Application of Designers' Sketching Skills in Design Education

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Abstract

The use of sketches in the generation of design ideas is thought to have various effects. However, previous studies have yet to elucidate exactly how sketching skills influence the expression and development of design solution candidates. Elucidating the role and effects of sketching skills is expected to transform sketching training, in which considerable time is traditionally spent on acquiring sketching skills, into an avenue for the effective acquisition of techniques for generating ideas for design features. We conducted a series of studies in order to clarify the role and effects of sketching skills in relation to the generation of design ideas in the process of product design. In our previous paper, a structural model of sketching skills was proposed upon analyzing the process of acquisition of sketching skills by students. In this study, we verified the usefulness of the proposed structural model of sketching skills for analyzing sketches drawn by designers. Specifically, we compared the differences between sketches of the same subject drawn by designers and students. Then, the usefulness of the model was demonstrated by clarifying the differences in sketching skills between designers and students as well as between individual designers. In addition, the results of analyzing sketches drawn by different designers suggested that the approach to idea generation and the sketching skills influence each other. This knowledge is expected to be of assistance in design education aimed at the integrated acquisition and utilization of comprehensive sketching skills.

Keywords: Design Education, Sketching, Structural Model of Sketching Skills

1 Introduction

Use of the sketching in design is utilized for many designers as what stimulates a new idea and creativity (1-5). Also in the field of design science, research taking sketching as a guidepost is being conducted to clarify the structure of creative thought in design (6-8). However, almost no research has been conducted that scientifically considers the effect of sketching skills, such as a perspective method and curved surface expression, in the generation of ideas for design features. Therefore, in the present design education, many sketch exercises centering on acquisition of drawing technique are imposed. If the effect of the sketching skills mentioned above can be solved, it is also expected that development of teaching methods centering on the development technique of a design and development of the sketch skill education which specialized idea generation technique are also expected.

In previous research, we modeled the relationship of the sketching skills for the purpose of the elucidation of the effect of sketching skills (9, 10). "The structural model of sketching skills" was proposed by performing the sketch education for students who have not received design education, observing sketching skills acquisition process, and analyzing drawn sketches. However, since this model was proposed based on students' sketches, it is necessary to check usefulness by applying to analysis of sketches of the designers who have already learned sketching skills.

From the above background, this research aimed at the check of the usefulness of "the structural model of sketching skills" towards the elucidation of the effect of the sketching skills in design. Then, this model is applied to analysis of designers' sketching skills, and it checks that this model is useful also in analysis of designers' sketches. First we compared the difference in sketches which designers who work for an electrical equipment manufacturer, college students of design who received design education, and the college student of the faculty of technology without experience which received design education till then drew to the same subject. Next, we compared the difference in sketches between designers.

2 Methods

Structural Model of Sketching Skills

Figure 1 shows a "Structural model of sketching skills." Sketching skills are here divided into "Expression skills", which enable accurate expression of the shape of a design proposal, and "Development skills", which enable the development of numerous candidates for design proposals. "Expression skills" consists of four items of "Skills for expression of three-dimensional form" "Skills for expression of perspective" "Skills for expression of curved form" and "Skills for expression of object image." "Development skills" consists of four items of "Skills for development of structure" "Skills for development of shape" "Skills for development of detailed shape" and "Skills for development of constituent elements." Each skill is typified from its relation with skills in three groups, "Development of shape", "Development of structure" and "Development of element." The arrow shown in a figure expresses the precondition of acquisition, and, in many cases, the skill of the direction shown in

an arrow expresses that it is the skill used as the necessary condition for learning the skill shown in the direction which becomes the origin of an arrow.

Evaluation of Sketching Skills of Designers and Students

Sketches of designers and students who are in the acquisition stage of sketching skills were collected on the conditions shown below, and evaluation by eight items of skill shown in "Structural model of sketch skill" was performed (Figure 2).

Theme: Liquid crystal projector

Creation time: For 60 minutes

The candidate could be three categories by six designers who work in an electrical equipment manufacturer (following: designer), ten college students of design speciality who received design education (following: design student), and six college students of the faculty of technology without experience which received education (following: engineering student), and a total of 22 persons.

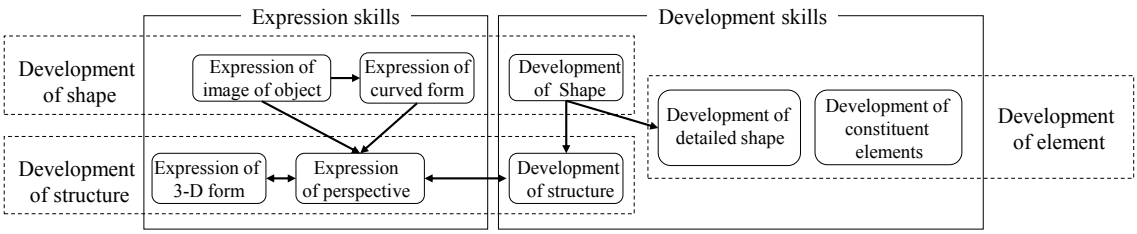
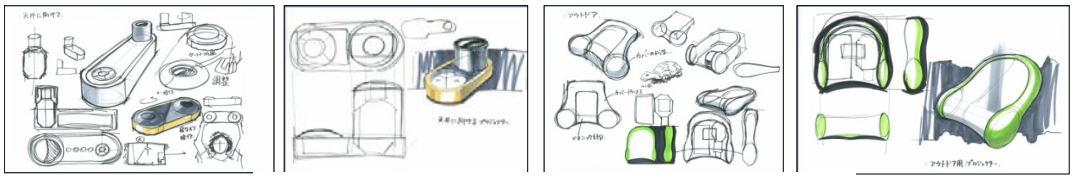
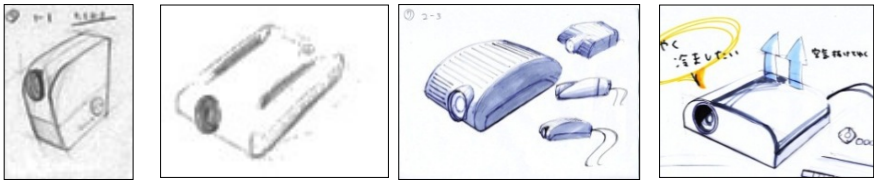


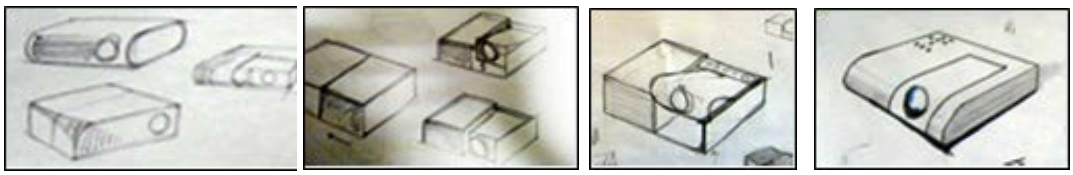
Fig. 1. Structural model of sketching skills



(a) Designer



(b) Design Student



(c) Engineering Student

Fig.2. Example of a series of sketches by student and designer

3 Analysis of the Difference in Sketching Skills

Difference in Sketching Skills between Designers and Students

Every item of the sketching skills evaluation value of designers and students were normalized, and the average differences were authorized. The average, unbiased variance and standard deviation of four items of "Expression skills" and four items of "Development skills" were calculated (Table 1, 2). In average value, it was shown that all the values of eight items of a designer's sketch skill are high compared with a student, and it was shown that experience of design business affects sketch skill. In average, it was shown that all the values of eight items of designers' sketching skills are high compared with students, and it was shown that experience as a professional designer affects sketch skill. High distribution was shown in much the student's unbiased variance and standard deviation of skill in the acquisition stage of sketching skills. However as for “Skills for development of structure” and “Skills for development of shape”, high distribution was shown to the designers. It is possible that such skills are skills which acquisition of other sketch skills influences as the reason.

Table 3 and 4 shows the result of the official approval of homogeneity of variance to each data, and t-test or t-test by the method of Welch. In four items of "Expression skill", and four items of "Development skill", all single-sided P value became 0.05 or less, and it was shown that designers` sketching skills are higher than students. Among these, it was shown that single-sided P value of “Skills for expression of perspective” and “Skills for development of structure” are larger compared with other skills, and there is little skill difference relatively. These skills are fundamental skills which will be the requisite for other sketching skills acquisition in "the structural model of sketching skills" (Fig. 1). From this, it is thought that this skill was learned to some extent by design education also in the student.

Difference in Sketch Skill between Students

Next, same analysis was conducted to design students and engineering students (Table, 5-8). Compared with the engineering student, high evaluation was shown in the design student's four items of "Expression skills" and three items of "Development skills (“Skills for development of structure” “Skills for development of shape” “Skills for development of detailed shape”)." On the other hand, in “Skills for development of constituent elements,” although the significant difference by t-official approval was not shown, it was shown that an engineering student's average value is high compared with a design student. It is considered as this reason that engineering students with the knowledge about a machine design have many knowledge about the components of the equipment to design students, and it is estimated that the skill is affected in the knowledge about the equipment.

Table1. The average, unbiased variance, and standard deviation of expression skills between designers and students

	Designer (n:6)			Student (n:16)		
	Average	Unbiased variance	Standard deviation	Average	Unbiased variance	Standard deviation
Curved form	0.949	0.247	0.497	-0.356	0.822	0.906
The object image	0.830	0.489	0.699	-0.312	0.859	0.927
Perspective	0.504	0.456	0.675	-0.189	1.109	1.053
3-D form	0.890	0.000	0.000	-0.312	0.972	0.986

Table2. The average, unbiased variance, and standard deviation of development skills between designers and students

	Designer (n:6)			Student (n:16)		
	Average	Unbiased variance	Standard deviation	Average	Unbiased variance	Standard deviation
Constituent elements	1.081	0.294	0.542	-0.405	0.661	0.813
Detailed shape	1.074	0.405	0.636	-0.403	0.631	0.794
Shape	0.894	0.847	0.920	-0.335	0.677	0.823
Structure	0.717	1.252	1.119	-0.268	0.701	0.837

Table3. The result of F-test and t-test for expression skills of designers and students

	F-test			T-test			
	Statistic:F	P value		Statistic:t	Two-tail p value	one-tail p value	
Curved form	3.569	0.166		3.691	0.001	0.001	**
The object image	3.648	0.160		3.212	0.004	0.002	**
Perspective	2.074	0.436		1.903	0.078	0.039	*
3-D form	7.E+31	0.000	**	4.987	0.000	0.000	**

＊＊： Significance level 1% ＊：Significance level 5%

Table4. The result of F-test and t-test for development skills of designers and students

	F-test			T-test			
	Statistic:F	P value		Statistic:t	Two-tail p value	one-tail p value	
Constituent elements	2.250	0.379		4.117	0.001	0.000	**
Detailed shape	1.559	0.656		4.068	0.001	0.000	**
Shape	1.250	0.670		3.028	0.007	0.003	**
Structure	1.786	0.352		2.247	0.036	0.018	*

＊＊： Significance level 1% ＊：Significance level 5%

Table5. The average, unbiased variance, and standard deviation of expression skills between design student and engineering students

	Design Student (n:10)			Eng. Student (n:6)		
	Average	Unbiased variance	Standard deviation	Average	Unbiased variance	Standard deviation
Curved form	0.132	0.587	0.766	-1.170	0.137	0.371
The object image	0.211	0.623	0.789	-1.182	0.000	0.000
Perspective	0.125	0.696	0.834	-1.074	0.298	0.546
3-D form	0.294	0.330	0.575	-1.381	0.193	0.440

Table6. The average, unbiased variance, and standard deviation of development skills between design student and engineering students

	Design Student (n:10)			Eng. Student (n:6)		
	Average	Unbiased variance	Standard deviation	Average	Unbiased variance	Standard deviation
Constituent elements	-0.562	0.599	0.774	-0.143	0.771	0.878
Detailed shape	-0.179	0.848	0.921	-0.775	0.101	0.318
Shape	0.156	0.323	0.568	-1.155	0.161	0.402
Structure	0.163	0.526	0.725	-0.987	0.163	0.404

Table7. The result of F-test and t-test for expression skills of design students and engineering students

	F-test			T-test			
	Statistic:F	P value		Statistic:t	Two-tail p value	one-tail p value	
Curved form	4.267	0.125		3.862	0.002	0.001	**
The object image	1.E+31	0.000	**	5.582	0.000	0.000	**
Perspective	2.333	0.364		3.119	0.008	0.004	**
3-D form	1.708	0.576		6.113	0.000	0.000	**

＊＊： Significance level 1% ＊：Significance level 5%

Table8. The result of F-test and t-test for development skills of design students and engineering students

	F-test			T-test			
	Statistic:F	P value		Statistic:t	Two-tail p value	one-tail p value	
Constituent elements	1.286	0.699		1.000	0.334	0.167	
Detailed shape	8.375	0.031	*	1.868	0.086	0.043	*
Shape	2.000	0.461		4.934	0.000	0.000	**
Structure	3.222	0.211		3.537	0.003	0.002	**

＊＊： Significance level 1% ＊：Significance level 5%

4 Discussion for Sketching Skills of Designers

Feature of Sketches which Designers Draw

Figure 3 shows examples of sketches drawn by six designers. The following features were observed by each designer's sketch from how depending on which an outline, the shade, etc. draw.

Designer 1:
The sketches of the impression which was effective by the outline lucidly drawn with the felt pen (Figure 3 (a))

Designer 2:
The sketches of the sophisticated impression by the combination of the outline delicately drawn to details with the ball-point, and the shade by a marker (Fig. 3 (b))

Designer 3:
The sketches of the sophisticated impression of the outline delicately drawn to details with the ball-point (Figure 3 (c))

Designer 4:
The sketches of sophisticated and three-dimensional impression by the combination of the shade by the outline and mesh which were drawn with the ball-point (Figure 3 (d))

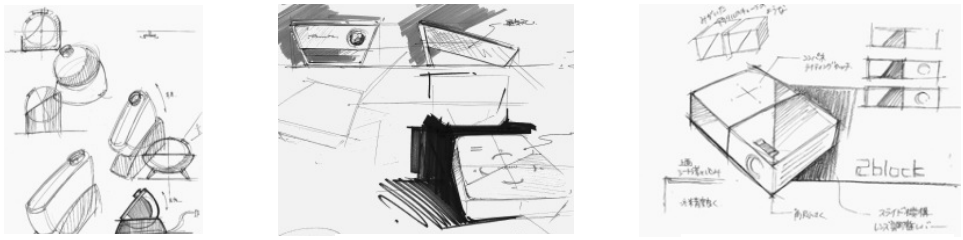
Designer 5:
The sketches of the strong impression which was effective by the combination of the outline by a felt pen, the shade by a marker, or color pencil (Figure 3 (e))

Designer 6:
The sketches of the three-dimensional impression by the combination of soft field composition including an outline with a colored pencil, and the gradation expression with a colored pencil (Figure 3 (f))

In designers' sketch, it was observed that sketch expression differs from the painting tools to utilize among designers. As a result of carrying out a hearing to a designer about the reason, the reply that the mode of expression and painting tools which are made elated [them] were chosen and the sketch was drawn was obtained.

Classification of Designers by Sketching Skills

Factor analysis to the sketching skills evaluation value of 22 candidates including designers were conducted, and three factors of "expression", "element", and "outside" were extracted. To the result obtained by the candidate's factor analysis, cluster analysis was conducted and it classified into four clusters. Designers are classified into three clusters among those, and the following features are shown to designers of each cluster.



(a) Designer1 (b) Designer2 (c) Designer3

(d) Designer4 (e) Designer5 (f) Designer6

Fig.3. Examples of sketches drawn by six designers

Cluster 1:
It involves in an "element" and an "outside" strongly, and the designer1 who has the feature in outline expression, and the designer2 correspond. "Structure deployment skill", "Form development skill", "Detailed element deployment skill", and "Component development skill" are high, and develop many form and elements by sketch mainly expressed by line depiction.

Cluster 2:
It involves to "expression" strongly and the designer3 who has the feature in the field expression for taking out a cubic effect, the designer4, and the designer6 correspond. "Curved surface form expression skill" and "Component development skill" are high. A polite field expression expresses a design.

Cluster 3:
The designer 5 who has the feature in an advanced expression which uses a marker corresponds. While four items of "Expression skills" are high, its "Development skills" are low.

In the "Solid form expression skill", all designers have got the highest evaluation. As mentioned above, basing a designer on fundamental "Expression skills" already learned, The difference in the sketch skill between designers was shown by "the structural model of sketch skill." Moreover, it was guessed that a designer utilizes sketch skill suitable for the way of thinking of each design based on fundamental "expression skill" already learned.

5 Conclusion

We evaluated the sketch which designers, design students, and engineering students drew to the same theme with the application of "The structural model of sketching skills." As a result, the difference in the sketching skills between designers and students were clarified, and the generality of this model was able to be shown by indicating the difference of sketching skills between designers. Furthermore, it was shown from the analysis result of sketches by designers that sketching skills and the design idea generation have influence mutually. We would like to develop the design educational method towards the acquisition of sketch skill based on the result obtained this research.

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