Relationships of Creative Personality Traits and Spatial Abilities to Shaping Creativity and Floriculture Material Shaping Skills

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SUMMARY. **In floriculture design, "shaping" is the use of floral materials as media for expressing ideas. Common floriculture techniques include tying, pasting, winding, connecting, overlapping, and weaving. Shaping is also a key factor in the appeal of the final product. Therefore, this study recruited 149 university students to explore how their floriculture material-shaping skills are affected by factors such as creative personality traits, spatial abilities, and shaping creativity. Students were allowed to use three different leaf materials in their floriculture works: planar leaf, linear leaf, and amorphous leaf materials. Representative planar, linear, and amorphous floriculture materials used in the current study were yellow palm (*Chrysalidocarpus lutescens*), veitch's screw pine (*Pandanus baptistii*), and tree fern (*Asparagus virgatus*), respectively. The average score for creativity in shaping floriculture material was (±SD) 3.26 ± 0.84 (range, 1.33–4.67). Comparisons of the three leaf materials showed that the score for shaping creativity was highest for the planar leaf material (3.70 ± 1.23), followed by the amorphous leaf material (3.18 ± 0.99) and the linear leaf material (2.91 ± 0.94). The chi-square test results indicated that creative personality traits affected the number of shaping skills used, and that spatial abilities and floriculture material-shaping creativity further enhanced skills in floriculture material-shaping. Suggestions for floriculture educators and practitioners are provided accordingly.**

Flowers are among the most vital cash crops in agriculture worldwide. In Taiwan, the flower industry has flourished in the past 30 years. According to the tax agency, the number of flower shops registered as a profit-seeking business since 1970 is ≈8500 (Taiwan Ministry of Finance, 2017). In 2016, however, the transaction volume of the flower market declined by 10% (Chen, 2017), and the number of flower shops in operation decreased to ≈3500 (Taiwan Ministry of Finance, 2017). The main causes of the decreased transaction volume were climate change, economic recession, and low professional competence of florists (Chen, 2017; Chou, 2017). The main services currently provided by Taiwan flower shops include general table flower design, bouquet packaging, and venue decoration for weddings or funerals. Relevant floriculture courses are rarely offered as part of formal education; therefore, most practitioners acquire their basic design skills through apprenticeships, nongovernmental organizations, or institutes that promote adult education. Additionally, the Taiwan government has not implemented a system for testing the skills of floriculture practitioners (Chou, 2017). All of these factors have contributed to the limited ability of florists to design floral products that attract the interest of consumers, which, in turn, has contributed to the weak consumer market. Therefore, how to enhance the professionalism of florists is a topic that should be explored to revitalize the flower industry in Taiwan.

Creativity of floral designers can substantially affect the attractiveness and values of floral products. Studies have shown that when consumers purchase products, their choices are based on the image created by the products (Khalid, 2006), and that image is determined by shaping. Shaping is a key determinant of the appeal of a floral product because of its large effects on the purchase intention and satisfaction of the consumer (Schmitt and Simonson, 1997). For example, large wholesale flower markets in Taiwan sell a bouquet of 20 roses (*Rosa hybrida*) for ≈$9 (US dollars) (Taiwan Agriculture and Food Agency, 2017). However, after shaping and packaging in flower shops operated by prominent floral designers, those same roses are sold for up to $126 (US dollars) (Taipei Florist, 2017). Therefore, shaping can increase the value of a floral product by up to 10-fold after packaging costs are deducted. By using their ingenuity, designers can transform low-price flowers into sophisticated shapes and combinations, which can decrease the price sensitivity of consumers and increase sales profits (Floristware, 2017). Therefore, shaping of floral materials is an essential skill for floriculture designers and an essential component of a floriculture curriculum.

Floriculture design is a visual art (Henss et al., 2006). Shaping in floral design is the use of techniques such as trimming, weaving, pasting, tying, wrapping, layering, and threading to transform the original shape of floral materials to express an abstract idea (Chou, 2017); therefore, shaping is considered a creative activity (Sotirova-Kohli, 2009). Creativity has been described as an aggregation of multiple personal characteristics, including personality traits (Sternberg and Lubart, 1995) and spatial abilities (Gardner, 1983). For example, studies have shown that individuals who have highly creative personality traits (e.g., independent thinking and curiosity) tend to not only exhibit good shaping ability in arts and crafts but also perform well in mathematics and science (Mallappa and Upadhyaya, 1977). Additionally, workers with excellent spatial abilities tend to have superior professional and technical performance (Wanzel et al., 2002).

In the past, introductory training in floriculture design commonly included practice in the use of

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geometric figures such as semi-circles, triangles, horizontal shapes, C shapes, and S shapes to cultivate skills in judging angles and spatial abilities (Alexander, 2010). Researchers have also used floriculture design activities to improve the visuospatial working memory of patients with schizophrenia and have demonstrated associations between floricultural design skills and spatial abilities (Mochizuki-Kawai et al., 2016). Creative personality traits and spatial ability are positively associated with academic performance (Ai, 1999; Ganley and Vasilyeva, 2011) and socioeconomic status (Castillo-Vergara et al., 2018; Levine et al., 2005); however, spatial ability is positively associated with age during childhood but negatively associated with age during adulthood (Techentin et al., 2014). Although spatial ability tends to be superior in men compared with women (Wei et al., 2016), gender differences in creative personality traits have not been established (Prado and Fleith, 2016).

Based on the aforementioned research, the variables explored in this study were the creative personality traits and spatial abilities of university students. A clear understanding of the relationships between creativity in shaping floriculture materials and shaping skills would have practical applications for floriculture teachers interested in using diverse teaching methods to attract the interest of students.

Materials and methods

SUBJECTS. Purposive sampling was used to recruit 154 students enrolled in a commercial floriculture course during the 2017–18 academic year at a Taiwan university. Because this course was an advanced course in basic floriculture design, the students were not formally enrolled as participants in the study until after they had received relevant training during a one-semester basic floriculture design course. The basic floriculture design course mainly trained students in floriculture materials and basic shapes for table centerpieces (e.g., hemispheres, triangles, and horizontal shapes) and gave students a preliminary understanding of floral nomenclature, the characteristics of floriculture materials, and floral patterns. The curriculum did not include a course regarding free creation; therefore, all students had similar training before they participated in the study.

All 154 questionnaires distributed were retrieved, for a return rate of 100%. Eliminating five questionnaires with incomplete answers yielded 149 valid questionnaires, for a total return rate of 96.8%.

MEASUREMENTS. The survey instruments were a demographic information questionnaire, a creative personality scale (CPS), a mental rotations test, and a shaping creativity test. The demographic information questionnaire collected data regarding four variables: gender, age, academic performance during the previous semester, and family socioeconomic status. The modification of a CPS developed by Gough (1979) included 30 items: 18 items for highly creative personality traits with positive connotations and 12 items for weakly creative personality traits with negative connotations. For each positive adjective selected by the respondent, the score was increased by 1 point. For each negative adjective selected, the score was decreased by 1 point. The total score for all selected items represented the self-perceived creativity of the respondent. High and low scores were interpreted as high-creatively and low-creativity personality traits, respectively. The CPS uses nontechnical language and is easy to understand. To minimize the effects of preconceived notions, the researchers did not tell the participants which adjectives were positive or negative. The text of the instructions for the CPS is as follows: "Please indicate which of the following adjectives best describe yourself. Check all that apply." The participant then selects from a list of 30 adjectives. Table 1 lists the items for this scale. After the content validity of the scale was confirmed by a panel of six experts and scholars in Taiwan, the pretest questionnaire was prepared. The pretest questionnaire was then administered to 90 subjects in the sample population (i.e., students in the sampled department). Finally, a reliability analysis of the questionnaire data was performed. The total alpha of the CPS in this study was 0.746 (>0.70), indicating high reliability.

A spatial ability test was performed using the "mental rotations test" designed by Vandenberg and Kuse (1978). Participants were required to judge the four images on the right side in comparison with the target image on the left side. The two images on the right were then spatially rotated, and the participants were asked to indicate which image was identical to the target image. Participants circled their answers. The questionnaire included 20 questions, each of which had two answers. Participants gained 1 point only when they correctly circled both answers for one item, and the total test time was 10 min. Incorrect answers and unanswered questions were not scored,

Table 1. The number of times each item on a creative personality scale (CPS) was selected by the participants (Gough, 1979).

Positive creative personality trait (selection frequency)[z]			Negative creative personality trait (selection frequency)	
Humorous (108)	Sexy (43)	Clever (46)	Commonplace (87)	Sincere (64)
Wide interests (102)	Informal (56)	Original (51)	Mannerly (87)	Affected (0)
Self-confident (94)	Capable (61)	Confident (47)	Honest (101)	Cautious (66)
Inventive (49)	Egotistical (12)	Reflective (48)	Conservative (42)	Interests narrow (8)
Insightful (87)	Intelligent (44)	Resourceful (47)	Submissive (62)	Suspicious (64)
Individualistic (48)	Snobbish (2)	Unconventional (23)	Conventional (10)	Dissatisfied (24)

Participants were 149 college students (21 years or younger) enrolled in a commercial floriculture course during 2017–18. Participants were given a list of 30 adjectives and asked to select those that matched their personality traits adjectives (multiple responses were allowed). The survey was based on the study of relationships of creative personality traits and spatial abilities with shaping creativity and floriculture material-shaping skills. Numbers in parentheses are the total number of times the item was selected by the participants.

[z]The CPS was scored as follows: selection of a positive trait was scored as +1; selection of a negative trait was scored as –1. Multiple answers could be selected. The sum of the positive and negative personality trait scores comprised the total creative personality scale score; a high score indicated highly creative personality traits (Gough, 1979).

and the total score represented the participants' spatial abilities. Figure 1 presents an illustrated example of the mental rotations test.

The criterion-related validity of the mental rotations test exceeded 0.30 in a study by Kuse (1977). The Kuder–Richardson formula 20 (Wilson et al., 1975) yielded a score of 0.88, which indicated satisfactory reliability and stability of the mental rotations test.

Based on previous studies (Hunter, 2012; Pepler and Ross, 1981; Wang, 2003), the researchers designed the practical test for floriculture material-shaping (hereafter referred to as the shaping creativity test) to assess shaping creativity. The test for floriculture material-shaping evaluated the ability to shape commonly used floriculture materials, which were defined as materials that had a high trading volume in various flower wholesale markets according to the Taiwan Agriculture and Food Agency (2017). The shapes of flower arrangement materials can be approximately categorized as mass or rounded shapes, spiky or linear shapes, spray or filler shapes, and form shapes (Culbert, 1978; Hunter, 2012). Floriculture materials for creativity tests should have high flexibility, low resistance, and a simple structure to enable convenient expression of abstract concepts (Lowenfeld, 1957; Pepler and Ross, 1981; Spodek and Saracho, 2013; Wang, 2003). Representative planar, linear, and amorphous floriculture materials used in the current study were yellow palm, veitch's screw pine, and tree fern, respectively. Although form shapes of floriculture materials [e.g., blood iris (*Iris sanguinea*)] are generally considered beautiful, complex, and

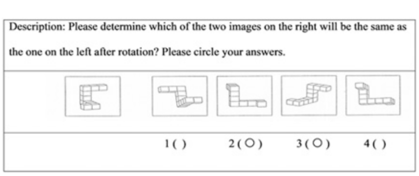

Fig. 1. Illustrated example of the mental rotations test (Vandenberg and Kuse, 1978). Each item of this 20-item questionnaire included two questions. A score of 1 was given for correctly answering both questions for each item. Total test time was 10 min.

unique, novices tend to have difficulty using these materials creatively. Therefore, form shapes of floriculture materials were not used to test the floriculture material-shaping ability.

The pretest results indicated that the participants required an average of 10 min to shape a floriculture material. Three different leaf materials were used during this test, and each subject received three pieces of each material. Participants were asked to use the leaf materials to shape a decorative centerpiece.

The test was administered in a classroom. Before the test, the researchers arranged the students into six rows. A different floriculture leaf material was distributed to each of the first three rows. The same materials were then distributed in the same sequence to the next three rows. Therefore, each material type was separated by only two rows. Participants were given a time limit of 10 min to use each leaf material so that they would not have time to observe or imitate works created by other participants. Therefore, each participant completed three works within a total test time of 30 min.

Front and back views of each completed work were photographed with a digital camera (IXUS 285 HS; Canon, Tokyo, Japan) at a distance of 75 cm (29.5 inches). Two experts with more than 10 years of experience teaching floriculture were invited to score the following three dimensions for each work: novelty, problem-solving, and elaboration and synthesis (Besemer and O'Quin, 1999). Shaping creativity was defined as the average creativity score for the three leaf materials. The scores were then rounded to integers from 1 to 5, which were interpreted as follows: 1 = very low creativity; 2 = low creativity; 3 = average creativity; 4 = high creativity; and 5 = very high creativity. Then, the researchers asked two experts to classify the works according to the leaf-shaping techniques defined by Alexander (2010). The classification criteria included six leaf-shaping techniques: trimming, weaving, winding, comprehensive, planar winding, and three-dimensional winding.

Trimming involves using scissors to trim more than half of the outline or interior of the leaf material. Weaving is repeatedly overlapping more than half of the appearance of the leaf material to form a closed-loop grid. Winding is repeatedly overlapping more than half of the appearance of the leaf material in a curved direction to form a closed or hollow shape. A comprehensive method involves using two or more techniques to shape the leaf material. Planar winding is using linear materials to wind the leaf material into a two-dimensional planar object. Finally, three-dimensional winding involves using linear material to wind the leaf material into a three-dimensional object.

The content validity of this test was assessed by six floriculture experts in Taiwan. Reliability was tested using the scorer reliability method. Two floriculture experts rated works by 10 pretest participants. Their Pearson correlation coefficient was 0.846, which indicated satisfactory validity. For tests of the classification of leaf materials, Cohen's kappa coefficients were κ = 0.714 for planar leaves, κ = 0.692 for linear leaves, and κ = 0.737 for amorphous leaves, which indicated that the scorers had high consistency when classifying shaping techniques. Figure 2 presents the materials used for the shaping creativity test. The figure also shows works that the students produced using various leaf material-shaping techniques.

Data analysis. SPSS software (version 22.0; IBM Corp., Armonk, NY) was used to analyze the collected questionnaire data. Data analyses included calculations of means, SD, and percentage frequencies for the answers and scores for each scale. One-way analysis of variance (ANOVA) was used to determine differences between scores for the CPS, mental rotations test, and shaping creativity test for various demographic variables. The chi-square test was also performed to analyze correlations among the scores of the CPS, mental rotations test, shaping creativity test, and shaping techniques. Finally, multivariate stepwise regression was used to evaluate the demographic variables, CPS scores, and mental rotations test scores as predictors of shaping creativity.

Results

Differentiation test of the CPS and mental rotations test. The CPS scores ranged from –6 to +12 (mean ± SD, 2.34 ± 5.03). The total score for the mental rotations test was 10.28 ± 5.85, and the average score for a single question was 0.51 ± 0.29, which was slightly higher than the median. Statistical analyses showed that the adjectives most frequently selected by the participants were "humorous" (108 times), "wide interests" (102 times), and "honest" (101 times). Researchers used the mean scores of the three tests (CPS, mental rotations test, and shaping creativity test) as criteria for dividing the 149 participants into high-scoring and "low-scoring groups. For the CPS, mental rotations test, and shaping creativity test, the high-scoring groups included 51, 79, and 78 individuals, and the low-scoring groups included 98, 70, and 71 individuals, respectively. According to the statistical analysis, those who had high CPS scores were characterized by a good sense of humor, inventiveness, and insightfulness. Those who had high spatial abilities and those who had high shaping creativity tended to be have a good sense of humor, wide interests, and strong self-confidence. In contrast, participants who had low CPS scores, low spatial abilities, and low shaping creativity were conventional, mannerly, and honest. These results are consistent with those of previous reports indicating that creativity personality traits are positively associated with spatial ability and shaping creativity. Table 1 presents the data for the number of times each adjective was checked by the subjects. Table 2 presents the data for the number of persons in each group and the three most frequently selected answer choices for the CPS, mental rotations test, and shaping creativity test in the high score and low score groups.

Table 3 presents the one-way ANOVA results for various demographic variables in terms of their associations with the CPS and mental rotations test. According to the ANOVA results, the factors that significantly affected the CPS and mental rotations test were age ($P < 0.001$ and $P = 0.005$, respectively) and academic performance (P = 0.001 and 0.021,

Fig. 2. Test materials used for the shaping creativity test and examples of works produced by students. The test used yellow palm, veitch's screw pine, and tree fern as materials for planar, linear, and amorphous floriculture works, respectively. The time limit for using each material was 10 min. For each floriculture material, shaping creativity and shaping techniques were evaluated by two floricultural experts.

Table 2. The three creative personality scale (CPS) items most frequently selected by each group (Gough, 1979).

Creativity personality scale[z]		Mental rotations test[z]		Shaping creativity test[z]	
High (N = 51)	Low (N = 98)	High (N = 79)	Low (N = 70)	High (N = 78)	Low (N = 71)
Personality trait (selection frequency)					
Humorous (45)	Commonplace (73)	Humorous (67)	Mannerly (48)	Humorous (63)	Honest (46)
Inventive (44)	Mannerly (67)	Wide interests (64)	Honest (45)	Self-confident (63)	Mannerly (44)
Insightful (43)	Honest (60)	Self-confident (60)	Commonplace (42)	Wide interests (59)	Commonplace (42)

Participants were 149 college students (21 years or younger) enrolled in a commercial floriculture course during 2017–18. Participants were given a list of 30 adjectives and asked to select those that matched their personality traits (multiple responses were allowed). The survey was based on the study of relationships of creative personality traits and spatial abilities with shaping creativity and floriculture material shaping skills. Numbers in parentheses are the total number of times the item was selected by the participants.
[z]Mean scores for the CPS (Gough, 1979), mental rotations test (Vandenberg and Kuse, 1978), and shaping creativity test were used as criteria for dividing participants into high score and low score groups. The numbers in parentheses are the total number of persons in each group.

Table 3. Results of one-way analysis of variance (ANOVA) between the creative personality scale (CPS) and mental rotations test for different demographic variables.

Demographic variables	Sample size (no.)	Creative personality scale		Mental rotations test	
		Mean score[z]	*P*	Mean score[y]	*P*
Gender					
Male	19	1.95 a[x]	0.720	0.57 a[x]	0.341
Female	130	2.39 a		0.51 a	
Age (years)					
<20	72	0.40 a	0.000***	0.43 a	0.005**
20–21	61	4.36 b		0.59 b	
≥22	16	3.31 ab		0.60 ab	
Academic performance (points)					
≥80	91	3.52 a	0.001***	0.57 a	0.021*
79–70	49	0.84 b		0.43 b	
69–60	9	–1.44 bc		0.45 ab	
Socioeconomic status					
High	23	0.65 a	0.003**	0.46 a	0.243
Middle	97	3.35 ab		0.54 a	
Low	29	0.28 c		0.46 a	

Participants were 149 college students (21 years or younger) enrolled in a commercial floriculture course during 2017–18. The survey instruments were the 30-item CPS (Gough, 1979) and the 20-item mental rotations test (Vandenberg and Kuse, 1978). The survey was based on the study of relationships of creative personality traits and spatial abilities to shaping creativity and floriculture material shaping skills.
[z]Calculated by summing scores for CPS. The scale was scored as follows: selecting a positive trait was scored as +1; selecting a negative trait was scored as –1. Multiple answers could be selected, and the total score ranged from +18 to –12. The sum of the positive and negative personality trait scores comprised the total creative personality scale score; a high score indicated highly creative personality traits (Gough, 1979).
[y]Calculated by summing responses of the mental rotations test, which comprises 20 multiple choice questions, each of which has two answer choices. A correct answer is scored as 1 point. No points are given if only one answer is correct or if no answer is selected (Vandenberg and Kuse, 1978); a high score indicates superior spatial abilities.
[x]The same letters after the mean scores indicate that Scheffe post hoc test scores did not significantly differ at $P = 0.05$.
*, **, ***Statistically significant according to the one-way ANOVA at $P \leq 0.05$, 0.01, or 0.001, respectively.

Table 4. Results of one-way analysis of variance (ANOVA) of the shaping creativity test of horticulture material.

Social and psychological traits	Planar leaf material[z]		Linear leaf material[z]		Amorphous leaf material[z]		Overall[y]	
	Mean score	*P*	Mean score	*P*	Mean score	*P*	Mean score	*P*
Gender								
Male	3.68 a[x]	0.959	2.58 a[x]	0.105	3.21 a[x]	0.089	3.16 a[x]	0.566
Female	3.70 a		2.95 a		3.18 a		3.28 a	
Age (years)								
<20	3.39 a	0.006**	2.67 a	0.010**	3.00 a	0.053	3.02 a	0.002**
20–21	3.90 a		3.15 b		3.28 a		3.44 b	
≥22	4.31 b		3.06 ab		3.63 a		3.67 bc	
Academic performance (points)								
≥80	3.71 a	0.943	3.05 a	0.051	3.43 a	0.000***	3.40 a	0.039*
79–70	3.65 a		2.65 a		2.78 b		3.03 b	
69–60	3.78 a		2.78 a		2.89 ab		3.15 ab	
Socioeconomic status								
High	3.52 a	0.745	2.78 a	0.235	2.91 a	0.223	3.07 a	0.284
Middle	3.74 a		3.00 a		3.28 a		3.34 a	
Low	3.69 a		2.69 a		3.07 a		3.15 a	
Creative personality scale								
High	4.06 a	0.010**	3.43 a	0.000***	3.51 a	0.003**	3.67 a	0.000***
Low	3.51 b		2.63 b		3.01 b		3.05 b	
Mental rotations test								
High	4.18 a	0.000***	3.38 a	0.000***	3.68 a	0.000***	3.75 a	0.000***
Low	3.16 b		2.37 b		2.61 b		2.71 b	

Participants were 149 college students (21 years or younger) enrolled in a commercial floriculture course during 2017–18. Participants were asked to use a different leaf material to shape each of three decorative centerpieces. The time limit was 10 min for each leaf material. Each work was scored by two horticultural experts. The survey was based on the study of relationships of creative personality traits and spatial abilities with shaping creativity and floriculture material shaping skills.
[z]The leaf materials used for this test were yellow palm for planar leaf material, veitch's screw pine for linear leaf material, and tree fern for amorphous leaf material.
[y]Calculated by summing judges using the shaping creativity test for all leaf materials. Scores could possibly range from 1 to 5. High and low scores were interpreted as high and low creativity for shaping the leaf materials, respectively.
[x]The same letters after the mean scores indicate that Scheffe post hoc test scores did not significantly differ at $P = 0.05$.
*, **, ***Statistically significant according to one-way ANOVA at $P \leq 0.05$, 0.01, or 0.001, respectively.

Table 5. Chi-square analysis results of creative personality scale scores, mental rotations test scores, shaping creativity test scores, and horticulture shaping techniques scores of the high and low score groups.

	Creativity personality scale[y]			Mental rotations test[y]			Shaping creativity test[y]		
	High (N = 51)	Low (N = 98)	*P*	High (N = 79)	Low (N = 70)	*P*	High (N = 78)	Low (N = 71)	*P*
Yellow palm									
Trimming (20)[z]	4	16	NS	6	14 b	0.000***	6	14 b	0.000***
Weaving (31)	10	21		14	17		9	22 b	
Winding (23)	5	18		6	17 b		5	18 b	
Comprehensive (75)	32	43		53 a	22		58 a	17	
Veitch's screw pine									
Trimming (41)	7	34	0.002**	12	29 b	0.002**	8	33 b	0.000***
Weaving (32)	13	19 b[x]		19 a	13		22 a	10	
Winding (56)	18	38		33	23		31	25	
Comprehensive (20)	13 a[x]	7		15 a	5		17 a	3	
Tree fern									
Planar winding (113)	40	73	NS	54	59 b	0.023*	52	61 b	0.006**
Three-dimensional winding (36)	11	25		25 a	11		26 a	10	

Participants were 149 college students (21 years or younger) enrolled in a commercial floriculture course during 2017–18. The survey was based on the study of relationships of creative personality traits and spatial abilities with shaping creativity and floriculture material shaping skills.

[z]In the first column, the numbers in brackets indicate the number of times the two experts observed a shaping skill according to the definitions of leaf styling techniques applied in the study by Alexander (2010).

[y]Mean scores for the creative personality scale (Gough, 1979), mental rotations test (Vandenberg and Kuse, 1978), and shaping creativity test were used as criteria for dividing participants into high and low scoring groups. The numbers in parentheses are the total number of persons in each group.

[x]In the columns for the same leaf material group, a different letter indicates a significant difference in chi-square test results at $P \leq 0.05$. An adjusted residual >1.96 indicates the shaping technique most frequently used in each group; that is, the shaping technique was not randomly used. A letter "a" indicates a shaping technique that was used with particularly high frequency in the high score group, and a letter "b" indicates a shaping technique that was used with particularly high frequency in the low score group.

*, **, ***Statistically significant according to the chi-square tests at $P \leq 0.05$, 0.01, or 0.001, respectively.

NS = Not significant in chi-square tests at $P < 0.05$.

respectively). Participants who were older and who had good academic performance tended to perform well on both tests. The mental rotations test scores were significantly (P = 0.003) higher for subjects with moderate socioeconomic status compared with those with low socioeconomic status.

Differentiation of the shaping creativity test. The overall score for the shaping creativity test was (±SD) 9.79 ± 2.52, and the average score for single leaf materials was 3.26 ± 0.84. The average score accounted for 0.65 of the total score, which indicated a moderately positive overall score for shaping creativity. Comparisons of scores for single leaf materials showed that the highest scores were achieved for planar leaf material (3.70 ± 1.23), followed by amorphous leaf material (3.18 ± 0.99). Linear leaf material (2.91 ± 0.94) had the lowest score, probably because the relatively monotonous structure of this material rarely triggered the conception of works compared with those created using other materials.

Table 4 displays the results of the one-way ANOVA for the shaping creativity test with consideration for social and psychological traits. According to the t test and ANOVA results, the overall shaping score, and the shaping scores for the three leaf material types, participants with high CPS scores and high spatial abilities had significantly higher shaping creativity compared with those with low CPS scores and low spatial abilities ($P < 0.05$). For all materials except for amorphous leaf materials, shaping creativity was significantly higher for older participants compared with younger participants ($P < 0.05$). Overall shaping creativity was higher for students whose academic performance score was more than 80 points compared with those whose academic performance score was 70 to 79 points ($P < 0.05$). A possible explanation is that spatial abilities are a component of intelligence, which is related to academic performance.

Correlation analysis of the CPS, mental rotations test, shaping creativity test, and floriculture material-shaping techniques. Researchers used the mean scale scores for the CPS, mental rotations test, and shaping creativity test to classify the participants into high score and low score groups. The chi-square tests were then used to investigate whether shaping techniques had significant correlations with the three variables. The results presented in Table 5 show that the CPS had significant correlations with the shaping techniques applied for the veitch's screw pine material (P = 0.002). Participants with low CPS scores tended to use trimming, whereas those with high CPS scores tended to use the comprehensive method. Additionally, spatial abilities and shaping creativity had significant associations with material-shaping skills. Participants with high spatial abilities and high shaping creativity tended to use the comprehensive method to shape yellow palm ($P < 0.001$), weaving and the comprehensive method to shape veitch's screw pine (P = 0.002 and $P < 0.001$), and three-dimensional winding to shape tree fern (P = 0.023 and P = 0.006). Participants with low spatial abilities and low shaping capabilities tended to use a single technique to shape yellow palm (e.g., either trimming or winding), whereas they commonly used trimming and planar winding to shape veitch's screw pine and tree fern, respectively. Table 5 summarizes the results.

Analysis of demographic variables, CPS scores, and spatial abilities as predictors of the shaping creativity test. Table 6 presents the results of a multivariate

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Table 6. Multivariate stepwise regression analysis of the power of demographic variables, creative personality scale, and spatial abilities for predicting shaping creativity.

Order of the selected variables	Multiple correlation coefficient R	R^2	R^2 increased variance explained[z]	F value	Net F value	Standardized regression coefficients
Spatial abilities	0.554	0.307	0.307	65.196***	65.196	0.416
Creative personality scale	0.620	0.384	0.077	45.495***	18.117	0.309

Participants were 149 college students (21 years or younger) enrolled in a commercial floriculture course during 2017–18. The survey was based on the study of relationships of creative personality traits and spatial abilities with shaping creativity and floriculture material shaping skills.
[z]Variables with a higher R^2 increased variance explained had more power in predicting shaping creativity.
***Significant according to stepwise multiple linear regression at $P < 0.001$.

stepwise analysis of the power of demographic variables, CPS, and spatial abilities for predicting shaping creativity. Two significant variables were entered in the regression equation when the six predictor variables predicted the criterion variable (shaping creativity). The multivariate correlation coefficient was 0.620, whereas the joint variance explained was 0.384; specifically, the two variables in the regression equation jointly predicted 38.4% of the variance in creativity for floriculture material-shaping. Regarding the explanatory power of individual variables, "spatial abilities" had the most predictive power, with a 30.7% variance explained, followed by "CPS," with a 7.7% variance explained. Table 6 summarizes the results of the multivariate stepwise regression analysis of the power of each variable for predicting shaping creativity.

Discussion

In flower markets, the shaping of floral products has become a key factor in their price. This study discovered that creative personality traits, spatial abilities, and shaping creativity had significant associations with floriculture material-shaping techniques. Compared with participants with low CPS scores, those with high CPS scores tended to be more humorous, inventive, and insightful, they displayed more creativity in shaping simple materials (e.g., veitch's screw pine), and they were more willing to use diverse combinations of techniques to produce their designs (i.e., the number of different techniques they used was significantly larger than the number used by participants with low CPS scores). Participants with high spatial ability and shaping creativity had a wide range of interests and high self-confidence, and they tended to produce the most diverse designs. That is, they used a wider variety of design techniques, and their technical skills were more refined and delicate compared with those of their counterparts with low spatial abilities and low shaping creativity. For example, they were more likely to apply a combination of techniques, (e.g., weaving combined with three-dimensional winding) in the design process.

In contrast, participants with low CPS scores, low spatial abilities, and low shaping capabilities were younger and had less satisfactory academic achievements; they were conventional, polite, and honest, as well as more conservative and lacking in confidence. Therefore, they tended to use basic trimming techniques that they had learned in previous courses rather than experimenting with other creative techniques. They used a less diverse range of creative techniques, which resulted in relatively simple and two-dimensional works. For example, participants with low CPS scores, low spatial abilities, and low shaping capabilities often used a single technique to produce a work and lacked capability in three-dimensional design, which resulted in lower expert ratings of their works.

According to Trivedi and Bhargava (2010), various factors contribute to the development of a creative personality, including age, academic achievement, and socioeconomic environment, which is consistent with the results of the present study showing that age, academic achievement, and socioeconomic status affect creative personality traits. This study showed that creativity can be cultivated by providing a learning environment that is rich in learning resources and by providing positive encouragement to explore more than one creative solution. Therefore, even if a floriculture teacher repeatedly uses the same floriculture materials, the teacher should modify the methods according to the traits of individual learners. For learners with low-creativity personality traits, teachers should ensure that the proportion of class time spent on creativity teaching is higher than the proportion spent on conventional demonstrative teaching. This would encourage hands-on learning among students and provide more encouragement for their work, thereby enhancing their self-confidence and creative motivation.

This study also revealed that spatial abilities and shaping creativity not only influenced the number of techniques used by participants but also affected the quality of their technical displays. Spatial abilities had a power of 30.7% for predicting shaping capabilities, which indicated the importance of spatial abilities and was consistent with the findings of numerous studies of the relationship between art and spatial abilities (Bailey, 2011; Wanzel et al., 2002). Notably, spatial abilities can be improved through training (e.g., Rubik's cube and three-dimensional computer games) (Cherney, 2008; Lohman and Nichols, 1990). Therefore, floriculture teachers can improve the design techniques used by their students by enhancing students' spatial abilities. For example, to stimulate visual imagery in their students, teachers can show them works by famous artists or ask them to draw three-dimensional sketches before they begin designing. Teachers can also encourage students to perform their own analyses of flower patterns and structures instead of simply following instructions. Additionally, teachers can use materials with high plasticity (e.g., bamboo, paper, and acrylic strips) instead of expensive floriculture materials to train students in various floriculture techniques (e.g., paper folding, knotting, and weaving). These approaches (Bailey, 2011; Boakes, 2011) would enrich the creative experience of learners and enhance their spatial abilities, which would then enhance the spatial aesthetics of their works. The floriculture industry should also develop an aptitude test that measures creative personality traits and spatial ability to serve as a measurement instrument for screening practitioners and identifying outstanding floriculture designers.

A limitation of this study was that only three different leaf material types were used for the assessment of creative shaping capabilities, which limited its objectivity. Future studies should provide a wider variety of materials or integrate other data collection approaches such as direct observation or video-recording to achieve more accurate results.

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