systematic coding. The final transcripts resulted in 61 coded messages that corresponded to the interview questions. Two coders participated in the data analysis process to ensure reliability. The researchers classified the data into three predetermined themes: process, impact, and challenge. Subsequently, they associated these codes with the four components of the concept of creativity, which are its contribution to inventive thinking in the design process.

5.4. Validity and reliability

The internal validity and reliability of this study were ensured through triangulation and data analysis. Rigorous training was provided to all assessors to ensure consistency in the analysis of the work and coding of the interviews, thereby ensuring that their understanding of the assessment criteria and coding methods remained consistent. Two college peers were invited to assess the validity of the findings.

6. Summary of the findings

Each topic in the semi-structured interviews was considered a theme. The first theme focused on the process of creating answers and aimed to illustrate situations where a student comes up with multiple solutions. The researcher developed two distinct codes depending on the student's responses. The second theme explored the impact of DfHF cards on the creativity process, specifically focusing on the spread and alteration of innovative ideas. The researchers identified four codes to categorize their findings. The third subject focused on the challenges that the participants faced during the innovation process, encompassing both the difficulties related to the initial design as well as those associated with the utilization of the cards. The analysis of the interviews confirmed three main themes. By referring to Table 4, which presents the participants' experiences with the DfHF cards during the creative process, the

findings indicate that the DfHF cards offer a beneficial environment for participants to think and utilize innovative thinking efficiently. Most respondents expressed a positive response, acknowledging that the DfHF card had enhanced their ability to think creatively.

6.1. Innovative thinking in teaching mode construction

The results of the research demonstrated that the DfHF cards had a notable advantage in fostering students' creative thinking abilities. The use of the cards contributed to students' enhanced ability to think divergently and critically, leading to increased flexibility and sophistication in their utilization of design aspects and elements. The researcher observed a substantial improvement in student's ability to create efficiently, and the change in their cognitive flexibility during the design process boosted the quality of their idea generation. Using the DfHF cards, participants were able to develop their first idea in a significantly shorter amount of time. Their ideation time decreased from an average of two and a half minutes to one and a half minutes, and their creation time decreased from an average of 12 min to 8 min. This represents an increase in efficiency of approximately 40 % and 33 %, respectively. The rapid advancement of innovative thinking indicates that the DfHF cards play a seamless and efficient role in promoting imaginative connections and directing design decisions.

One respondent (A7) said, *'The cards helped me to get into the design state quickly and brought new design inspirations.'*

Another respondent (A4) also said, *'The cards have very clear directions, which gave me a clearer idea of my design goals, and the positive keywords gave me guidance to play positively with my designs.'*

Respondents generally felt that the DfHF cards effectively aided them in overcoming their creative stagnation by offering explicit instructions that enabled them to concentrate and swiftly develop ideas.

Respondent (A5) had the same feedback: *'The cards made me look at design from a different perspective and be more open to experimenting with new elements and forms.'*

This process encouraged students to be courageous and confident in their creative thinking. The DfHF cards helped to improve and streamline the thinking process, highlighting the significance of incorporating useful resources into the teaching model to enhance students' creative thinking [61]. The positive outcomes addressed questions (i) and (ii) effectively.

6.2. Relationship between external stimulation and intrinsic motivation

The DfHF cards functioned as a tool for practical design and showcased a strong emphasis on emotional integration and positive design. The cards acted as external stimuli, offering students fresh perspectives and inspirations, prompting them to integrate positive design concepts into their design process actively. The external stimulus also enhanced the application of the design thinking methodology by stimulating students' intrinsic motivation. Emotional communication accelerates and improves the process of generating ideas, and this design thinking technique that incorporates emotions promotes the performance of the final work in terms of evoking strong emotions and increasing user satisfaction.

One respondent (A7) stated, 'During the design process, I was constantly thinking about how my design was going to convey the idea of how it was going to look to someone else and what kind of emotion it would give to the user.'

The researcher received similar feedback from another participant (A3): 'The keywords in the card made me feel the importance of conveying positive emotions and I started to make associations about how the chair gives emotional fulfillment.'

Similarly, another participant (A2) enthused, 'The cards helped me to understand the various emotions and made my final work more relevant to the users' emotional needs, thus enhancing their well-being.'

The finding that DfHF cards facilitated students in contemplating the beneficial effects of design in a more spontaneous manner, driven by their internal motivation [62,63], especially in relation to improving user well-being, is a satisfactory response to the question (iii). Additionally, it showcases the robust assistance that DfHF cards can offer in the development of future related courses. The integration of internal and external elements in this design tool's implementation in design education can significantly enhance students' creative thinking [64].

These findings highlight the influence of the DfHF cards on students' creative design processes. By conducting observations and interviews with focus groups who had not been previously exposed to the cards, this investigation confirmed the applicability of the DfHF cards. The focus group participants exhibited comparable improvements in creative thinking to students in the classroom following their use of the cards. Additionally, the validation of diverse viewpoints further substantiated the efficacy of the cards across various settings. According to this study, both groups of students showed favorable reactions to the cards during the design process.

Table 4
Theme coding table.

Themes	Codes	Related component	Frequency
Process	Design strategies	Fluency, Originality	6
	Design details	Elaboration	8
Impact	Cognitive	Fluency, Flexibility	7
	Inspirations	Flexibility, Originality	12
	Emotions	Fluency, Elaboration	9
	Mindset shift	Flexibility	11
Challenges	Initial design	Originality	7
	Card use	Fluency, Flexibility	6

The consistent design responses indicate that the DfHF cards are successful in directing innovative thinking and have a significant impact on positive design.

7. Conclusions

For this instructional exercise, we created DfHF cards by combining the DfH framework with PEG Emotional Granularity Cards for Happiness Furniture Design. The DfHF cards have a beneficial influence on the innovative thinking and drive of design students and as a potent pedagogical tool, which can aid design instructors in establishing an efficient learning and teaching process. The cards promote the integration of emotion into design and equip students with motivational resources to unleash their creative abilities, and their structured approach enhances designers' creative confidence and fosters design students' willingness to think innovatively [65]. They not only facilitates the development of students' ideas but also motivates design students to actively engage in the process of critical and creative thinking and improvement.

The study's findings indicated that participants had a favorable experience utilizing the DfHF cards to enhance their creative thinking abilities when confronted with a challenge requiring a solution in the design process. The DfHF cards prompted students to consider how sustainable design affects well-being, with the goal of fostering enduring emotional connections and interactions with users. Emotional plasticity, in addition to emotional sustainability, refers to how design can assist users in transitioning from negative to positive feelings. This transition is supported by methodological aspects that allow for improved emotional granularity over time. The constructivist perspective on emotion proposes that emotional granularity can be improved via deliberate practice [55]. Additionally, students must concentrate on comprehending the specific design elements that are necessary and how they should be integrated to facilitate this transformation. Positive design and psychology are inherently interconnected. Positive design is based on the principles of positive psychology and is primarily used in the fields of industrial and interaction design [15]. Different psychological principles, including emotional psychology, color psychology, and cognitive psychology, influence various positive emotions [66]. Understanding these principles can help students develop a deeper comprehension of emotional design. Furthermore, the DfHF cards can motivate students to apply these principles to their designs.

The relationship between creativity and design outcomes is highly correlated, and the DfHF Cards provide designers with abundant possibilities and suitable tools to improve creativity. The DfHF Cards serve as a valuable instrument for facilitating productive learning and enhancing the cognitive process of design students as they encounter obstacles. Utilizing a variety of data sources ensures a thorough and inclusive examination of the student's design process. This approach captures not only the students' actual process, but also considers their design outcomes and subjective comprehension of the process. By employing cross-validation with numerous data sources, the measuring tools and methods may effectively capture the students' performance and the development of their creative thinking throughout the design curriculum. Regarding the level of involvement in the creative process, we were glad to see that participants expressed feeling highly driven to utilize the DfHF in order to accomplish their design objectives. Moreover, they expressed enjoyment in the delightful process of creation.

The DfHF card functions as a prominent catalyst that successfully converts these intricate principles into concrete sustainable design solutions, thereby engaging designers in an inventive 'Design for Happiness' attitude [44]. The combination of rationality, innovative thinking, and design philosophy demonstrates that the generation of DfHF is not a mere amalgamation of ideas and tools but rather a process of multidimensional thinking and systematic exploration. This process involves reconstructing the intricate connections between relevant elements in order to achieve a novel and improved functional outcome. The intricate nature of this complexity demonstrates the profound comprehension of the exploration of human emotions that underlies the design discipline and teaching methodology [67].

The teaching process in question incorporates an innovative approach that does not have a specific design objective. Instead, it centers around the method and logic of generating design strategies. It involves analyzing and combining design concepts and tools to discover new combinations, ultimately fostering the development of creative thinking skills. This type of diverse analytical training is crucial in fostering students' critical thinking and problem-solving skills, as well as stimulating innovative thinking in the field of design. In essence, our goal is to introduce a fresh perspective on the fundamental education of design majors by engaging in a comprehensive discourse on this subject.

Limitations and future work

Although this study yielded favorable outcomes for the generation and utilization of DfHF cards, it is important to acknowledge many possible limitations. Firstly, the study's validity may have been constrained by the restricted number of participants, and the unique backgrounds and experiences of the participants may have influenced the applicability of the results. Subsequent research endeavors should contemplate enlarging the sample size in order to obtain a more exhaustive comprehension of the various groups' reactions to DfHF cards. Furthermore, the study primarily centered on gathering students' input regarding the DfHF cards and examining the immediate impact of fostering innovative thinking. However, it did not include an assessment of the long-term consequences. To obtain a more comprehensive knowledge of the impact of cards on students' long-term creative development, future research might consider doing a long-term monitoring study. In addition, while the DfHF cards showed their usefulness in certain disciplines in the present study, their effectiveness in cross-disciplinary applications has not been thoroughly verified. Hence, future studies must investigate the use of DfHF cards in many fields of study in order to verify their ability to be applied across different disciplines, which will also aid in gaining a deeper understanding of any necessary modifications and potential obstacles that may arise. Finally, the study did not investigate the influence of variations in instructional approaches on the outcomes. Distinct teaching

strategies could potentially result in variations in students' adoption and utilization of the DfHF cards, and future research could consider comparing the effects under different teaching methods.

CRediT authorship contribution statement

Wenjia Li: Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Xinni Zhang:** Writing – original draft, Software, Investigation, Formal analysis, Data curation. **Han Gao:** Visualization, Validation. **Jingjing Gui:** Visualization, Validation. **Xiaoyu Yang:** Resources, Investigation. **Jidong Yang:** Writing – review & editing, Funding acquisition, Conceptualization.

Data availability statement

Data are available from the authors upon reasonable request.

Ethics statement

The study adhered to ethical guidelines under the supervision of the Academic Ethics Committee of the University of Shanghai for Science and Technology (USST). The data used in this study did not involve ethical issues. All methods employed in the study were performed in accordance with the relevant international guidelines and regulations. The contents of the questionnaire were all multiple-choice questions with clear. Authors are respected for the autonomy, privacy, and dignity of all participants involved in the survey, and the datasets contain no personal identities for the participants with their informed consent. All contents of the questionnaire were communicated in advance to the survey participants, who assisted the authors in completing the questionnaire activities out of total voluntariness.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Please read the entire brief carefully before you start designing.

Design Task: Seating.

Phase 1: Generating ideas. Duration: 10 min.

In this creative thinking course, you are tasked with designing a seating product. Any material, function, or shape of seating is encouraged. Please utilize your creative thinking as much as possible based on the DFHF cards. These ideas can be quite conceptual, and each idea should be sketched and described in writing.

Phase 2: Choose one idea. Duration: 30 min.

After generating various ideas, you are required to select one idea and further develop it into a final design based on the keyword 'relaxation.' Please draw a design sketch and write a brief description, including an explanation of the design and how you connected the DfHF cards with practical application. Use a new sheet of paper for each design iteration.

Phase 3: Advantages of your final idea. Duration: 5 min.

Finally, you are required to articulate as many advantages of your designed product as possible, with a focus on how your design showcases emotional experiences. Additionally, explain how you considered user needs to create functional solutions tailored to real-life scenarios.

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