

## Analysis of the Conceptual Diagrams of Prospective Engineers and Prospective Designers on Creativity

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**Abstract:** These instructions give you guidelines for preparing papers for IJEMSR. Use this document as a template if you are using Microsoft Word. This word template is useful for estimating the length of an study but it is optional. The electronic file of your study will be formatted further at IJEMSR. Paper titles should be written in uppercase and lowercase letters. Avoid writing long formulas with subscripts in the title; short formulas that identify the elements are fine (e.g., “Nd-Fe-B”). Do not begin a title with the word “On.” Avoid starting a title with articles like “The” full names of researchers are much preferred but initials may be used instead. Chinese, Japanese and Korean researcher are encouraged to include their names in native characters in parentheses after their Romanized names. More information may be found at the journal website. Department names are optional in the affiliations. Do not give street addresses in the affiliations (except for researchers with no institutional affiliation). Define all symbols used in the abstract and again in the text. Do not cite references in the abstract. The purpose of this study is to analyze the knowledge and structure of creativity to understand the concept of creativity of preliminary designers and preliminary engineers among university students. In this study, 30 preliminary designers and 30 preliminary engineers among the university students of 2 universities located in Busan City were randomly sampled and 60 students were selected as research subjects. The findings of the study were as follows: First, both the preliminary designer and the preliminary engineer had the highest idea of ‘idea’ as the upper concept of creativity. Second, the number of the superordinate concepts that the prospective engineers described was 165 and that of the superordinate concepts used by the prospective designers was 136. As a result of categorizing the terms presented by the two groups based on similarity, their words were respectively classified into 19 categories. Third, as a result of analyzing their density scores on creativity, the density of the conceptual diagrams of the prospective engineers ranged from 1.00-2.62 and that of the conceptual diagrams of the prospective designers was between 1.00 and 3.42. The density scores of the two groups tended not to be high. The findings imply that their knowledge of creativity was parallel and not integrated properly rather than hierarchical and well organized.

**Key words:** Prospective engineer, prospective designer, creativity, conceptual diagram, parallel

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### INTRODUCTION

In the 21st century education and emphasizing creativity it may not be an exaggeration to say that there are constantly emerging as global core competencies for this. Recent scholars who study creativity are extracted as the toughness factor in creativity including positive examples in creativity, not to environmental factors (Fischman *et al.*, 2004). Creativity is also the importance of creativity in education but education is recognized and appreciation of creativity, education is do not understand (Kim, 2013; Nam, 2013). To find out the general awareness of the creativity in the education of these are out of

this study is the concept of creativity targeted pre-kindergarten teachers (Kim *et al.*, 2016). But the study also looks will need to analyze the concept of creativity in other fields.

Especially these days, there is education including science, technology, engineering, emotion, art and expression of creativity to be made in the area of individual competence in the various areas of convergence talent and future oriented (Kim, 2013). Thus, in the field of information technology and design arts to foster integration and human resources, it needs to be investigated on the perception of creativity.

The purpose of this study is to analyze the knowledge and structure of creativity to understand the concept of creativity of preliminary designers and preliminary engineers among university students. To be specific, it's intended to analyze the conceptual diagrams of prospective engineers and prospective designers about creativity to determine their knowledge of creativity and the structure of their knowledge to find out what knowledge made up for their ideas of creativity what concepts they properly understood and what concept they didn't in order to suggest some of the right directions for creativity education and lay the foundation for the development of creativity education programs (Kim *et al.*, 2015, 2016a, b).

In order to achieve such research objectives, the following research problems were set up. What are the contents of the creativity concepts of prospective engineers and prospective designers that appear in their conceptual diagrams? What are the levels of their knowledge of creativity concepts that appear in their conceptual diagrams?

## MATERIALS AND METHODS

**The subjects:** The subjects in this study were 60 randomly selected students at two different universities located in the city of Busan. Out of them, 30 students were prospective engineers who majored in media engineering and computer engineering at one of the two universities and 30 students were prospective designers who majored in fashion design at the same university and who majored in visual design at the other university.

**Data collection:** Small group interviews were conducted to ask them to draw up conceptual diagrams. After this researcher explained conceptual diagram and how to make it to the prospective engineers and designers, they drew up conceptual diagrams in the following order: First, they wrote down every concept that came into their mind about creativity. Second, they put more comprehensive and general superordinate concepts on the top and then subordinate concepts of Level 1 related to the superordinate concepts were listed under them. Third, the superordinate concepts were linked to the corresponding subordinate concepts by drawing lines. Fourth, additional subordinate concepts related to the subordinate concepts of Level 1 were listed under them and the concepts that seemed to be related to each other were linked by drawing lines. Fifth, connective words were written on the lines that linked the concepts in order to show how they were related. Whenever a new concept came into their mind,

they wrote it on a new notepad and put the notepad on what seemed to be the right location in the conceptual diagrams. There was no limit to the number of the concepts described by them and it took about 30 min to an hour for them to draw up the diagrams.

**Data analysis:** The collected data were analyzed based on earlier studies of conceptual diagrams including Dershimer (1993)'s study and Novak and Gowin (1984)'s study and according to the analysis methods used in (Lee., 2014)'s study. A statistical package PASW 18.0 was utilized to obtain statistical data on mean, standard deviation, frequency and percentile.

## RESULTS AND DISCUSSION

### **The contents of the conceptual diagrams on creativity**

**The contents of the conceptual diagrams of the prospective engineers:** Table 1 shows the superordinate concepts described by the prospective engineers. As shown in Table 1, the number of the superordinate concepts described by the prospective engineers was 165. When the concepts were categorized based on similarity, there were 19 superordinate concept categories. To be specific, "development" and "idea" were the most widely used concepts (15 times, 9.09%, respectively).

**The contents of the conceptual diagrams of the prospective designers on creativity:** Table 2 shows the superordinate concepts described by the prospective designers.

As shown in Table 2, there were 136 superordinate concepts that the prospective designers described about the contents of creativity. As a result of categorizing the concepts based on similarity, 19 categories of superordinate concepts were selected and "thought" was the most frequent concept that appeared 18 times (13.23%).

### **The knowledge level of the conceptual diagrams on creativity**

**The knowledge level of the conceptual diagrams of the prospective engineers**

**The characteristics of the superordinate concepts in the conceptual diagrams of the prospective engineers:** The hierarchy of the ten superordinate concepts that most frequently appeared in the conceptual diagrams of the prospective engineers was analyzed and the number of the subordinate concepts that belonged to each of the superordinate concepts was investigated as well besides, the saliency scores of the superordinate concepts were calculated (Table 3).

**Table 1: The frequency of the superordinate concepts in the conceptual diagrams of the prospective engineers on creativity of table**

The superordinate concepts	The similar concepts	Frequency (N)	Percentage
Development	Development (8), progress (2), patent (2), research (2), change (1)	15	9.09
Idea	Idea (7), ideas in the department of media engineering (1), unique idea (1)	9	5.45
Imagination	Imaginative power (5), imagination (3), thinking faculty (1), daydream (1)	10	6.06
Originality	Originality (4), novel (3), something unthinkable (1), something different (1), original (1), special (1), startup (1), something unusual (1)	13	7.87
Creation	Creation (3), newness (2), renovation (2), creativity (1), something new (1), making something out of nothing (1), novel (1), novel things (1), new (1)	13	7.87
Human	Human (3), talented person (1), genius (1), me (1), Seo min Gyo (1), cleverness (1), friend (1)	9	5.45
Science	Science (3), invention (2), IT convergence technology (2), IT convergence (2), convergence (1)	10	6.06
Inverse concept	Inverse concept (2), imitation (2), application (1), copy (1)	6	3.63
Thought	Thought (2) useless thoughts (1), the fourth dimension (1), sparkling (1), opinion (1), why (1), question (1), infinitude (1), novelty (1), chance (1), difference (1), outrageous (1), diverse (1), infinity (1)	15	9.09
Arts	Arts (2), experience (2), results (1), picture (1), product (1), creation (1), architecture (1), design (1), design (1), brand design (1)	12	7.27
Freedom	Freedom (2), life (1), daily life (1), money (1)	5	3.03
Future	Future (1), requirements of future society (1), future technology (1), revolution (1), improvement (1), dream (1)	6	3.63
Attitude	Insight (1), attention (1), agility (1), flexibility (1)	4	2.42
Media	Scenario (1), character (1), advertisement (1), cartoon (1), film (1)	5	3.03
Feeling	Difficult (1), tough (1), discomfort in daily life (1), inconvenience (1), repulsion (1), convenience (1)	6	3.63
Education	Character (1), college (1), educational background (1), activity (1), service (1), cognition (1), cognitive skills (1), necessity (1), employment (1), occupation (1)	10	6.06
Brain	Brain (1), IQ (1), aptitude test (1), IQ test (1)	4	2.42
Self-development	Ability (1), certificate (1), talent (1), ways of improvement (1), dexterity (1), possibility (1), success (1)	7	4.24
Others	CPCU (Creativity Personality Curation) (1), company (1), psycho (1), ×2 (1), gemstone (1), plus (1)	6	3.63
Total		165	100.00

**Table 2: The frequency of the superordinate concepts in the creativity conceptual diagrams of the prospective designers on creativity of table**

The superordinate concepts	The similar concepts	Frequency (N)	Percentage
Arts	Arts (8), artistic (1), intuition (1), expression (1), having to acquire a lot of experiences (1), experience (1)	13	9.55
Idea	Idea (7), question mark (2), exclamation mark (2), something momentary (1)	12	8.82
Thought	Thought (5), inspiration (2), open-mindedness (1), something different (1), brilliant idea (1), taking a new perspective (1), lots of thoughts (1), liberal thinking (1), unusual thought (1), different thought (1), new thinking (1), occurring to one's mind (1), something like seasoning for food (1)	18	13.23
Design	Design (4), color (2), clothes (1), cartoon (1)	8	5.88
Creation	Something new (3), creation (2), creative (2), newness (1),	8	5.88
Future	Dream (2), future (1), making a further progress (1), innovation (1)	5	3.67
Human	Talented person (2), gifted person (1), genius (1), designer (1), children (1), professor (1), being born with (1)	8	5.88
Self-development	Endeavor (2), self-development (1), self-confidence (1), what I have to do (1), growing (1), note (1)	7	5.14
Travel	Travel (2), observation (1), money (1)	4	2.94
Invention	Invention (1), discovery and invention (1), machine (1), shifting a viewpoint (1), observation (1)	5	3.67
Originality	Originality (1), my own unique thing (1), something unique (1), something different (1), something amazing (1) being differentiated from others (1), what everybody pursues yet not everybody tries to get (1), good solutions (1), startup (1)	9	6.61
Imaginative power	Imaginative power (1), imagination (1), something hidden (1), what can make me fly if it wants to do it (1)	4	2.94
Education	Study, knowledge is the basis (1), basis (1), humanities (1), assignment (1), goal (1)	5	3.67
Creativity	Creativity (1), individuality (1), imitation (1)	3	2.20
Feeling	Pleasant (1), interest (1), stereotyped (1), hard (1), something difficult to do (1), the best is doing without any preset plan (1), different (1), not easy (1), the same in form yet different somewhere (1), cannot control one's amazement (1), intuition (1)	11	8.08
Brain	Brain (1), human desires (1), head (1)	3	2.20
Creation	Creation (1), folding paper (1), what's helpful for drawing a picture (1)	3	2.20
Age	Age (1), country (1), competitiveness (1)	3	2.20
Others	Conversation (1), insurance (1), start (1), sleeping (1), the opposite of being fed up (1), de-constructivism (1) being concerned with character (1)	7	5.14
Total		136	100.0

Table 3: The characteristics of the superordinate concepts in the conceptual diagrams of the prospective engineers on creativity of table

The superordinate concept	Frequency (%)	No. of the subordinate concepts		Hierarchy		Saliency scores	
		M	SD	M	SD	M	SD
Development	15 (9.09)	5.08	2.79	3.08	1.31	0.26	0.14
Idea	9 (5.45)	5.50	3.93	3.00	1.41	0.24	0.12
Imaginative power	10 (6.06)	3.89	2.57	2.56	1.13	0.19	0.10
Originality	13 (7.87)	3.60	2.12	2.60	1.17	0.19	0.08
Creation	13 (7.87)	4.00	2.13	2.83	1.11	0.19	0.09
Human	9 (5.45)	3.88	2.30	2.63	1.30	0.20	0.10
Science	10 (6.06)	4.44	2.45	2.89	1.09	0.21	0.10
Inverse concept	6 (3.63)	4.25	3.40	2.50	1.29	0.12	0.07
Thought	15 (9.09)	5.00	3.78	2.58	1.38	0.21	0.15
Arts	12 (7.27)	3.60	3.13	2.20	1.13	0.13	0.07

Table 4: The density of the creativity conceptual diagrams of the prospective engineers of table

Engineer ID	Density	Engineer ID	Density	Engineer ID	Density
1	1.75	11	1.23	21	1.14
2	1.00	12	1.00	22	1.45
3	2.50	13	2.62	23	1.35
4	1.35	14	2.33	24	1.25
5	1.94	15	1.50	25	1.52
6	1.50	16	1.77	26	2.22
7	1.00	17	1.92	27	1.60
8	1.00	18	1.29	28	2.00
9	1.00	19	1.07	29	1.88
10	1.13	20	1.82	30	1.10

Table 5: The characteristics of the superordinate concepts in the creativity conceptual diagrams of the prospective designers of table

The superordinate concept	Frequency (%)	No. of the subordinate concepts		Hierarchy		Saliency scores	
		M	SD	M	SD	M	SD
Arts	13 (9.55)	4.57	2.77	2.71	1.14	0.24	0.11
Idea	12 (8.82)	3.89	3.34	2.20	0.94	0.24	0.18
Thought	18 (13.23)	4.00	2.65	4.15	1.30	0.30	0.25
Design	8 (5.88)	4.83	2.32	5.83	1.17	0.27	0.09
Creation	8 (5.88)	4.43	2.51	6.71	0.69	0.24	0.06
Future	5 (3.67)	4.25	1.71	3.00	1.41	0.21	0.12
Human	8 (5.88)	5.63	5.15	2.75	0.89	0.27	0.20
Self-development	7 (5.14)	5.67	5.79	3.67	2.08	0.27	0.14
Travel	4 (2.94)	2.67	1.53	2.00	1.00	0.18	0.08
Invention	5 (3.67)	5.00	2.45	3.20	0.84	0.22	0.18

As shown in Table 3, the number of the subordinate concepts was analyzed and the average of the subordinate concepts that belonged to “idea” was highest with 5.50 times (SD = 3.93), followed by “development” (M = 5.08, SD = 2.79) and “thought” (M = 5.00, SD = 3.78). As for hierarchy, the hierarchy average of “development” was highest with 3.08 (SD = 1.31), followed by “idea” (M = 3.00, SD = 1.41) and “science” (M = 2.89, SD = 1.09). Regarding saliency scores, the average of the saliency scores of “development” was highest with 0.26 (SD = 0.14), followed by “idea” (M = 0.24, SD = 0.012), “science” (M = 0.21, SD = 0.10) and “thought” (M = 0.21, SD = 0.15).

**The density of the conceptual diagrams of the prospective engineers on creativity:** Density refers to how much each category is organized in a hierarchical and integrative way in a conceptual diagram. Table 4 shows the density of the conceptual diagrams of the 40 prospective engineers. As Table 4 shows, the density of the conceptual diagrams of the prospective engineers ranged from 1.00-2.62.

### The knowledge level of the conceptual diagrams of the prospective designers on creativity

**The characteristics of the superordinate concepts:** The hierarchy of the superordinate concepts that most frequently appeared in the conceptual diagrams of the prospective designers was analyzed and the number of the subordinate concepts that belonged to each of the superordinate concepts was analyzed as well. In addition, the saliency scores of the superordinate concepts were calculated (Table 5).

As shown in Table 5, the number of the subordinate concepts was analyzed and the average of the subordinate concepts that belonged to “self-development” was largest with 2.67 times (SD = 5.79) followed by “human” (M = 5.63, SD = 5.15) and invention” (M = 5.00, SD = 2.56). As to hierarchy, the hierarchy average of “creation” was highest with 6.71 (SD = 0.69), followed by “design” (M = 5.83, SD = 1.17) and “thought” (M = 4.15, SD = 1.30). Concerning saliency scores, the average of the saliency scores of “thought” was largest with 0.30 (SD = 0.25) followed by

Table 6: The density of the creativity conceptual diagrams of the prospective designers of table

Designer ID	Density	Designer ID	Density	Designer ID	Density
1	2.33	11	2.09	21	2.07
2	1.45	12	1.60	22	1.41
3	1.23	13	2.60	23	1.40
4	1.00	14	1.26	24	1.70
5	1.40	15	1.62	25	3.42
6	1.00	16	2.00	26	1.25
7	1.10	17	1.41	27	1.10
8	1.33	18	1.31	28	1.00
9	2.25	19	1.80	29	1.33
10	1.00	20	1.37	30	1.00

“design” (M = 0.27, SD = 0.09), “human” (M = 0.27, SD = 0.20) and “self-development” (M = 0.27, SD = 0.14).

**The density of the conceptual diagrams of the prospective designers on creativity:** Density refers to how much each category is constructed in a hierarchical and integrative way in a conceptual diagram. The density of the conceptual diagrams of the 30 prospective designers is shown in Table 6. As Table 6, the density of the conceptual diagrams of the prospective designers ranged from 1.00-3.42.

## CONCLUSION

The findings of the study on the creativity knowledge level of the prospective engineers and designers can be summarized and discussed as follows: First, when the knowledge level of the prospective engineers and designers on creativity was analyzed using a conceptual diagram technique, “thought” was most frequently used in both groups. In other words, the prospective engineers and designers placed the most importance on “thought” in terms of creativity. In the conceptual diagrams of the prospective engineers, the number of the subordinate concepts that belonged to “idea” was largest and the hierarchy and saliency scores of “development” were highest. In contrast, the number of the subordinate concepts that belonged to “self-development” was largest in the conceptual diagrams of the prospective designers. “Creation” was highest in hierarchy and the saliency scores of “thought” was highest.

Second, the number of the superordinate concepts was 165 in the prospective engineers and 136 in the prospective designers. When the concepts described by the two groups were categorized based on similarity, they were classified into 19 categories, respectively.

Third, density refers to how much a category of knowledge is organized in a hierarchical and integrative way. As a result of analyzing the density scores of their conceptual diagrams, the density of the conceptual diagrams of the prospective engineers was between 1.00

and 2.62 that of the conceptual diagrams of the prospective designers ranged from 1.00-3.42. The density tended not to be high in the two groups. The findings imply that their knowledge of creativity was parallel and not integrated properly rather than hierarchical and well organized.

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