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Demystifying emotion for designers: A five-day course based on seven fundamental principles

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ABSTRACT

This paper introduces a five-day intensive course, conducted over five years from 2018 to 2022, aimed at teaching emotion-driven design (EDD) to graduate students with diverse disciplinary backgrounds at Beijing Normal University. EDD is the practice of designing products or services that are informed by user or consumer emotions and/or aim to elicit predetermined emotions. The course was designed to teach students about human emotions from a scientific perspective and to provide hands-on experience in creative processes. To structure the course, seven principles derived from emotion-related design knowledge were employed, which guided the development of learning activities and course materials. The paper also includes student evaluations and reflections on the strengths and weaknesses of the course design. It intends to serve as a resource for design educators who wish to teach the practical application of emotion psychology to students with limited prior expertise.

1. Introduction

Remember the Juicero fruit juicer? In 2017, it was hailed as the next big thing in kitchen appliances, promising to revolutionize the way we make juice at home. But the excitement quickly turned to disappointment when it was revealed that the design was essentially just a fancy machine that squeezed pre-packaged juice bags. The company shut down after 16 months, with many pointing to its failure as a prime example of bad *emotional design* [1]. What is emotional design? – and why is it Important? Emotional design or emotion-driven design (EDD) is the practice of designing products or services that are informed by user (or consumer) emotions and/or aim to elicit predetermined emotions [2]. Good emotional design can create a lasting connection with consumers, increase customer satisfaction, and drive brand loyalty and commercial success [3]. Take the *Nike Run Club* app as an example. More than providing functional information, it has community and social features that connect with users on an emotional level, motivating them to reach their personal fitness goals [4]. In contrast, bad emotional design can have the opposite effect, leading to frustration, disappointment, or even anger. The Juicero did not evoke any positive emotions beyond the initial hype because it failed to connect to emotional needs and exactions of consumers, ultimately contributing to its downfall.

Skilled designers have long recognized the critical role of emotions in their practice. Hartmut Esslinger, the founder of Frog Design, famously proclaimed that “form follows emotion”, a philosophy that has been consistently reflected in Frog's designs since the 1980s [5]. Similarly, today's design leaders like Russell [6] of design consultancy LOVE, continue to emphasize the significance of emotions in creating designs that move people, stating that “As humans, we hunt out things that move us”. In essence, emotional design is not a new concept, but rather a longstanding principle that has been refined over time to produce effective and engaging user experiences [7]. elaborated on this principle by providing several arguments for the importance of emotional design. Firstly, user emotions shape behavior as they heavily influence decision-making. Design that evokes positive emotions can encourage consumers to purchase products or services. Secondly, emotional design can have a longer-lasting impact because designs that evoke positive emotions are often more memorable than those do not. Thirdly, emotional design can contribute to the users' overall sense of wellbeing with a product or service. Finally, emotional design creates differentiation as products and services that are emotionally engaging can stand out in a crowded market, providing a competitive advantage.

Successful designers who create emotionally impactful designs, often attribute their success to personal intuition and serendipitous moments

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of inspiration, which creates a sense of mystery around emotional design. As Steve Jobs once noted, "When you ask creative people how they did something, they feel a little guilty because they didn't really do it, they just saw something" [8]. While experienced designers may have developed the ability to include an understanding of user emotions in their design processes, it can be a struggle for novice designers to develop this competence due to the subjective and ephemeral nature of emotion. This poses a challenge for design educators. Scientific research in psychology has generated a wealth of knowledge on human emotions that can provide evidence-based guidance for novice designers. Unfortunately, this knowledge is notoriously difficult to access and understand due to its size, constant evolution, and occasional contradictions. Moreover, it Is typically not situated or tailored to support design practice, which can overwhelm or confuse novice designers.

Acknowledging this challenge, over the past 25 years, design researchers have made significant progress in developing an understanding of design-evoked emotions. This progress has resulted in a wealth of emotion-related knowledge and tools that can support EDD. This includes models and theories that offer an understanding of emotions in the context of human-design interactions, as well as tools and techniques that facilitate structured EDD approaches [9,10]. This growing knowledge base can support design educators in their attempts to demystify emotion for novice designers, offering possibilities for effective education on how to operationalize emotions and incorporate emotion-related design knowledge into creative design processes.

In this paper, we present a five-day intensive EDD course that was developed leveraging this knowledge base. It teaches design students scientific knowledge about human emotion, and helps them implement this knowledge in their design activities with hands-on EDD exercises. The course was developed by the authors and debuted at Delft University of Technology in 2009. Since then, it has been offered once or twice per year for the past 14 years, with each iteration building upon the lessons learned from the previous version to improve its effectiveness. Additionally, various versions of the course have been taught in Spain, Denmark, China, USA, South Korea, and Italy. The version outlined in this paper was customized for graduate students at Beijing Normal University, taking into consideration that it needed to cater to a large number of students (ranging from 60 to 100) with varied disciplinary backgrounds and little prior knowledge or expertise in emotion psychology, all within a limited timeframe of 40 teaching hours.

Our course is not unique. Other courses focusing on EDD have been developed and are being taught at other design schools. However, reports or analyses of EDD teaching cases and their outcomes are notably absent from the current literature. By documenting and reporting our course design we aim to address this gap and contribute to the development of effective courses in the field. Our paper presents seven key principles that guided the course design. Each principle is elaborated upon, explaining the scientific knowledge that underlies it and illustrating its relevance to EDD practice through the outcomes of students' course projects. Additionally, student evaluations are concisely reported, and the course's strengths and weaknesses are evaluated. By sharing our experiences, we aim to offer a practical resource for design educators and researchers seeking insights into EDD pedagogy. In doing so, we hope to provide informative guidance to design educators who are dedicated to demystifying the role of emotion for novice designers.

2. Course structure and embedding

The course was offered to graduate students enrolled in the user experience (UX) program at Beijing Normal University, as reported by Refs. [11,12]. Its primary objectives were to (1) teach scientific knowledge about human emotion, and (2) inspire students to engage in direct action in creative processes. Each year, enrolled students formed groups that were balanced based on their undergraduate backgrounds to ensure within-team diversity. The course was delivered in a hybrid format, with a combination of in-class and online activities over five consecutive days, using the Zoom platform. Two professors participated in the online component, with one providing lectures on the academic knowledge, while the other guided students' practice in small-scale group-based design projects through one-on-one online meeting rooms. Additionally, two teaching assistants supported the classroom-based activities, having previously taken the course and were able to answer basic questions.

Each day of the five-day course, except for the first, began with student presentations on their projects, which included their process, results, and key learnings. From days 2–4, six different teams presented, with each team focusing on projects that explored specific EDD principles. On day 2, the micro emotion project (see Principle 2) was presented, followed by the fundamental needs project (see Principle 3) on day 3, and the rich experience project (see Principle 5) on day 4. On the final day, all teams presented their motive analysis (see Principle 6) and dilemma-driven designs (see Principle 7). The development of learning objectives, activities and course materials was based on the seven principles drawn from 25 years of research into EDD, as presented by Ref. [2].

(1) Emotions are subjective: All emotions a person experiences, including those in response to design, are mediated by the individual's personal history, motives, and interests. Therefore, there are no one-to-one relationships between design features and emotional experiences.
(2) Design evokes micro emotions: Rather than evoking strong emotions, design primarily evokes a continuous stream of multiple mild emotions that are short-lived, of low intensity, and have a mild impact. These micro emotions are less intense, shorter in duration, and have a fleeting impact compared to those emotional experiences that stand out and are memorable.
(3) Humans have fundamental needs: While the motives of humans that underly emotions are infinitely diverse, all people share a limited set of universal psychological needs that forms the basis of our emotion system.
(4) Design can evoke diverse emotions: The range of emotions that people can experience in response to consumer goods is much more diverse than typically acknowledged in emotion-driven innovation.
(5) Emotions reveal user motives: Emotions are gateways to understanding what people care about while interacting with design. They can serve as effective entry-points to comprehending people's goals, needs, and values.
(6) Emotions are often driven by dilemmas: Most designs evoke mixed emotions as they often fulfil one motive while violating another.
(7) Negative emotions can be enjoyable: The human emotion repertoire includes a unique space of rich experiences, which embodies emotions that combine pleasure and displeasure.

This paper is structured around the seven principles. Each principle is elaborated upon, explaining the scientific knowledge that underlies it and illustrating its relevance to EDD practice through the outcomes of students' course projects. Table 1 gives an overview of the principles, the related design (research) exercises, and student work examples reported in this manuscript.

2.1. Principle 1: emotions are subjective

Emotional experience is subjective—an inner state felt by an experiencing individual. While certain manifestations of human emotion, such as behavioral and expressive responses can be observed and measured objectively, the content of emotional experience itself is fundamentally inaccessible to anyone other than the individual experiencing it. This means that the only means of accessing the vivid and rich information about how an emotional experience feels is through introspection or inward observation from the first-person perspective [13]. As an additional consequence, it is virtually impossible to predict or model the impact of design on emotional experience. Emotion is a form of relational

Table 1
EDD principles, exercises, and student work examples.

EDD principles	Exercises	Reported examples
(1) Emotions are subjective	Bring a product that holds personal significance.	String and spinning wheel. Fig. 1.
(2) Design evokes micro emotions	Do a "Micro Emotion Scan", creating an emotion-focused timeline of using a product.	Instant milk tea and self-heating rice. Figs. 2 and 3.
(3) Humans have fundamental needs	Make a redesign of a functional architecture space using an overview of 13 fundamental needs.	Learning goal display and flexible seating. Figs. 4 and 5.
(4) Design can evoke diverse emotions	Collect six samples of emotions experienced in response to product designs.	Six collected emotion samples. Fig. 6.
(5) Emotions reveal user motives	Capture and analyze emotions experienced during an activity.	Karaoke bar. Fig. 7.
(6) Emotions are often driven by dilemmas	Identify dilemmas in the emotions uncovered in the previous exercise and use them to design a product.	Room battle and wait for vote. Figs. 8 and 9.
(7) Negative emotions can be enjoyable	Design for a rich experience at a selected location within the university campus.	Pac-man automatic door. Fig. 10.

meaning, which means that it is inherently tied to the individual's personal history and interests. Consequently, there are no one-to-one relationships between design features and emotional responses. The same design may elicit completely different emotional reactions in two individuals, and one person may find a product delightful, while another is offended by it. Despite this inherent subjectivity, emotions are not entirely unpredictable or chaotic. Basic mechanisms underlie the complex and idiosyncratic emotional experiences [14,15], and intersubjective (not objective) truths about emotions can be identified across individuals [16]. To teach design-relevant emotion knowledge, it is crucial to guide students to first become aware of and reflect on the subjective nature of emotion through introspection and discussion. This serves as a necessary first step in understanding the complexities of EDD.

2.1.1. Exercise

As part of an introspective exercise, each student is asked to bring a product to class that holds personal significance to them. The product should be irreplaceable—an object that is cherished by the student. They are also required to write a short essay reflecting on their feelings towards the object and why it holds meaning to them. During class, students share their reflections in small groups, allowing for meaningful discussions around the personal and subjective nature of emotional experiences.

2.1.2. Learning goal

Through the essay writing and sharing exercise, students can gain valuable insights into two aspects of emotional experience. Firstly, they develop a first-hand understanding of how introspection can be used to access emotional experiences, and how these introspections can serve as a basis for reflection and analysis. Secondly, they come to realize that emotions are inherently subjective and personal, while at the same time being able to appreciate, resonate with, or emphasize other people's emotions. To illustrate the exercise outcomes, we present examples from two students in the following subsection.

2.1.3. Student examples (see Fig. 1)

2.2. Principle 2: design evokes micro emotions

Emotions that are evoked by consumer goods are typically subtle and low in intensity. Of course, design can occasionally evoke strong emotions—your car breaks down, you unbox your new phone, or you find a missing heritage necklace. However, these emotional moments are the exceptions, rare and isolated emotion peaks in a wide landscape of mostly mild experiences. In reality, the majority of our emotional experiences with products are short-lived and mild, often not remembered after the episode [17]. This has led many to believe that they are "not so emotional" about products. But upon mindful observation, a rich flow of emergent micro-emotions can be seen in all human-design interactions. We call these emotions "micro" due to their ephemeral nature, as they do not leave a lasting impression. Although elusive, they are significant because they can influence our thoughts, actions, decisions, mood, and overall well-being. Zooming in on these micro emotions can be a valuable practice for designers, as each one points to something that is of

String

"During our visit to the Yonghe Lamasery, my friend requested a special string for me. This string is made of incense ash glazed material obtained from the Lamasery and blessed by the temple lama through burning it with incense ash. It features beads symbolizing various aspirations, including white for education, blue for health, gold for wealth, green for career, and red for marriage. This string holds my friend's heartfelt wishes for me and serves as a warm welcome back to Beijing, where I can reconnect with my friends."

Spinning pen

"This spinning pen holds a special place in my heart. A close friend gave it to me on my birthday after my college entrance examination. It has a unique color scheme that remained intact over the past five years. I carry it with me everywhere. As a skilled pen-spinner, I find immense pleasure in executing intricate moves with the pen. Watching it spin at my fingertips brings me wonder and satisfaction. This pen is a meaningful coming-of-age gift that I treasure deeply, especially since my birthday coincides with the college entrance exam."

Fig. 1. Two examples of results for the introspective exercise.
"During our visit to the Yonghe Lamasery, my friend requested a special string for me. This string is made of incense ash glazed material obtained from the Lamasery and blessed by the temple lama through burning it with incense ash. It features beads symbolizing various aspirations, including white for education, blue for health, gold for wealth, green for career, and red for marriage. This string holds my friend's heartfelt wishes for me and serves as a warm welcome back to Beijing, where I can reconnect with my friends."
"This spinning pen holds a special place in my heart. A close friend gave it to me on my birthday after my college entrance examination. It has a unique color scheme that remained intact over the past five years. I carry it with me everywhere. As a skilled pen-spinner, I find immense pleasure in executing intricate moves with the pen. Watching it spin at my fingertips brings me wonder and satisfaction. This pen is a meaningful coming-of-age gift that I treasure deeply, especially since my birthday coincides with the college entrance exam.". (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

importance to the user. Identifying micro-emotions can, therefore, reveal opportunities to improve the design by reducing negative experiences and/or strengthening positive ones or by formulating new propositions for design innovations.

2.2.1. Course exercise

In class, students engage in a practical exercise called the "Micro Emotion Scan" (MES) in small teams. This exercise aims to capture the range of subtle emotions experienced while using a simple everyday product, such as a chocolate box or a cleaning detergent. The result of the MES is an Emotion Map, which presents a visual timeline overview of all positive and negative emotions experienced during the usage journey, reported with a verbal label, a pictogram, and a one-sentence description of the specific cause. The MES exercise guides students to slow down usage and to zoom in on all the micro emotions. After making their Emotion Map, students select one negative and one positive emotion as design opportunities, based on which they develop two redesigns: one that amplifies the positive emotion, and one that reduces the negative emotion.

2.2.2. Learning goal

The main takeaway from this exercise is the firsthand realization that human-design interactions involve a continuous flow of micro emotions. This surprising insight applies not only to products that are expected to elicit strong emotions but also to everyday products. The second important lesson is that students learn that capturing these micro-emotions, although subtle and elusive, can reveal relevant and exploitable design opportunities.

2.2.3. Student examples

2.2.3.1. Instant milk tea. The student team conducted a detailed analysis of their emotional responses while using a bottle of instant milk tea, as shown in Fig. 2. They were surprised to discover 39 distinct emotions arising solely from the act of opening the bottle. For their redesign, the team focused on enhancing *satisfaction*, which was experienced when enjoying the aroma of the milk tea while stirring, and reducing *anger*, which was experienced when picking up the cup and getting scalded. To enhance the positive emotion of satisfaction, the team leveraged the personalization option of adding sugar by designing a sugar bag divided

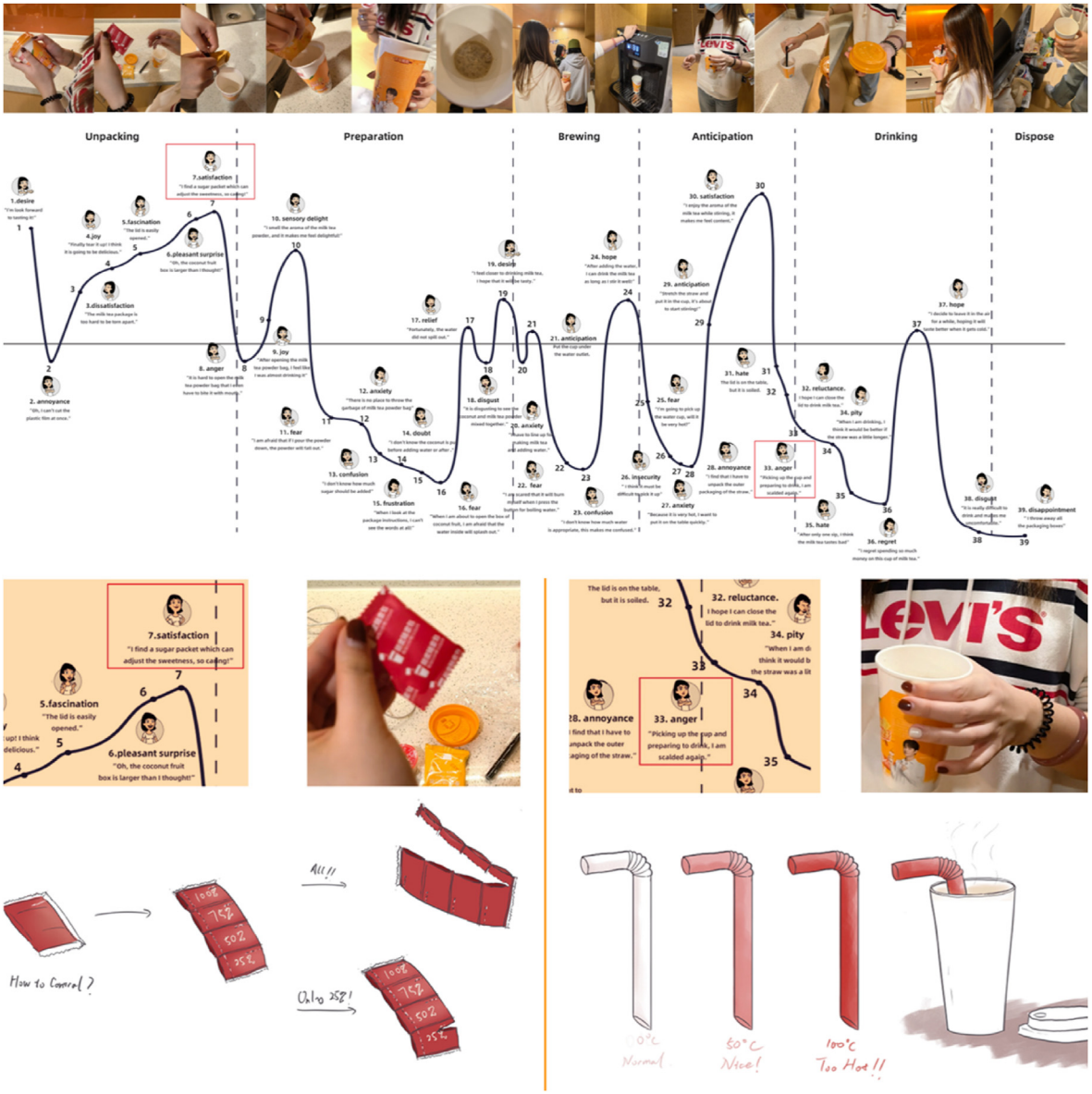

Fig. 2. The micro emotion scan (top) and redesigns (bottom).

into four portions, each labelled with a percentage (25%, 50%, 75%, and 100%) for users to match their preferences. To reduce anger, the team designed a temperature-sensitive straw that changes color (white at 20 °C, pink at 50 °C, and deep red at 100 °C) to indicate the tea's temperature and enable users to proactively manage their safety, minimizing the risk of scalding caused by hot milk tea.

2.2.3.2. Self-heating rice. Self-heating food has become increasingly popular among young people as an easy-to-prepare instant food. The preparation process involves four simple steps: placing the seasoning and rice in the upper container, adding water to the upper container, inserting the self-heating bag in the underlying container, and adding cold water to the underlying container. The student team conducted an emotional scan of the instant meal preparation process and identified 16 emotions, as depicted in Fig. 3. *Anticipation* and *insecurity* were selected as the basis for redesigning the product. To enhance the emotion of anticipation, the team redesigned the lid of the upper container using a transparent material, allowing users to observe the changing process of the food from raw to well-done, adding a sense of excitement and enjoyment during an otherwise mundane wait. To address the negative emotion of insecurity, the team added several small holes to the side of the underlying container. These holes are sealed during the heating process but can be pierced with chopsticks after the rice has cooked, allowing the steam to diffuse faster. Additionally, a long handle was added to the edge of the upper container, enabling users to safely remove the container without the risk of injury.

2.3. Principle 3: humans have fundamental needs

All humans share a set of fundamental psychological needs that can be fulfilled by a wide range of human-design interactions. For instance, the smell of freshly washed laundry, parachuting out of an aeroplane, or taking the first sip of beer on a hot summer day can evoke positive emotions because they contribute, in one way or another, to the fulfilment of some fundamental needs, such as beauty, stimulation, competence, comfort etc. These needs are the basic requirements for our functioning, the nutrients for our development—and the foundation of our emotion system. To inform design activities [18], developed a typology of thirteen fundamental psychological needs that balances comprehensiveness and nuance. While these needs are universal, unaffected by culture, age, or lifestyle, people fulfil them in various ways, depending on their preferences and circumstances. One person may satisfy their need for stimulation by jumping out of an aeroplane, while another gets stimulated by solving the Sunday crossword. Understanding fundamental needs reveals at least two design opportunities. First, designers can use them to precisely target what core needs that a product or service addresses. Second, designers can identify and focus on the needs that are unfulfilled or under-fulfilled by the currently available products, using the overview of fundamental needs as a source of creative inspiration.

2.3.1. Exercise

In teams, students analyze a functional architectural space, using the overview of 13 fundamental needs as their lens. Their classroom is the selected space, which includes a gallery, informal meeting spaces, and movable workshop tables. Students use their own experiences as the entry-point of their analysis. They identify the four needs that, in their view, are best fulfilled by the classroom and explain why. They also identify the four needs which are most hindered or least fulfilled. Next, they select two needs that are currently unfulfilled and interesting from a design perspective and create a conceptual redesign of the space that satisfies both needs.

2.3.2. Learning goal

In this project, students learn that despite surface-level differences in goals and desires, deep down all individuals have the same universal psychological needs. They become familiar with these needs and practice utilizing them both as a tool for analyzing the emotional impact of design, and as a starting point for design innovation.

2.3.3. Student examples

2.3.3.1. Learning goal display. Drawn from their experiences as daily users of the learning space, the student team identified three important needs that the design of learning space did not adequately meet, namely *recognition*, *purpose*, and *competence*. With these insights, the team developed a design intervention to address these unfulfilled needs. They located an underutilized corridor between a small bar and a break room, where students often pass by quickly, and designed a *learning goal display* that could be installed here. Fig. 4 depicts this display, which consists of a triangular prism made of cork packing material. Each student can post their individual learning objectives on the prism, which can be rotated to view all the sticky notes. Different surfaces on the prism are dedicated to various student year cohorts. This display helps students compare their goals with those of their peers and seniors, motivating them to achieve their objectives. Moreover, it facilitates interaction among students by

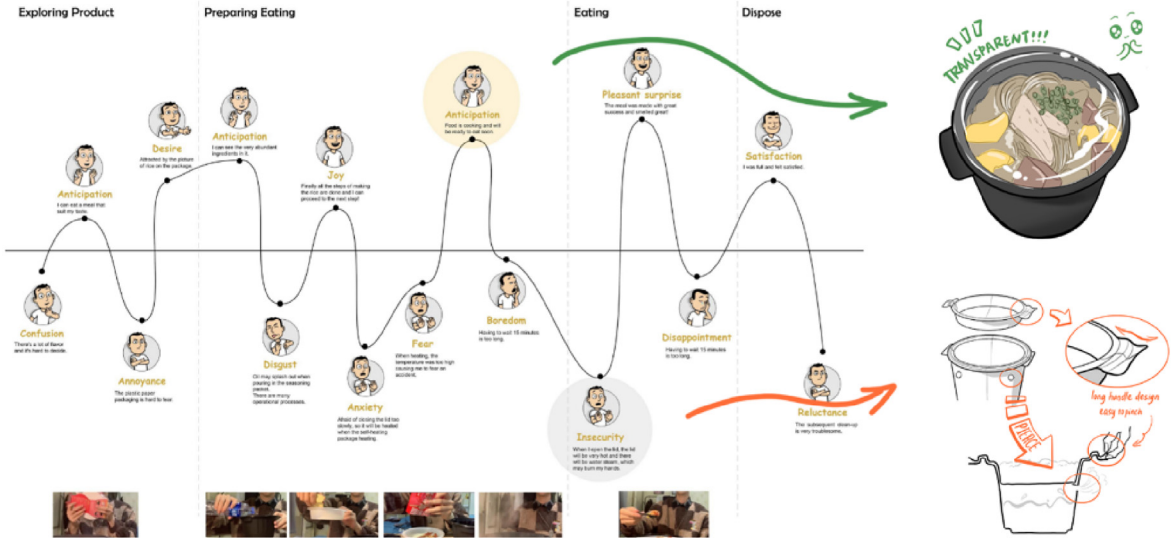

Fig. 3. The micro emotion scan (left) and redesigns (right).

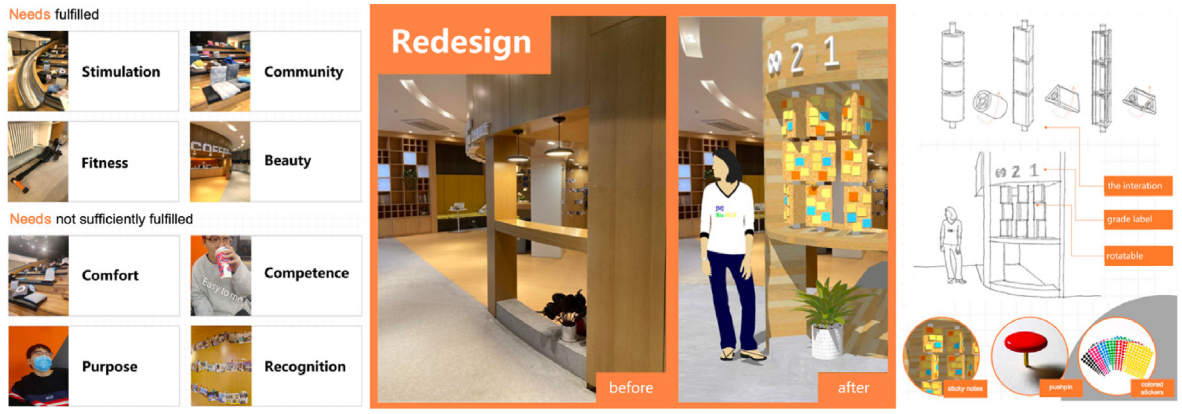

Fig. 4. The fundamental need analysis (left) and design intervention (right).

allowing them to post stickers on the targets they wish to encourage. This student example demonstrates the value of addressing subtle yet impactful issues within the classroom environment by identifying unfulfilled needs and developing appropriate design interventions accordingly.

2.3.3.2. Flexible seating. The current design of our institute's multifunctional classroom is intended to promote equality among students. However, the student team identified that it presents several challenges related to *comfort*, *fitness*, and *relatedness*. For instance, students have difficulty rearranging tables and chairs for group discussions, resulting in discomfort and physical strain. Additionally, the stepped seating design and limited space make it challenging for students to sit comfortably for extended periods, leading to back and neck pain. The fixed seating arrangements also hinder communication and relationship-building among students. The main pain points are limited seating positions, constrained class times, uncomfortable seating arrangements, and the need to move chairs during group discussions. To address these issues, students proposed a design solution that includes seats with adjustable height and paddles that can be moved from side to side, allowing for flexible seating arrangements. This design enables students to lie down, select group members at the same level, or stand and listen to the lesson. The proposed design also includes a ceiling projection for uninterrupted learning, as shown in Fig. 5. These changes would improve comfort, encourage group interaction, and facilitate discussions.

2.4. Principle 4: design evokes a wide diversity of emotions

Positive emotions experienced in human-design interactions are highly diverse. The range of positive emotions that people can experience in response to consumer goods is much more diverse than often recognized or acknowledged in emotion-driven innovation. According to Ref. [19]; users can experience at least 25 different positive emotions when interacting with products. For instance, when using a novel medical device (e.g., a blood pressure monitor), users may be *inspired* by the innovative technology, *fascinated* by the ergonomic design, *proud* of becoming capable of using all the functions very quickly, *relieved* by the sense of security it provides, and so forth. Given this diversity, designers can benefit from having a broad repertoire of positive emotions and an understanding of their nuances to support effective and innovative design activities. Specifically, a nuanced understanding of these emotions can support empathy, precise determination of the intended emotional impact for more effective EDD, stimulate creativity, and provide a shared language for design teams to collaborate and communicate about the subjective qualities of the design and its experiential impact [20].

2.4.1. Course exercise

In this exercise, students collect six product emotion “samples”. First,

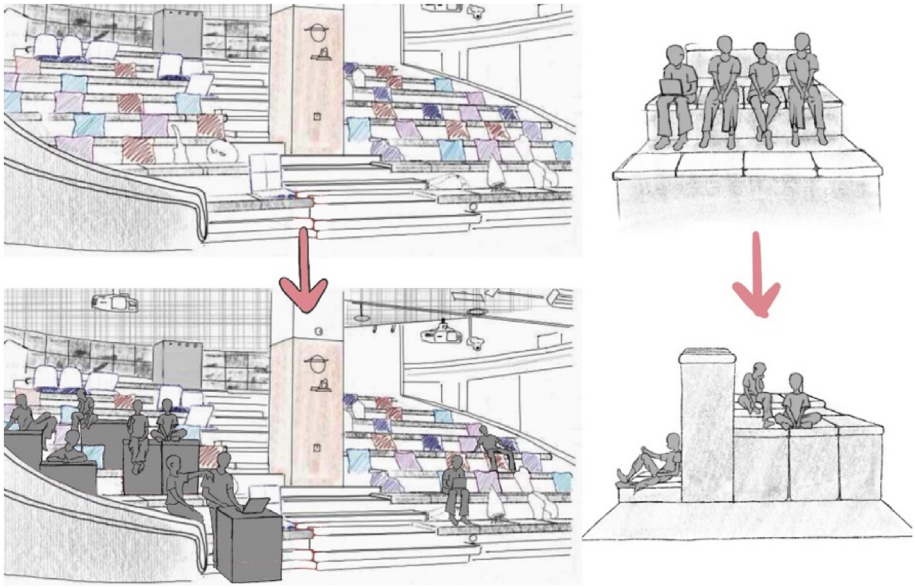

Fig. 5. The current seating arrangements (top) and the redesign that better fulfils the needs of comfort, fitness, and relatedness (bottom).

they are provided with a long list of 50 emotions, including 25 pleasant and 25 unpleasant emotions, and corresponding definitions. Students pick three emotions randomly and then collect two samples for each selected emotion, by paying special attention to their emotional experiences with products that they interact with during the day. To document their samples, students create a separate card for each using a predefined format that includes a picture, emotion label, and short description. These cards are printed and placed on a workshop table to serve as input for a class discussion about the subjective quality and diversity of emotions. By putting all the cards on a big table and discussing and reflecting on the overview, students gain a better impression of the range of emotions people can have in human-design interaction. In total, hundreds of cards are created, leading to a rich and diverse discussion.

2.4.2. Learning goal

By engaging in this activity, students (1) gain first-hand experience with the diverse range of emotions that may arise from human-design interaction, and (2) enhance their "emotional granularity", which is the ability to distinguish between similar yet distinct emotional states with subtle nuances, and to accurately interpret and articulate them [21].

2.4.3. Student examples: six collected emotion samples (see Fig. 6)

2.5. Principle 5: emotions reveal user motives

Emotions are gateways to understanding what people care about in the context of consuming goods and services. The occurrence of an emotion, be it positive or negative, always points to the presence of a personal motive—a goal, need, value, or concern [22]. Positive emotions signal the fulfilment of a personal motive, and negative emotions signal an obstruction to motive fulfillment. This principle explains why different people can have different emotions in reaction to the same product: Because their situational motives differ. The proposition that every emotion hides a personal motive implies that the practice of EDD can be reframed as a motive-driven design. A key challenge of working with personal motives is that people often find it difficult to retrieve and formulate their situational motives. Moreover, they are often not aware of all their motives that can be relevant to the design brief at hand. In those cases, lived emotional experiences, when properly probed, can be a valuable gateway to these motives. Emotion measurement, through self-report, can generate insights that are useful for EDD when followed up with an interview about underlying consumer motives. Key to the procedure for uncovering motives is to distinguish between three components of an emotional event: The emotion (What is the experience?), the stimulus event (What event caused the emotion?), and the relevant motive (Why is this event personally relevant and significant?).

2.5.1. Exercise

In small teams, students participate in a structured self-report procedure aimed at uncovering relevant consumer motives for a given activity, such as buying a snack in a convenience store or going to a karaoke bar with friends. In a two-stage procedure, students first conduct field research with one student acting as the user/consumer while the others observe and capture as many as emotions experienced by the "user" in that activity, following an established procedure [23]. Next, they use the

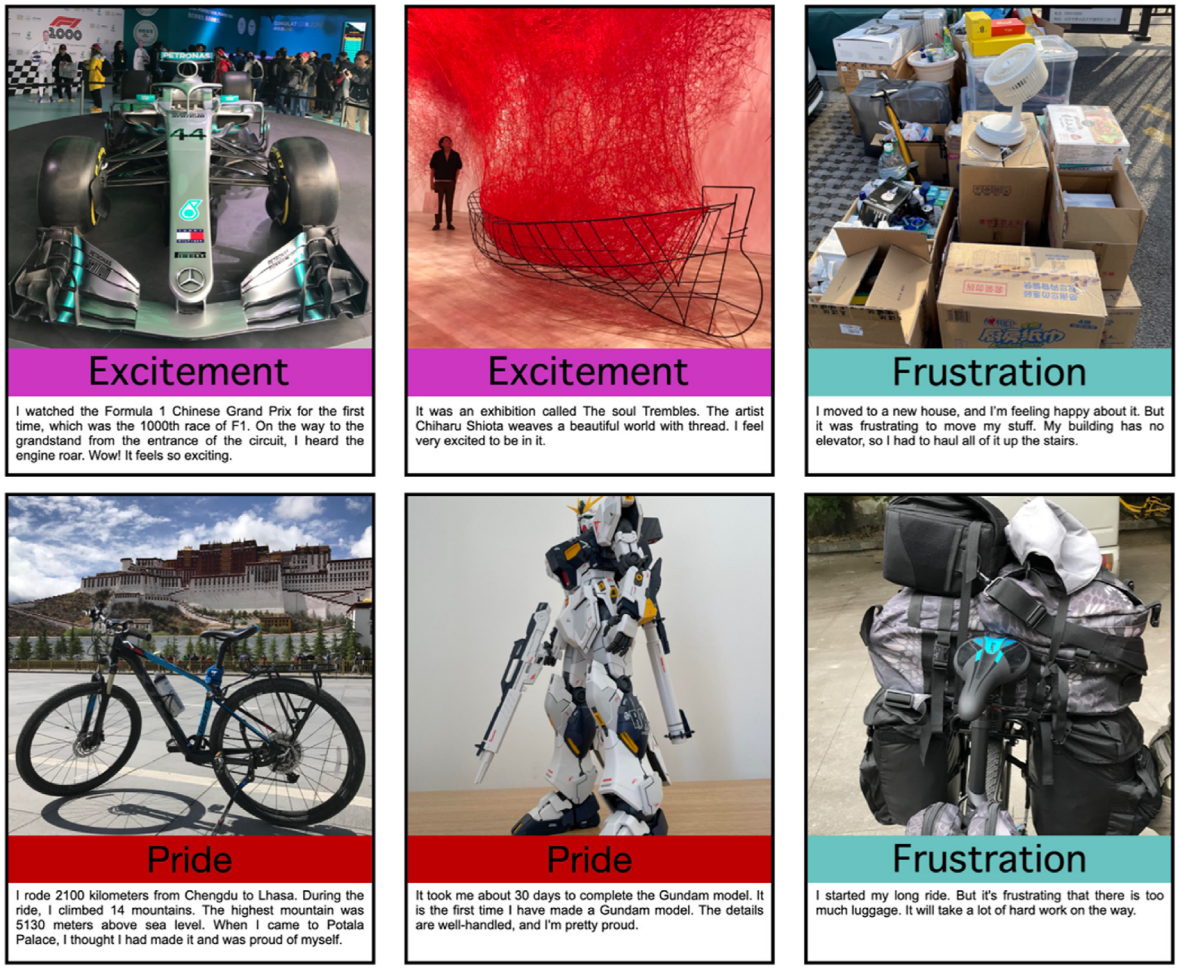

Fig. 6. Six examples of emotion sample cards.

found emotions as entry-points for a shared reflection that aims to uncover the underlying motives. For each emotion, three types of questions are asked: "what" questions to determine what happened (e.g., "I bought a bag of nuts that was expired"), "how" questions to determine how the person felt about this event (e.g., "I was angry"), and "why" questions to understand why this event was important (e.g., "shops should pay attention to what they are selling"). Asking the "why" question helps gain access to underlying personal motives.

2.5.2. Learning goals

With this exercise, students (1) practice observation and interview techniques that enable them to uncover the relational meaning underlying emotions. They also learn that (2) each emotion is associated with a stimulus (the event that evokes the emotion) and a personal motive (which is what gives the stimulus personal relevance). Furthermore, students learn (3) how to formulate human motives in various levels of abstraction and how this impacts the space of design opportunities.

2.5.3. Student example: karaoke bar

When students discussed possible negative emotions in the context of a karaoke bar, it became clear that people can have very different experiences. While some students may feel excited about going to a karaoke bar, others may have a negative attitude toward it. To explore this topic, students recalled their recent experiences at a karaoke bar, starting from the moment they got into the cab to the end of the activity. Through this process, they retrospectively captured a range of emotions that frequently occurred in their karaoke experience and identified the causing events and underlying personal motives behind these emotions, as depicted in Fig. 7.

2.6. Principle 6: emotions are often driven by dilemmas

User emotions are often influenced by conflicting motives, resulting in emotional dilemmas. When people face two mutually exclusive choices of action, they experience positive and negative emotions towards both options, as each choice fulfils one motive while violating the other [24]. For example, during dinner, you might feel delighted about the idea of having a chocolate dessert (need for sensory pleasure) but also anticipate the regret of this choice and feel better off with a fruit salad (need for physical health). Designing with dilemmas offers several opportunities. First, it can stimulate design creativity, as contradictions challenge problem solvers to find solutions that eliminate tension and restore consistency. Second, designs that resolve motive conflicts can have high emotional relevance. For instance, a fruit salad designed to be as indulgent as a chocolate dessert (or a chocolate dessert that is as healthy as a fruit salad) can fulfil both of our motives. A dilemma-driven approach to design requires an overview of relevant and inspiring user motives. By juxtaposing these motives, designers can identify relevant dilemmas in the domain of the design brief. For instance, if the design brief is to create a product that promotes health and sustainability, designers could explore dilemmas such as convenience versus sustainability or taste versus nutrition to develop innovative solutions that address these conflicting motives.

2.6.1. Exercise

The dilemma-driven design exercise builds on the previous exercise in which students created an overview of user motives. All identified user emotions (including the stimulus and underlying motive) are mapped on separate motive cards. Three teams that studied the same type of activity in the field combined their motive cards and place them on a table. They then cluster these cards to identify motive categories and dilemmas between them. Finally, each team selects three dilemmas, or pairs of conflicting motives, as starting points, and designs three interventions that aim to reconcile the conflicts. Three design strategies are introduced to them as pathways - resolving, moderating, and triggering dilemmas. For more details on the three strategies, see Ref. [25].

2.6.2. Learning goal

In this exercise, students learn that (1) motives are most useful in design processes when formulated in an open-ended positive manner (e.g., "I want to eat healthy," instead of "I want to eat a banana") and positive (e.g., "I want to eat healthy," instead of "I do not want to eat unhealthy"). Additionally, students (2) gain experience with various design opportunities (e.g., compromising, resolving, contrasting) that can be utilized as pathways to leverage user dilemmas for design innovation [25].

2.6.3. Student example

2.6.3.1. Room battle. The student team's focus was on the emotional challenges experienced in the context of Karaoke, a popular leisure activity in China. They discovered the dilemma of "I want to creatively express myself" versus "I want to do so freely without being judged by others". In response, they designed the "Room Battle" system (see Fig. 8), which enables participants to compete with people in other rooms of the karaoke facility. The competition is not based on singing skills but on decibels, body movements, and bounces, which are visualized on a LED column in each room. By shifting the participants' focus from the individual to the inter-room dynamics, the system encourages them to creatively express themselves with little chance to feel being judged by others and helps quickly elevate the atmosphere in the room.

2.6.3.2. Wait to vote. The student team's research revealed a dilemma encountered by Karaoke participants. It was the conflict between the motive "I want to sing my preferred songs" and the motive "I want to consider my friends' preferences". To address this dilemma, the team designed a new feature called "Wait to vote" (see Fig. 9). When a participant selects a song, a pop-up window appears, asking them if they want to add it to the "Wait to vote" list, which is visible to everyone.

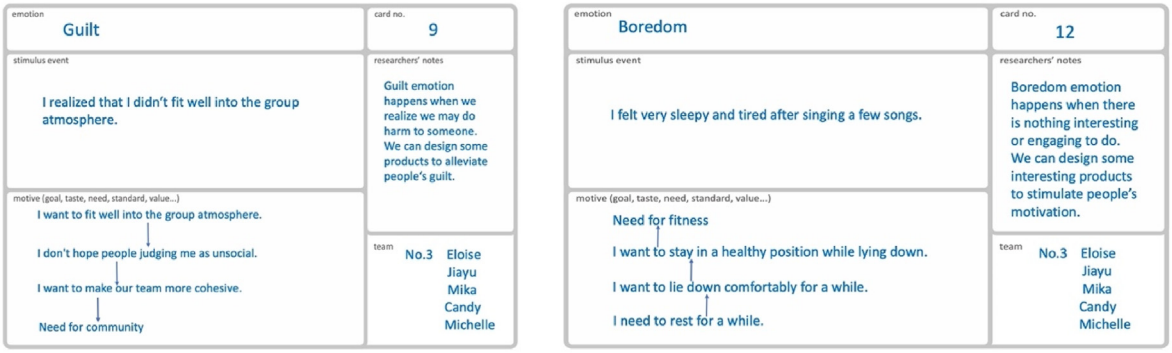

Fig. 7. Possible negative emotions in the context of a karaoke bar, e.g., guilt and boredom.

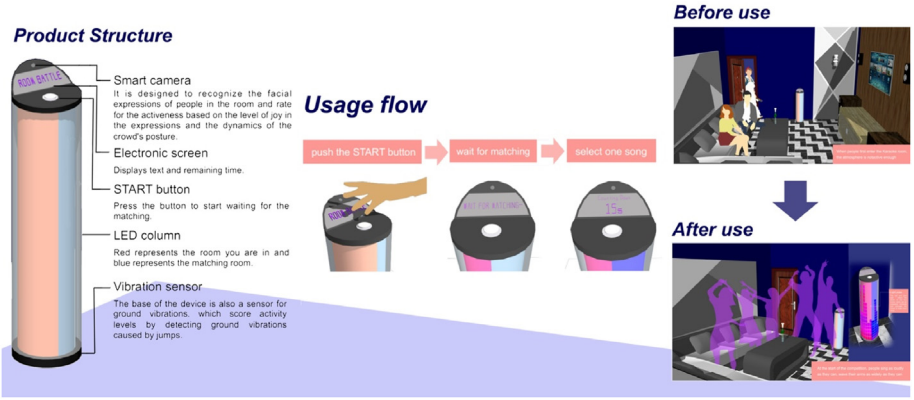

Fig. 8. The "Room battle" system redesign.

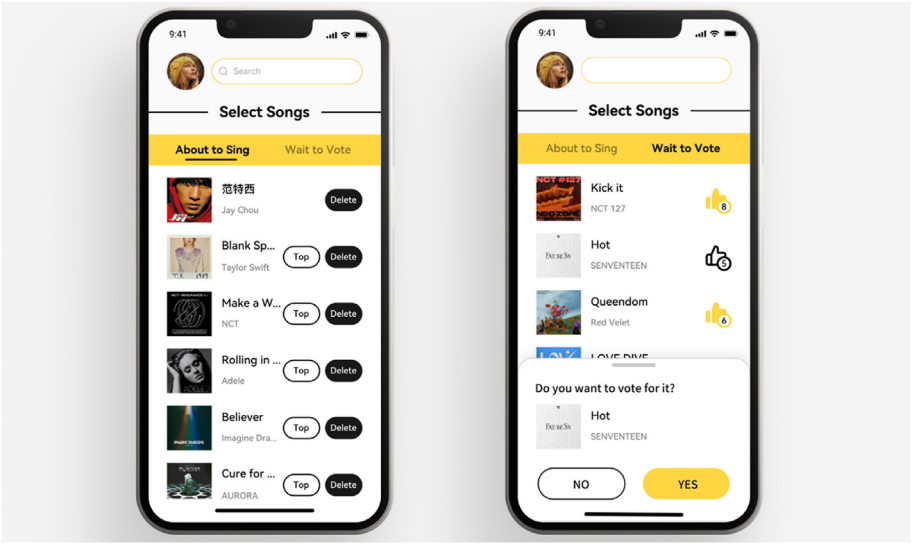

Fig. 9. The "Wait for Vote" system (left) and redesign (right).

Subsequently, other participants can vote on the song, enabling the team to decide which songs should be moved from the "Wait to Vote" list the "About to Sing" list. As such, this approach aims to resolve the dilemma, ensuring that every participant has an equal opportunity to sing their favourite songs.

2.7. Principle 7: negative emotions can be enjoyable

Contrary to common sense, people can enjoy experiencing negative emotions. Companies often make significant efforts to avoid evoking negative emotions with their products. For instance, a food package should not be *frustratingly* difficult to open, and an aeroplane flight should arouse as little *anxiety* as possible. However, when delving deeper into the nuances of emotional experiences, we can identify many enjoyable activities that involve negative emotions. For example, people enjoy spending time on frustratingly difficult puzzles and riding rollercoasters that literally sway them between anxiety and terror. Not only do people enjoy these activities, but they also actively seek them out and are willing to spend money on them. There are several reasons why it can be beneficial to include negative emotions in the designer's repertoire. Firstly, they add edginess and engagement to product experiences that can surpass that of positive emotions. Secondly, negative emotions are typically easier to evoke with high intensity than purely positive emotions. Lastly, like positive emotions, each negative emotion has a unique effect on people's perception, thoughts, and behavior, which can be functionalized to influence the product users in a favorable way [26].

2.7.1. Exercise

Students work in teams to design for a "rich experience". As a design context, students are free to select an interesting location on the university campus (e.g., library, canteen, sports field). They start by targeting a negative emotion and brainstorming how it can be evoked with a design intervention in the given context. Next, they reflect on how the negative emotion can be transformed into a rich experience (i.e., an enjoyable negative emotion) by ensuring that the user is protected from possible negative consequences [27].

2.7.2. Learning goal

In this exercise, students learn (1) how negative emotions can serve a function in creating enjoyable experiences, (2) how to distinguish between negative emotions that are unpleasant and those that involve a sense of enjoyment, (3) how to create a negative stimulus while protecting the user from its adverse consequences, so that a negative emotion can be enjoyable.

2.7.3. Student example

2.7.3.1. Pac-man automatic door. The student team chose to focus on the entrance door to the classroom. Following observations and interviews, they found that many people were apprehensive of the fast automatic

door as they feared it would close while they were passing through it. The door's transparency meant that users might inadvertently collide with it if they failed to notice that it had shut. Students decided to leverage the rich experience of "thrilling" as the basis for their redesign. They incorporated elements such as Pac-Man animations, a countdown, and a progress bar (see Fig. 10). Rather than addressing the fear directly, their redesign reframed it as a positive feeling of excitement while simultaneously helping users avoid accidents (by reducing the likelihood of walking into the glass door using animations).

2.7.3.2. Smart electronic flower. Various study rooms are available on the university campus, where students aim to maintain concentration and achieve high productivity. However, they can struggle with self-discipline and tend to work intensely just before the deadline. To address this issue, the student team developed a smart bottle that contains an electronic flower in transparent glass (see Fig. 11). The bottle functions as a timer, tracking the student's behavior in the study room, and providing feedback to encourage them to study with greater self-discipline. Over time, the flower gradually withers, accelerating if the student leaves the seat to do other activities. This intends to evoke distress as users become aware that their behavior is the cause of the withering. The gradual withering of the electronic flower is intended to create an experiential learning process that evokes a deep emotional response in users, helping them to recognize that wasting time is akin to causing harm to a living organism.

3. Course evaluation

This section provides an overview of the course assessment and student reflections, which generated insights into the strengths and weaknesses of the instructional design, teaching strategies, and the overall impact of the EDD course on students' knowledge acquisition and practical application of EDD principles.

3.1. Course assessment

The university conducts course assessments as a standard procedure to ensure a high-quality pedagogy. Over the past five years (from 2018 to 2022), a total of 269 students assessed the EDD course across the ten criteria outlined in Table 2. The course has consistently received high scores, with an average of 4.83 out of 5 across all criteria. The 2022 assessment yielded an exceptional overall score of 4.91, further reinforcing our commitment to teaching quality.

3.2. Student reflections

In addition to the evaluation conducted using the ten criteria outlined in Table 2, students were also actively encouraged to provide qualitative feedback on their experiences with the course. Data was collected with various methods, including online feedback forms, informal interviews in the student meeting rooms, and post-class group discussions. These reflections served two primary purposes. The first purpose was to encourage students to consolidate and internalize the acquired knowledge, facilitating long-term retention by connecting new information with their prior understanding. In their reflections, students emphasized the importance of considering user emotions in all product designs, as emotions influence behavior and are intrinsically linked to well-being. They mentioned that the course gave them the insight that emotions are always present, both in response to everyday items and to luxury goods. They also learned that emotions one experiences during product usage are subtle and of low intensity, highlighting the need to attend to these nuances when designing products. Furthermore, they recognized that emotions experienced during user-product interactions are complex and dynamic, varying among individuals and evolving over time. Several students also mentioned that the course increased their general understanding of emotions. For example, they reflected on the wide spectrum of emotions in their daily lives, increasing their general emotional awareness. Additionally, they expressed being inspired by the complex nature of human emotions. For instance, some students mentioned being amazed by the co-occurrence of sometimes-contradicting emotions, which can combine negative and positive emotions in a single experience.

The second purpose of the student reflections was to provide insights for continuous course improvement. Due to space constraints, presenting a comprehensive report of the student evaluations is not feasible. Instead, we present a concise summary of key findings, encompassing five strengths and weaknesses, which were derived from the data of the 2023 course edition using a thematic analysis approach [28]. Our analysis process involved multiple readings to familiarize ourselves with the data and gain an overall understanding of the students' experiences and perspectives. Rather than distilling general codes, as is customary in thematic analysis, we focused on labelling and categorizing data segments related to course strengths and weaknesses. Through an iterative process of reviewing and refining, these segments were organized into broader themes, capturing the main strengths and weaknesses of the course.

3.2.1. Five EDD strengths as reported by the students

(1) Emphasis on human-centred design: Students appreciate that the course teaches them how emotions can be utilized in human-centred design, understanding the significance of catering to users' emotions to create meaningful experiences.
(2) In-depth exploration: The course provides students with a deep understanding and exploration of emotions and their connection

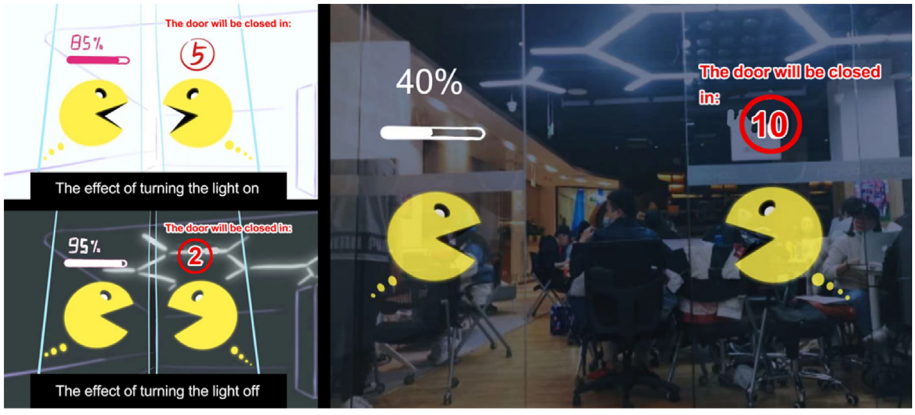

Fig. 10. Pac-man automatic door to enhance the fear of door closing.

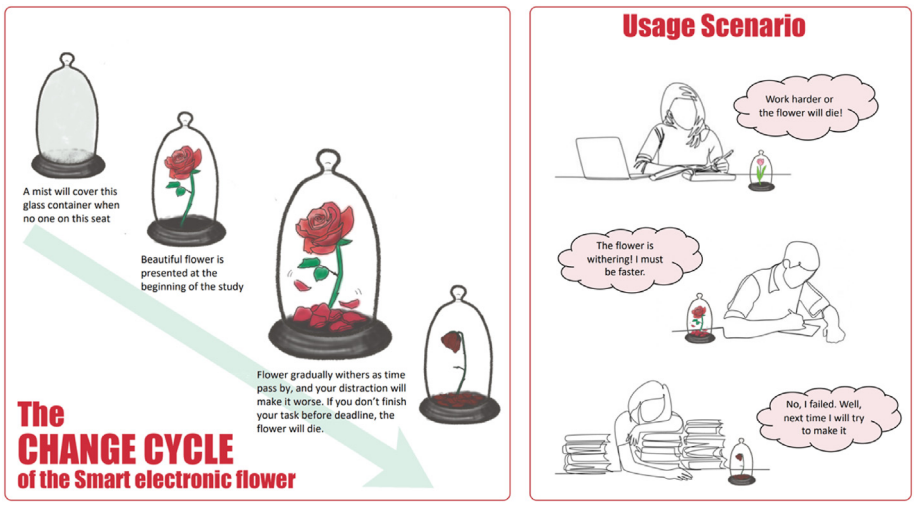

Fig. 11. An electronic flower in transparent glass.

Table 2
Course assessment criteria and scores in the period from 2018 to 2022.

Criteria	Average score (1-5 scale)
Being dedicated to teaching	4.95
Ensuring content is up to date with moderate difficulty	4.85
Adopting appropriate methods according to the content	4.85
Taking a moderate pace with the right amount of information	4.80
Being logical and focused	4.90
Taking a variety of assessment methods	4.80
Providing adequate learning resources in paper or digital form	4.70
Focusing on the development of research thinking	4.75
Cultivating creative consciousness and innovative ability	4.90
Responding promptly to problems encountered by students	4.70
Average across the ten criteria	4.83

to product design. It allows for reflection and insightful analysis of how emotions can be harnessed in the design process.

(3) Broadening design perspectives: Students report that the course encourages them to think beyond traditional boundaries, fostering a mindset that encompasses new perspectives and innovative approaches to product design.

(4) Practical frameworks for implementing EDD: Theoretical concepts were presented in a way that enabled the students them directly in design research and practice. In addition, the design exercises helped them to further develop their competence to create emotionally captivating products.

(5) Consideration of trade-offs: Students appreciate the recognition of trade-offs in product design that are created by conflicting emotions or need dilemmas. This helped them to recognize the need for careful research and analysis to find feasible trade-off solutions that effectively address user emotions.

3.2.2. Five EDD weaknesses as reported by the students

(1) Lack of implementation context: Students comment that design projects lack an implementation context, focusing more on theoretical aspects of emotions in product design rather than providing specific guidance on integrating emotions effectively in different projects.

(2) Absence of diverse viewpoints: Students note that lectures and exercises predominantly emphasize the positive aspects of emotions in product design, suggesting the incorporation of a wider range of viewpoints to provide a more balanced understanding of the merits and limitations of EDD.

(3) Lack of critical analysis: Students mention that the course primarily presents information and insights without critically examining limitations or alternative perspectives. They suggest a more critical analysis of discussed concepts, theories, and strategies to encourage further exploration.

(4) Lack of real-life design examples: Students express a desire for a broader range of concrete design examples in the lectures, specifically emphasizing the inclusion of real-life examples rather than solely student work. Real-life examples would help clarify theoretical concepts and provide practical insights.

(5) Limited discussion on addressing negative emotions: Students indicate a need for a more comprehensive discussion on strategies and approaches to effectively address unwanted negative emotions in product design. Concrete implementation strategies would assist students in applying them in their design practices.

The student reflections indicate that they have gained insights in the importance of considering user emotions in design, broadening their design perspectives, and providing practical frameworks for implementing EDD. However, they have also pointed out areas for improvement, including the need for an implementation context, diverse viewpoints, critical analysis, real-life design examples, and a more comprehensive discussion on how negative emotions can be effectively addressed. These insights will guide the further development of the course, aligning learning goals and pedagogy with students' prior knowledge and needs, thereby enhancing the effectiveness and impact of the EDD learning experience. The next edition of the course will provide a broader context of UX design and integrate critical discussions. In addition, we are in the process of developing a sourcebook with real life examples and a handbook that provides a comprehensive overview of strategies to strengthen positive emotions and to reduce negative emotions.

4. Discussion and conclusion

In our EDD pedagogy, we consider both theoretical knowledge and hands-on experiences to be of equal importance. Students are introduced to the principles of EDD through lectures, which provide a platform for understanding abstract emotion concepts and theories, supported by concrete design examples. However, we aim to transcend the traditional

"banking model" of education, where knowledge is simply "deposited" into students [29]. Instead, our approach is student-centric, active, and participatory, emphasizing experiential and fun learning. This pedagogy aligns with experiential learning theory [30], incorporating techniques such as role-play that encourages empathetic understanding, personal reflective writing, inquiry-based activities that promote curiosity and critical thinking, and outdoor activities that provide an engaging, real-world context [31,32]. Lectures are supplemented with meticulously designed hands-on exercises that immerse students in a range of emotional experiences and encourage reflection and application of insights in practical EDD scenarios. This pedagogical approach encourages students to not only appreciate theoretical knowledge in applicable situations but also to create personal connections with abstract concepts. It also motivates students to challenge theories that may not sufficiently describe or explain their own emotional experiences, promoting critical debates with teachers and peers.

The EDD course presented in this paper was designed to be inclusive of students with various disciplinary backgrounds, opportunities for collaboration and knowledge exchange. It aims to inspire educators to integrate EDD into their design pedagogy, and also emphasizes the importance of including diverse perspectives and interdisciplinary approaches in design education. In that sense, some of the principles outlined in this paper extend beyond the specific EDD course and can serve as a guide for designers and design educators in general. They can cultivate the mindset required to design products that better meet the needs of their users, ultimately resulting in more successful and impactful designs. As illustrated by a student's reflection in her course evaluation:

> *"The practical frameworks empower me to design products that genuinely resonate with users on an emotional level. I am excited to apply these insights in my future endeavors and make a meaningful impact by delivering products that enhance user satisfaction."*

While the course presented in this paper teaches some key EDD competences, it does not claim to be exhaustive. The limitations identified by the students in their evaluations will be addressed in future versions of the course. Furthermore, several EDD challenges are not (sufficiently) addressed in the current course design. For instance, targeting specific emotions in a design project and measuring the emotional impact of design (prototypes) are areas that require further attention. Another challenge lies in helping students navigate the ethical implications of emotional design, such as the potential manipulation or exploitation of vulnerable consumers. We foresee that these challenges can be tackled by incorporating additional lectures and exercises. Continual refinement of our pedagogical approach will contribute to the advancement of EDD integration in design education, equipping future designers with the necessary competences to create emotionally compelling and ethically conscious designs.

Ethics statement

The course presented in this paper was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Beijing Normal University (Code: 202202280023). Written informed consent for reporting student work examples was obtained from all participants involved in the course.

Declaration of competing interest

Haian Xue is an associate editor for Advanced Design Research Journal and was not involved in the editorial review or the decision to publish this article. The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Pieter Desmet reports financial support was provided by The Netherlands Organization for Scientific Research (NWO).

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