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Interactive effects of environmental experience and innovative cognitive style on student creativity in product design

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Abstract Environmental experience can enhance the ideas of design students. Thus, this type of experience may interfere with the influence of design students' cognitive style on creativity. The aim of this study was to examine the influence of environmental experience on the relationship between innovative cognitive style and industrial design students' creative outcomes. The environmental experience was measured according to the total scores of the five components of sense, feel, think, act, and relate on the basis of Schmitt's strategic experience modules. The cognitive styles were measured using Kirton's adaption–innovation inventory, and creative works were assessed through the consensus assessment technique, which was employed by three experts. Through a field experiment and survey investigation, the analysis indicated that innovative cognitive style significantly and positively influenced creativity, but this only occurred when student was accompanied with a low degree of environmental experience (i.e., a student had a low score for environmental experience); as the student attained a high degree of environmental experience, the influence of innovative cognitive style on creativity became weakened. The experiential media suggested that the natural elements, cultural history, group travel, and narrator effectively diversified the experiences of the students and enhanced creative thinking. This paper suggests providing increased stimulation of environmental experience prior to instructing design students to engage in creative activity. Environmental experience can benefit students by enhancing their creativity.

Keywords Environmental experience · Innovative cognitive style · Creativity

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Introduction

Creativity is the ability to generate both novel and appropriate product ideas (Sternberg and Lubart 1999). Creativity is composed of the operation and combination of cognitive processes; these include the overall process of people accepting and processing messages and making derivations and inferences (Ward et al. 1999). However, the cognitive style of an individual is a typical or habitual mode for problem solving, thinking, perceiving, and remembering (Allport 1937). Kirton (1999) asserted that cognitive style, as an individual's preferred style of problem solving, is highly resistant to change. Obviously, cognitive style is not easy to cultivate or change. Based on two extreme opposing methodical thought processes, Kirton (1976) distinguished cognitive styles by using propensity to innovate and adapt. Kirton (1976) considered that people exhibiting innovative cognitive styles are accustomed to seeking and integrating problem-related messages from various sources, redefining problems, and thinking resourcefully. By contrast, people who present adaptive styles are inclined to collect information by using constructed domains, accepting the original definitions of problems, and solving problems by using commonly accepted methods. Interestingly, previous studies have proved that only innovative cognitive style has a significant positive influence on creativity and that adaptive cognitive styles and creativity are unrelated. For example, Muñoz-Doyague et al. (2008) demonstrated that employees with innovative cognitive style had higher creativity than with adaptive cognitive style by using survey methods. Luh and Lu (2012) used Kirton Adaptation–Innovation Inventory (KAI) to measure the cognitive style and found that the innovative cognitive style positively and significantly predicted the students' creative achievement.

In addition to an individual's basic cognitive style, any external factor stimulating a creator's thinking experience also influences the formation of creative products. Petre et al. (2006) studied how designers transform sources of inspiration into commercialized design processes in which the sources of inspiration were all external stimulation objects (i.e., photographs, pictures, previous works, artwork, samples, texts, and natural objects). The results showed that designers experienced the three process stages of selection (choosing the elements to be used), adaptation (interpreting the selected elements), and transformation (forming unique combinations). Designers rely on their experience that is obtained through the five senses that stimulates increases in conceptual knowledge, emotions, or associations to enhance creativity. When external stimuli are received through the human senses to the brain and nervous system, a series of various degrees of responses are induced (Schmitt 1999). The formation of subjective cognition from stimulations through the process of individual observation and participation is called experience (Schmitt 1999). Desmet and Hekkert (2007) proposed a framework of product experience that was divided into three components, namely aesthetic experience, experience of meaning, and emotional experience. They affirmed that all types of subjective experience were involved a perceived pleasantness or unpleasantness. Obviously, experience is multidimensional and varies in specific degrees. Schmitt (1999) proposed the concept of strategic experiential modules (SEMs) and distinguished experience into five types, which comprised sense, feel, think, act, and relate. The sensory level includes peoples' reflective thoughts and feelings after interacting with the environment, actions and associations that are subsequently produced. Each experience represents various degrees of involvement.

Experience can create useful information, which benefits creative cognitive processes. Regarding the positive relationship between experience and creativity, Finke et al. (1992) considered that the cognitive process of creative thinking must comprise two stages

(generative and exploratory processes) and proposed the Geneplore model. The generative process refers to people actively retrieving several relevant and differing messages consisting of potentially creative candidate ideas; the exploratory process describes that people carefully examine the candidate ideas that must be corrected, refined, or transformed. People constantly alternate between these two processes until creative ideas or products are produced. Conceptual expansion occurs in the generative process when external sources or stimuli are added to their existing concept, and the extended conceptual boundary can enhance personal creativity (Ward et al. 1997; Wan and Chiu 2002). Madura (1996) studied 101 college students enrolled in vocal jazz courses and found that the jazz experience was significant enough to predict the vocal jazz improvisation achievement. Leung et al. (2008) found that extensiveness of multicultural experience was positively related to idea generation and recruitment of ideas from unfamiliar cultures for creative idea expansion. Robinson et al. (2013) examined the relationships among environmental influences and creativity of university students and found that exposure to media such as art and literature was positively correlated with creativity.

Experience can also interact with the cognitive style, which affects the creative cognitive process. However, in the process of creation, the role of experiences remains unclear. Ivcevic (2009) argued that future work in creativity research will have to specifically address domain-specific creative potential as well as the interaction of personal potential and social environment that will determine whether creativity is expressed. Pektas (2010) suggested that future studies could also be expanded by determining whether the relationship between cognitive style and performance in drafting and design tasks is moderated by experience. Tinajero et al. (2012) investigated the influence of the cognitive style on academic achievement of Brazilian university students as well as the mediating effect of learning strategies. Tinajero et al. (2012) found that a greater impact of cognitive style through learning strategies should be expected on less experienced students. Yazici (2013) mentioned that cognitive style varies according to the cognitive structure of persons, and spatial experience. They found that the cognitive styles and past spatial experiences of design students can influence their design processes.

Although cognitive style, experience, and creativity are assumed to be strongly linked, little empirical evidence has been found to establish a direct relationship among the three variables. Designers or design students often need to interact with external environments to obtain inspiration for creative thinking, but the interaction between individual cognitive style and experience has never been investigated in detail. According to previous empirical studies, a high degree of innovative cognitive style positively influences creativity (Kirton 1994; Muñoz-Doyague et al. 2008; Luh and Lu 2012). In addition, experience can positively relate to creativity according to conceptual expansion (Ward et al. 1997; Wan and Chiu 2002; Leung et al. 2008; Madura 1996) and it is also expected to moderate or mediate the relationship between cognitive style and creative outcomes (Pektas 2010; Tinajero et al. 2012). The high degrees of the innovator are preferably viewed as unique, visionary, and ingenious, and they prefer to challenge the definition of a problem by manipulating and questioning assumptions and using self-innovation strategies (Kirton 1994). Furthermore, the high degrees of the innovator prefer a profusion or proliferation of original ideas and are more intuitive (Isaksen et al. 2003). In other words, the low degrees of the innovator do not have the previously mentioned advantages, and then need more inspiration from the environment than the high degrees of innovator do. As mentioned previously, this study hypothesised that, for students with a propensity for using a low innovative cognitive style, a high degree of environmental experience results in more favourable creative outcomes than a low degree of environmental experience does. This study empirically examined the

effect of innovative cognitive style on student creativity and whether environmental experience moderates the effect of innovative cognitive style on design students' creative relationships.

Research methods

Experimental environment analysis

According to Pine and Gilmore (1999), the design elements of satisfactory experience locations must comprise five qualities: (a) Experiences must be thematized with simple and attractive topics that clearly convey feelings to the experiences. (b) Impressions must be harmonized with positive cues, and impressions of positive cues from the experience locations should prompt unforgettable memories among the experiences. (c) Negative cues must be eliminated; experience providers must delete any sector that possibly weakens, conflicts with, or dilutes the central topic. (d) Memorabilia must be incorporated; souvenirs can be used to invoke memorable experiences. (e) All five senses must be engaged and effective sensory stimulation can create deep experiential impressions (Pine and Gilmore 1999). Furthermore, Schmitt (1999) proposed seven experience media as instruments for creating experiences regarding the aspects of sense, feel, think, act, and relate. Communication media exist in the forms of advertisements, magazines, and annual reports; examples of identification systems include product names or corporate images; product presentation may comprise product design, packaging, and brand mascots; cobrands can be established through alliance cooperation or authorized uses; spatial environments can include retail and public spaces; electronic media can comprise online interactions; and people may include sales staff, customer service staff, or narrators.

On the basis of the aforementioned recommendations by Pine and Gilmore (1999) and Schmitt (1999), locations comprising feature topics and smooth journeys were selected. Additionally, the overall environment was considered suitable for studying experience and creation because the necessary conditions were provided, such as various natural open spaces for environmental experience, safe places for walking, and a room for drawing. Therefore, the most comprehensive and green campus in Central Taiwan, that of Tunghai University, was selected as the field location for this experiment.

The experience activities were primarily focused on the five major locations of the Avenue of Arts and Science, College of Arts, College of Sciences, Luce Chapel, and Priest Bell Tower for creating task ideas. The contributions of the aforementioned five locations were considered to create thematic and meaningful experiences according to the study by Pine and Gilmore (1999), and the details of the meaningful elements are displayed in Table 1. All the locations were selected during specific hours to eliminate negative cues, and all sensory stimulation, including sight, hearing, smell, and touch were used to engage the four senses to create deep experiential impressions, as suggested by Pine and Gilmore (1999). All the participants could collect local natural objects and take photographs as souvenirs for their reference (as suggested by Pine and Gilmore 1999). Four experience media, namely communication tools, an identification system, space, and staff were chosen, and an analysis based on that of Schmitt (1999) was conducted (Table 1). All the participants interacted with the experience media through their five senses to inspire their creativity.

Table 1 Experience design elements and media analysis of the activity locations

Topic	Experience learning and creation at Tunghai University				
Activity locations					
	The Avenue of Arts and Science	College of Arts	College of Sciences	Luce Chapel	Priest Bell Tower
Elements that create impressions	Towering trees on both sides of the walk and artificial trapezoidal grass steps in the center	A courtyard style comprising gray tiles, red bricks, and *Bambusa multiplex* cv. Fernleaf	The square pillared classroom and open space sanheyuan building	Yellow, diamond-shaped, glazed tiles stacked into a curved church building	A bell tower symbolizing tranquility and peace at Tunghai University
Eliminating negative cues	Specific hours were selected to reduce the interference of crowds				
Sensory stimulation	*Sight*: The visual environments of the five activity locations *Hearing*: The buzzing bugs, chirping birds, rustling trees, and giggling tourists *Smell*: The natural smell of grass and dirt and scent of trees and flowers *Touch*: The sensations caused by the wind, trees, flowers, and buildings				
Souvenirs	Collecting local natural objects (e.g., fallen leaves, flower petals, or tree branches) and photographing the beauty of buildings and the natural environment				
Experience media	*Communication tool*: Pictures of the experience activity locations were used to convey experience activities *Identification system*: The five activity locations are the Tunghai University's symbolic features *Space*: Outdoor environments at Tunghai University in which buildings and green spaces were integrated *Staff*: The narrator guiding the students and explaining the history and building features of each location at Tunghai University				

The Topic, Activity locations, Elements that create impressions, Eliminating negative cues, Sensory stimulation, and Souvenirs were based on the recommendations by Pine and Gilmore (1999). The four experience media were based on the recommendations by Schmitt (1999)

Research process and experimental task

This research process comprised environmental experience tasks, cultural product designs, and survey collection; the overall process required 2 h. Regarding the experimental tasks 1 to 5, the participants were allowed to freely experience the environments and complete the task requirements (i.e., collecting local natural objects and taking photographs) within these locations (Fig. 1). The experience tasks began with the experimenter explaining the experience environments, tasks, and processes. The narrator introduced experience media to participants by leading them through the five activity locations in a predetermined sequence and provided detailed onsite descriptions on the history and features of the buildings. All participants were led by the narrator to the five locations in the sequence of The Avenue of Arts and Science, College of Arts, College of Sciences, Luce Chapel, and Priest Bell Tower for 4–5 min at each stop; the entire process spanned 40 min. Finally, the participants were led back to the starting point without revisiting any locations to engage in conceptual culture product design and complete a questionnaire that included scales and open-ended questions in a classroom. The pilot study regarding the overall experience

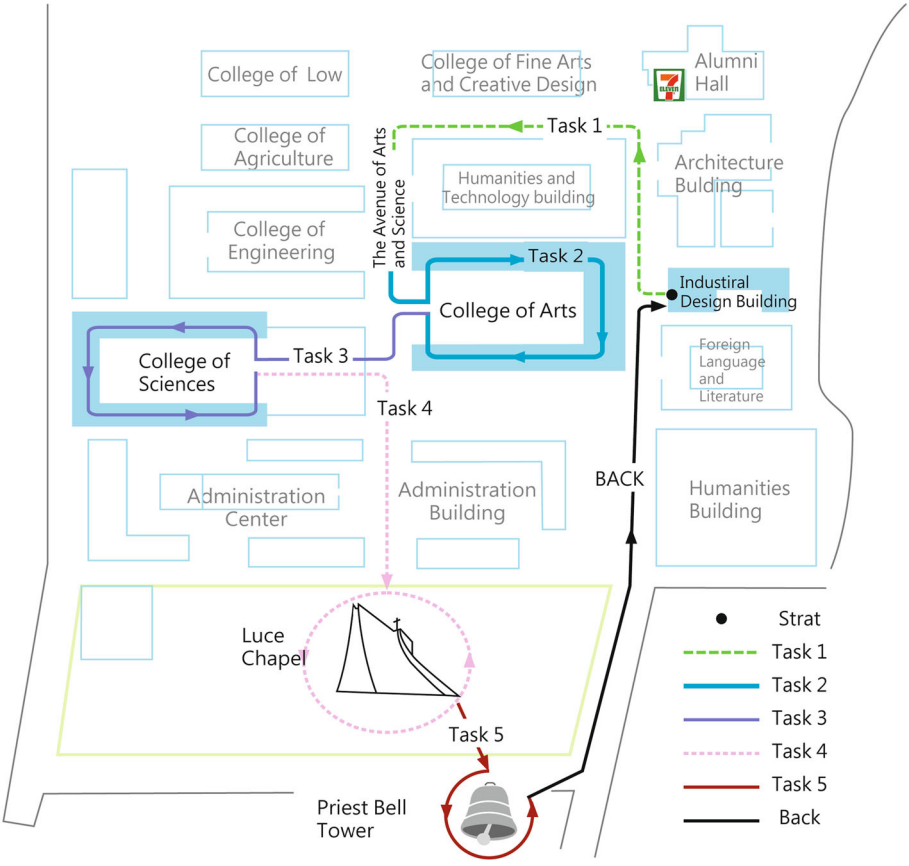


Fig. 1 Map of the experience tasks

process were conducted by three design graduate students to verify the consistency between task content and purpose and the evaluation and correctness of the scale.

The cultural product designs were arranged to enable all the participants to design a concept of campus cultural gifts. Chandrasekaran (1990) presented the definition of a design task and suggested that design problems require only a minimal statement of product functions, and design constraints might be available. The functions can be relaxed, and otherwise modified and identified for structural configurations. Each participant was required to design a gift that represented the Tunghai campus according to previous environmental experience. The design works consisted of conceptual images and detailed descriptions of their functions. They were drawn on A3-sized media and were accompanied by a 150-word description of the design concept.

Participants and experts

In this study, a field experiment was conducted and problems regarding geographic locations, variation in participants, and the safety of students were considered. Freshmen from the Department of Industrial Design of Tunghai University were sampled using convenience sampling and invited to enter the experiment field location. The sample group consisted of 45 students (21 male students [46.7 %] and 24 female students [53.3 %]) whose average age was 18.69 (standard deviation was 1.08).

Regarding the evaluation of cultural product creativity, previous studies have indicated that novices must undergo decades of constant practice to become an expert in a particular field (Hayes 1989; Gardner 1993). Thus, three design experts who possessed an average of 21.3 years of design experience and had each earned masters and doctoral degrees were invited. The first expert is a designer who works at a digital graphic design studio and simultaneously serves as a university lecturer; the second expert is a university industrial design lecturer who simultaneously works as a consultant for a design company; and the third expert is an industrial design assistant professor at a university.

Research instruments

The research instruments of this study comprised measurements of environmental experience, cognitive style, positive and negative emotions, creative achievement, and cultural product design as well as open-ended interview questions. Table 2 shows the interveners

Table 2 The interveners and steps in accordance with each of measurements

Steps	Measurements	Experts	Participants
1.	Environmental experience scale		V
2.	Cognitive style scale		V
3.	Positive and negative emotions scale		V
4.	Self-evaluated creativity achievement		V
5.	Drawing culture product design on A3 sheet		V
6.	Open-ended interview questions		V
7.	Expert-evaluated culture product design	V	

Steps 5 and 7 are based on the same data

and steps according to each of the measurements. All measurements adopted the 7-point Likert scale, which ranged from 7 (*agree*) to 1 (*disagree*).

The environmental experience scale proposed by Schmitt (1999) was used. This scale was composed of the five dimensions of sense, feel, think, act, and was relate and comprises of a total of 15 questions. Regarding the scale on the whole environmental experience, the Cronbach's α value for the 15 items were .92, which exhibited satisfactory internal consistency.

Regarding the cognitive style scale, the Kirton Adaptation–Innovation Inventory was adopted (Kirton 1976). Regarding variable operation, question items with extracted factor loadings of more than .5 were extracted based on the factor analysis conducted by Keller and Holland (1978). This scale comprised seven questions on innovation and seven questions on adaptation for a total of 14 questions. The Cronbach's α values obtained for the innovative and adaptive cognitive style dimensions were .83 and .66, respectively. The former innovation demonstrated the acceptable internal consistency suggested by George and Mallery (2003), but the latter adaptation was close to the recommended value of 0.7. Future researchers should note the lower Cronbach's α value on the adaptive cognitive style construct in this study.

The Positive and Negative Affect Scale by Watson et al. (1988) was also adopted; this is a scale on positive and negative emotions and includes 20 original questions. Based on the factor analysis results by Qiu et al. (2008), the six positive (i.e., active, enthusiastic, joyful, spirited, excited, and proud) and negative (i.e., ashamed, afraid, nervous, scared, guilty, and distressed) feel items of more than .5 factor loadings were extracted. The Cronbach's α value of the positive and negative feel dimensions were respectively .82 and .86, which exhibited satisfactory internal consistency.

Regarding creativity, the scale was distinguished into two major parts, which comprised creativity achievements from self-evaluation and culture product creativity evaluated through expert consensus. For self-evaluated creativity achievement, the creative achievement scale developed by Carson, Peterson, and Higgins (2005) was adopted. This study used the related three domains namely visual arts (i.e., painting and sculpture), inventions, and architectural domains. Each domain comprised eight items, and therefore three domains comprising a total of 24 items. The participants were permitted to make multiple responses based on the occurrences of previous achievements. The items in each domain were scored according to the arrangement of the question items from scores of 0 to 7. Thus, the lowest and highest scores for each domain were respectively 0 to 28. High overall creativity achievement scores represent high student creativity achievements.

For expert evaluated culture product creativity, the Consensus Assessment Technique (CAT) suggested by Baer, Kaufman, and Gentile (2004) was used to evaluate the students' creativity work. The experts individually ranked each work for creativity as high, medium, or low; then, the work in each of the aforementioned three levels were individually ranked as high or low, resulting in overall rankings scaled from 6 (*highest*) to 1 (*lowest*). High overall creativity works represent high product creativity. All the experts did not join the environmental experience process but understood this treatment input for students. The experts were simply asked to independently provide a ranking of all the student works according to useful and novel criteria by using CAT methods (Mayer 1999). All works were obtained from the Tunghai University culture product designs created by students after undergoing the environmental experience processes. The consistency of the three reviewers' creative product evaluations was analyzed. The resulting Kendall's ω was .507 and the p value was $.01 < .05$. This showed a significant moderate consistency and reliability among the three experts.

The outline of the open-ended questions was primarily derived from Schmitt's (1999) concepts of strategic experimental modules (SEMs) and the environmental experience elements of the Tunghai University campus. Schmitt (1999) categorized experience in his SEMs into five types: sense; feel; think; act; relate. During the pilot study, three design graduate students proposed corrections to the open-ended written questions to improve the clarity, focus, and content validity. These questions are as follows: Regarding the sense experiences, what were the events and objects you noticed through your sight, hearing, touch, and smell during the overall experience process? Regarding emotions, what were the events and objects during the overall experience process that generate emotional change? Please provide a list of at least three adjectives to describe your emotions. For the think experiences, what were the events that piqued your interest for focusing on thinking or making associations during the experience process? For the act experiences, what were the events and objects that caused you to want to alter your lifestyle or behavior patterns during the experience process? Please describe your feelings. Regarding the relate experiences, what were the events and objects that gave you a sense of identity and belonging to the Tunghai University campus during the overall experience process? Please describe these feelings of identity and belonging.

Control variables

The control variables of this study were primarily possible interfering variables compiled from creativity studies. These included demographic variables, knowledge, and motives (Amabile 1983). Regarding the demographic variables, gender, age, and environmental familiarity were primarily used as controls; for degree of knowledge, study year was primarily used as the control. Remuneration was described as the external motive and control. Additionally, Schmitt (1999) indicated that emotion is a condition of feeling for which the cause is unknown and can be influenced by specific stimuli. George and Zhou (2007) used emotional message processing theory for describing emotions that provide relevant environmental messages to people and influence their cognitive processes and behaviors. Vosburg (1998) considered that positive emotions promote the diffusion of thinking and that negative emotions promote solving the problems associated with creation. Thus, students' usual positive and negative emotions were measured as the control factors in this study. Additionally, open-ended questions were asked after conducting the experiments to determine the crucial environmental stimuli of the various types of experiences and provide additional explanation for the experiences.

Results and discussion

The interaction effect of environmental experience and innovative cognitive style on design creativity

The mean, standard deviation, correlation coefficient matrix, and hierarchical linear model statistics are shown in the "Appendix" tables. Two methods were used in this study to test student creativity (i.e., self-evaluated creativity achievement and expert-evaluated culture product design), and the correlation results demonstrated that a medium correlation existed in the two areas of creativity. Innovative cognitive style was significantly correlated with

environmental experience and both self- and expert-evaluated creativity, whereas environmental experience and self-evaluated creativity were not correlated. In the regression analysis, the results showed innovative cognitive style exerted significant positive influence on both self- and expert-evaluated creativity. This demonstrated robustness in this study's cognitive style measurements and showed satisfactory criterion-related validity (see "Appendix" tables). Additionally, adaptive cognitive style did not influence self- or expert-evaluated creativity. Regarding the results in cognitive style and creativity, we adopted Kirton's (1976) innovative and adaptive cognitive styles. Regardless of individual self-evaluated creativity achievements or expert-evaluated culture product creativity, the results showed that innovative cognitive styles significantly positively influenced creativity, whereas adaptive cognitive styles did not. Although the reliability of the adaptive cognitive style in this study was close to the recommended value, the results regarding the relationship between adaptive cognitive style and creativity are consistent with those of Muñoz-Doyague et al. (2008) and Luh and Lu (2012).

Based on the median, innovative cognitive styles were divided into high- and low-scoring groups. Moreover, the experience values were also divided into high- and low-scoring groups for plotting according to the median of experience (Fig. 2). The results showed that in the high-scoring environmental experience group, students presenting high and low innovative cognitive style scores yielded average creativity performance scores of 9.20, and 9.73, respectively. In the low-scoring environmental experience group, students presenting high and low experience scores yielded average creativity performance scores of 6.6, and 8.75, respectively. This indicated that if the degree of students' experience is high, then the detected relationship between innovative cognitive style and creativity is weak; conversely, if the degree of students' experience is low, then the detected relationship between innovative cognitive style and creativity is strong. The creativity of

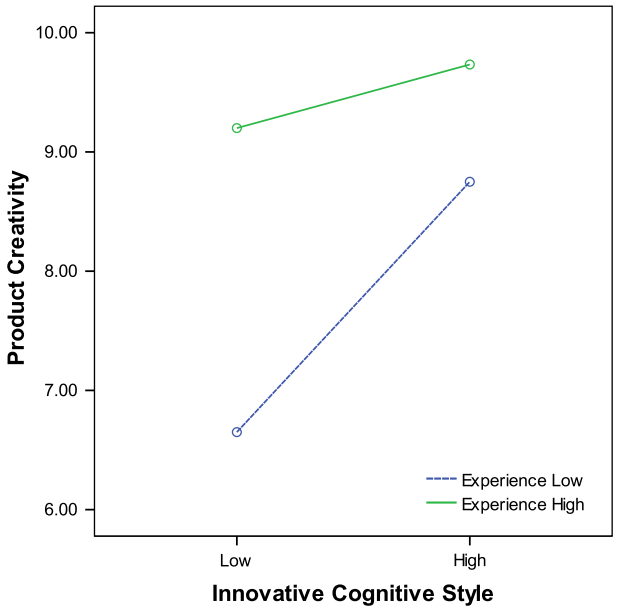


Fig. 2 Experience moderated innovative cognitive style and creativity

students with low innovation was enhanced greatly by the environmental experience. The creativity of students with high innovation was also enhanced by the environmental experience but to a lower degree.

Stimulating factors from environmental experiences

The responses to the open-ended questions were analyzed to determine the environmental stimulation factors associated with the various types of experiences. Thirteen students with the highest environmental experience and highest creativity score were collected; however, only seven students who had completed and returned open-ended questionnaires were analyzed.

Data were analyzed based on the open coding proposed by Strauss and Corbin (1990). Keywords, events, or topics were identified in the answers and were labelled correspondingly; the correlated conceptual terms were grouped for frequency statistics. Figure 3 shows the idea concepts, descriptions, and expert evaluated creativity scores from the six students with the highest environmental experience and creativity scores. The creativity scores of the seventh student were lower scores than 10 and were therefore not shown in Fig. 3.

Generally, 45, 13, 18, 6, and 4 counts of stimulated sense, feel, think, act, and relate experiences were obtained in the questionnaires, respectively (Table 3). In the sense experiences (sight, hearing, touch, and smell), the three most frequently identified sources of stimuli were breeze (10), the Avenue of Arts and Science (8), and chirping sounds (6). This demonstrated that natural elements facilitated the generation of environmental stimuli for sensory experiences. The students' sight, hearing, smell, and touch senses were respectively derived from a breeze (which provided feelings of coolness, relaxation [N36], and softness [N28]), the Avenue of Arts and Science (which possessed dense trees and plants [N23, 26, and 31]), and chirping sounds (which engendered comfort and pleasure; N36).

Regarding the feel experiences, the three most frequent sources of stimuli (in order) were Luce Chapel (3), the Avenue of Arts and Science (2), and group travel (2); the narrator conveyed information regarding each aspect for each test medium. Luce Chapel prompted a sense of excitement (N28), warmth and security (N26), and peacefulness (N36). The feel for Avenue of Arts and Science were removed tiredness (N36) and felt variation and freshness. The group travel evoked feelings of share, comfort, and happiness (N26 and N31). This demonstrated that narrator and group travel were important factors that facilitated the generation of environmental stimuli for feel experiences.

For the think experiences, the three most frequent sources of stimuli were culture history (6), the Avenue of Arts and Science (2), Luce Chapel (2), and lawn (2). Culture history caused students to think the past events, evoked nostalgia feeling and prompted students to reflect on the past, present and future of the self-experience (N11, 23, 26, 31, and 36). The Avenue of Arts and Science, Luce Chapel, and lawn inspired students to reflect and compare the external environment to their own remembered experiences. For example, a student thought about her childhood derived from the lawn, in which times/things were good, there were no worries, no pressure, and where playing or making a noise were acceptable activities. Then, she thought about how now, she had to rely on her own decision-making, compared to in the past when other made the decisions. Another student thought about the mood and concepts that the architectures used when they built the building experienced in this study. Additionally, when she became an architect, she could create outstanding buildings similar to those produced by architects in the past.

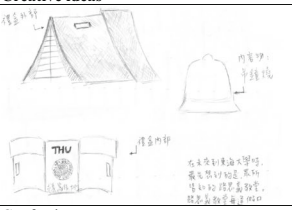
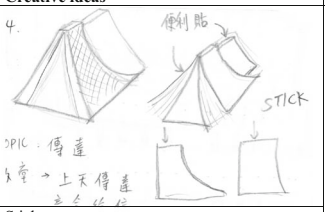
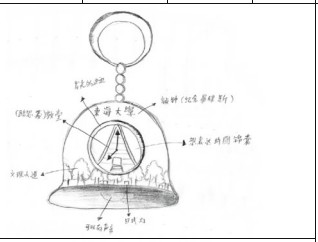
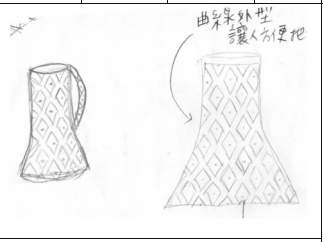
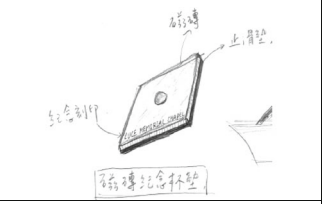
Code	Creative ideas				Code	Creative ideas			
N36					N29				
	Confectionary Using a shape of the Priest Bell Tower create a traditional Japanese confectionery. Moreover, the same method was used to create a gift box of Luce Chapel.					Sticky note The shape of Luce Chapel was Used to create a sticky note. People will remember the image of Luce Chapel when they use this sticky note.			
	Expert1	**Expert2**	**Expert3**	**Total**		**Expert1**	**Expert2**	**Expert3**	**Total**
	3.00	6.00	6.00	15.00		4.00	5.00	5.00	14.00
N26					N11				
	Commemorative key ring This key rain combines an image of Luce Chapel, the Grand Avenue of Arts and Science, and Priest Bell Tower with the functions of clock, lights, and bell sounds.					Mug This mug is made by small shape of ceramic tiles of Luce Chapel. This curve made people easy to grasp.			
	Expert1	**Expert2**	**Expert3**	**Total**		**Expert1**	**Expert2**	**Expert3**	**Total**
	3.00	5.00	6.00	14.00		2.00	6.00	5.00	13.00
N31					N23				
	Bulb The image of Luce Chapel was printed on the bulb present a 3 dimensional image that symbolize permanence.					Coaster Diamond ceramic tiles of Luce Chapel was transferred to coaster which symbolize memory and inheritance.			
	Expert1	**Expert2**	**Expert3**	**Total**		**Expert1**	**Expert2**	**Expert3**	**Total**
	3.00	6.00	2.00	11.00		3.00	4.00	3.00	10.00

Fig. 3 The concepts, descriptions and scores of creative ideas

Regarding the act and relate experiences, the most frequent source of stimuli was Luce Chapel (2), which prompted a sense the solemnness of the people who built the chapel and the academic lives of the current students (N23), and the pride as a Tunghai University student because of the aesthetics of the chapel (N28).

Discussion

We adopted a field experiment method and led student groups to the experience the five locations. A questionnaire survey was conducted after them had finished the tasks. The independent and dependent variables in this study were measured using various methods in

Table 3 Frequency statistics of the stimulating terms (items)

	A1 The Avenue of Arts and Science	A2 College of Arts	A3 College of Sciences	A4 Luce Chapel	A5 Priest Bell Tower	A6 Culture history	A7 Lawn	A8 Group travel	A9 Breeze	A10 Blue sky	A11 Chirping sounds	A12 Pedestrian behavior	Total (frequency)
Sense	8	2	2	5	2	0	2	2	10	3	6	3	45
Feel	2	1	0	3	1	1	0	2	1	0	1	1	13
Think	2	1	1	2	1	6	2	0	1	1	0	1	18
Act	1	1	0	1	0	1	1	0	0	0	0	1	6
Relate	0	0	0	2	0	0	0	1	0	0	0	1	4
Total	13	5	3	13	4	8	5	5	12	4	7	7	86

A1–A6 media was conveyed information and historical background of the building by a narrator

order to avoid the problem of common-method variance. The independent variables were measured using scales, whereas the dependent variables were obtained by adopting design drawings and expert evaluations. Moreover, Podsakoff et al. (2003) suggestion was adopted, and positive and negative emotions were added as the third factor to the existing control variables, which facilitated reducing the problem of the common-method variance and increased the reliability and validity of this study. However, the results showed that the mutual interaction between environmental experiences and innovative cognitive styles remained.

The limitations of this study included the fact that the reliability measurements did not obtain satisfactory reliability for the adaptive cognitive style construct. This caused all the results concerning adaptive cognitive style to be slightly less robust. This may have occurred because, among the 12 original items that were chosen, only seven items could be used to measure adaptive cognitive style. However, the finding that adaptive cognitive style did not influence creativity was consistent with the results of current research (Muñoz-Doyague et al. 2008; Luh and Lu 2012). In addition, although this study adopted Schmitt's (1999) SEM, which consists of five types of experience to measure student environmental experience, the influence of each type of experience was not analysed. This study suggested that increasing the number of samples can achieve the basic constraints of factor analysis, and further research can clarify the relationship between each construct of experience and creativity.

The results of this study can be used for contributing to design education and design methods. Pektas (2010) pointed that monitoring cognitive styles of design students might facilitate for improving teaching strategies and course design. In this study, we considered that experiences effectively increased student creativity and overcame the influence of cognitive styles on creativity. The design of curricula in which environmental experience is integrated can enhance student personal experiences of and feelings towards events and objects. When integrated with students' deep impressions of experiences, experiencing the same event using multiple perspectives produced varying design results, thus engendering differing meanings for each individual. Regarding design methods, several of the designers' sources of creativity were found to be derived from the interaction between an individual, the external environment, and events and objects. Yazici (2013) mentioned that increasing the awareness of the students on their own cognitive styles to better understand how they think and process design information in order to take better control of their design process.

Conclusion

Overcoming cognitive limitations and increasing creativity is a crucial concern in design education. From the perspective of cognitive creativity, we examined whether individuals' environmental experiences moderate the relationship between cognitive style and creativity. This study demonstrated that in the environmental experiences, the degree of experience was a crucial condition determining the influence of innovative cognitive styles on product creativity; the influence of high inputs of the experiences tends to surpass that of cognitive style on creativity. Thus, the degree of the experiences played a crucial role in increasing the creativity potential of the design students. In other words, environmental experience not only increases the creativity of design students but also assists design students with low degrees of innovative cognitive style in overcoming the typical mode

boundaries of cognitive style. Furthermore, the results of this study indicated that the three experience media of natural elements, cultural history, and the narrator helped students generate the environmental experience, which effectively enhanced creative thinking. When individuals integrate their sense, feel, and think experiences and develop the condition of experiential integration, comparatively greater creativity resulted.

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Appendix

See Tables 4 and 5.

Table 4 The correlation coefficient matrix

Variables	M	SD	A1	A2	A3	A4	A5	B1	B2	B3	D1
A1 gender	.53	.50									
A2 year	18.69	1.08	.06								
A3 familiarity	5.44	2.16	−.03	−.26							
A4 positive E	29.38	5.78	−.02	−.20	−.13						
A5 negative E	14.51	6.27	.25	−.01	.01	−.18					
B1 innovative CS	37.13	5.53	.04	.09	−.33*	.53**	−.20				
B2 adaptive CS	30.00	5.66	−.16	.21	−.13	.09	.05	.00			
B3 experience	79.09	13.12	.11	−.18	.12	.40**	−.11	.40**	−.01		
D1 creativity-S	6.80	5.77	.12	.05	−.33*	.15	.12	.50**	.02	.01	
D2 creativity-E	8.13	3.17	.22	.07	−.20	.21	.14	.36*	−.01	.37*	.38*

Gender, 0 = male; 1 = female. Familiarity, 1 = unfamiliarity to 5 = very familiarity. *E* emotion, *CS* cognitive style. *Creativity-S*, self-evaluated creativity achievement. *Creativity-E* expert-evaluation culture product design. Statistical explication: regarding the correlation coefficient of control variables, positive and negative emotion were no correlated, which showed that the two variables can be regarded as mutually independent. In terms of predict variables, the correlation coefficient and innovative and adaptive cognitive styles were not correlated. This showed that the variables can be regarded as mutually independent. Finally, various methods were used in this study to test the explanatory variables (students' creativity) and the results showed that the significantly correlation between creativity achievement and culture product creativity reached a moderate correlation in the two variables of creativity

$N = 45$, * $p < .05$; * $p < .01$

Table 5 Self- and expert-evaluated creativity hierarchical regression analysis

Variables	Creativity-S		Creativity-E			
	M1	M2	M1	M2	M3	M4
Control variables						
Gender	.12	.05	.16	.10	.05	−.04
Year	−.09	−.08	.10	.12	.16	.23
Familiar	−.32*	−.19	−.15	−.05	−.13	−.18
Positive emotion	.14	−.16	.22	−.01	−.09	−.07
Negative emotion	.12	.20	.14	.20	.22	.21
Predict variables						
Innovative CS		.56*		.43*	.32	.33
Adaptive CS		.03		−.01	−.03	−.11
Moderator						
Experience					.34*	.38
Moderating effect						
Innovative CS × experience						−.41*
Adaptive CS × experience						.29
ΔR^2	.05	.21	.14	.25	.33	.43
R^2	.16	.34	.03	.10	.18	.26
F-statistic	1.48	2.60*	1.26	1.70	2.18	2.53*
df	(5.38)	(7.36)	(5.38)	(7.36)	(8.35)	(10.33)

CS cognitive style. *Creativity-S* self-evaluated creativity achievement. *Creativity-E* expert-evaluation culture product design. Jarque–Bera test was performed to analyze the normality test of Creativity-E. The Jarque–Bera test result was 2.359, which was insignificant ($p = .3 > .05$). This showed that the Creativity-E in this study conformed to normal distributions. Hierarchical linear models were adopted to investigate the predictor, and explanatory variables and moderating products were sequentially added using the stepwise method. Therefore, the four models were produced using the fourth stepwise method. Model 1 shows the relationship between the control variables and creative outcomes according to the different creativity levels. Model 2 displays the relationship between cognitive styles and creativity. Model 3 illustrates the relationship between environmental experiences and creativity, and Model 4 shows the interaction effects on creativity between the environmental experiences and cognitive styles. In this Table, the tolerance value for each variable were between .45 and .82 and variance inflation factors were between 1.18 and 2.19. Thus, collinearity was unnoticeable

$N = 45$, * $p < .05$; ** $p < .01$

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