

A Study on the Effect of Students' Imagination by Utilizing the Creative Methods in Industrial Design Course

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ABSTRACT

The university students in departments of industrial design can perform quite well in design basis, practice courses, but their design thinking and imagination appear to be limited. The lack diversity and innovativeness may affect products they design. Therefore, incorporation of innovative theories and methods in design courses to stimulate students' imagination to enhance their performance can be an area worth examining in order to improve current design education. The purpose of this study is to investigate theories and methods that can be adopted in industrial design curriculum planning to stimulate imagination and analyze the effects on students' imaginations. Five experts, each with more than 10 years of experiences in industrial design, are invited to work with the research team to apply the contents of STEP Factors Analysis, Image Mind Map, TRIZ Method, Persona, and Scenario to design courses to be taught to second-year design class in a university for 18 weeks. There are 52 students and they are divided into two groups, 26 people each. The experimental group takes the courses designed to stimulate imagination and the control group the original courses. The experts use a 5-point Likert scale in which Vygotsky's imagination indexes are adapted to record the imagination each week. The results show that the group of using creative methods has better imagination at different design stages.

Keywords: creative methods, course design, design education, industrial design, imagination, students' learning

INTRODUCTION

As a consequence of the design industry becoming increasingly valued and the emergence of the concept of interdisciplinary design, the focus of design is no longer placed on functions and appearance only. The originality, user experience and even the spiritual connotation of a product are now highly regarded. Because of this change, design imagination has become an important drive behind R&D (Research & Development) and creativity in the design industry. Innovations and breakthroughs in all kinds of fields need imagination to lead to creative products with new contents and able to give new experiences (Liang, 2008). This is particularly true in the design industry where high-level creativity and innovativeness are needed (Liang, Lee, & Liu, 2016a). In addition, under the tendency of Industry 4.0, production processes and product life cycles will be shortened and products or services that can be replaced by robots and automation will cease to exist. Designers will have to use their imagination to improve the culture and story behind a product or service and give users new experiences (Hsu, Chang, & Lin, 2013). For example, in 2001 when design of portable music players was focused on CD layers, Apple already imagined making iPod, a creative product. Then, in 2007, the company came up with iPhone which exceeded people's imagination about portable phones (Isaacson, 2011).

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Contribution of this paper to the literature

- This study attempts to explore how to incorporate innovative theories and methods able to stimulate imagination to improve cultivation of imagination in design courses, even extended to the design and innovation industry.
- This study proposed a framework of the said course contents can serve as a reference in research and implementation of design education to stimulate the imagination of first- and second-year design students in university when they engage in practice work, so that these future designers can build up their soft power.
- The outcome of this study proves it is possible to improve students' imagination in different design stages by including various innovative theories and methods in design courses, especially in the early idea initiation stage.

However, design is a creative problem-solving process. Professional designers need to possess well-developed imagination to solve problems (Lawson, 2006; Smith, Kohn, & Shah, 2008). For this reason, discussion of how to cultivate design students to have the know-how and techniques to use their imagination systematically has become an important issue in the design industry and design education. Taiwanese design students have won many awards in international design competitions, but close examination of their design concepts shows there is still plenty of room for improvement in the user experience and originality of the products (Techbang, 2013) and whether a contestant can win an award has something to do with the viewpoints of the judges and angles of inspection (Meyer, 2016). Overemphasis on design competitions can reduce students' learning opportunities (Walden, Foor, Pan, Shehab, & Trytten, 2015). Presently in Taiwan, design departments in university stress more on basic design training and practice courses but lack courses that can stimulate imagination and innovativeness. As a consequence, they neglect the fact that cultivation of imagination is the source of creative energy of design students (Liang, Lee, & Liu, 2016a). In other words, current arrangement of design courses is not helpful in cultivation of design students' imagination and this is a problem urgently calling for research and improvement in design education.

In recent years, the application of imagination has expanded the influence area, such as mathematics and science and technology education also attaches great importance to the introduction of imagination in curriculum design and student participation (Caiman & Lundegård, 2017; Noel & Liub, 2017), especially in design area (Anderson & Priest, 2017; Madani, Moroz, & Makled, 2016). In the field of design, designers must learn mathematics and science and engineering professional knowledge and technology, but also need to cultivate humanistic qualities and aesthetic experience (Liang, Lee, & Liu, 2016b). The results of many studies show that the characteristics of theories and methods such as STEP factors analysis, Image Mind Map, TRIZ method, Persona and Scenario can facilitate to some extent use of imagination during early stages of design and initiation of original and breakthrough design concepts (Alexander & Maiden, 2004; Cagan & Vogel, 2002; Goodwin, 2009; Hsu, 2008; Yu, 2013). Nevertheless, there have been fewer studies on integration of these theories and methods in design course planning. The purpose of this study is to examine the influence of courses incorporated with theories and methods able to stimulate imagination on the imagination of students. In Chapter 2, the abovementioned theories and methods will be discussed to establish the contents of courses able to stimulate imagination.

LITERATURE REVIEW

STEP Factors Analysis Theory and Method

STEP factors analysis is an innovative method for product investigation and analysis during early stages of R&D process in Integrated New Product development (iNPD). First, the SET factors, Social trends (S), economic forces (E) and technological advances (T) are applied to initiate ideas and exploration (Cagan & Vogel, 2002). Then policy (P) is added as the fourth factor. Some studies have pointed out that policy is an important factor that has influence on the R&D directions in a country. At the beginning of product development, if designers can research and investigate through these four aspects, they will be able to establish a more comprehensive understanding of user needs and find the Product Opportunity Gaps (POGs). Vogel, Cagan, and Boatright (2005) have clearly defined the scope of each factor in STEP factors analysis: Social trends include the social and cultural trends in the past, present and future; economic forces are consumption changes in different economic conditions and the discretionary income of target clientele; and technological advances are all the items and contents associated with policy. Meanwhile, the results of related studies (Liang, Liang, & Chen, 2012; Vogel, Cagan, & Boatright, 2005) are sorted out in this study and the particulars of each factor are classified, as shown in [Table 1](#).

Table 1. The scope of the STEP factors

STEP factors	The scope of STEP factors
Social trends (S) The social and cultural trends in the past, present and future	Family and work, computers and the Internet, sports, leisure activities and health issues, entertainment industry, newspapers, books and magazines, and successful products
Economic forces (E) Consumption changes in different economic conditions and the discretionary income of target clientele	Econometrics, extra buying power, ability to purchase life-improving products and services, raw material costs, loan interest rates, stock market and fund fluctuations, consideration of who has the income, who will purchase and purchase for who
Technological advances (T) The latest technologies or reassessment of existing technologies	Research capacity in industrial, public and academic sectors, innovativeness in automated computation and electronic machine production, reduction and nanonization of integrated circuit dimensions, new materials and progress in production, technologies in entertainment industry, biology and chemistry
Policy (P) The capacity and policy enforcement of the government	All policy-related items and contents

Image Mind Map Theory and Method

British psychologist Tony Buzan invented mind map, a brain development method, and described in his book *Use Your Head* the mind mapping technique of applying illustrations of mental images and keywords to conceptualize thinking (Buzan, 2000). Mind mapping is like drawing a city map. The central theme represents an important idea and it is like the city center from which the main streets, representing the main thoughts, extend outward and the secondary streets connecting to the main streets are secondary thoughts (Buzan & Buzan, 1999). When all the thoughts interweave into a network, a complete mind map is created. When the radiant thinking pattern is combined with concept visualization, it allows humans to utilize the functions and potential of both sides of the brain effectively. In consequence, more new ideas can be produced, organized and applied in learning, work and any task in daily life to achieve great results (Buzan, Griffiths, & Harrison, 2013).

Use of mind maps has the following functions: (1) allowing learners to get a general idea of book contents and understand the general direction the book is intended to present; (2) guiding learners to find problem-solving directions and know the following steps to take; (3) helping learners to collect large amounts of information; (4) enabling learners to work or learn more efficiently; (5) making it possible for learners to read, visualize and remember better; and (6) improving learners' attention to think more comprehensively (Buzan, 2000; Buzan, Griffiths, & Harrison, 2013). The study by Yu (2013) indicates use of images in idea initiation, such as applying mind map images to present concepts, has the following advantages: (1) Visualized concepts can allow designers to make more associations; (2) images can stimulate others to come up with new concepts; (3) verbal and physical actions can be conducted synchronously; and (4) whether a designer is good at drawing or not will not hinder idea initiation with images. Therefore, use of image mind mapping to initiate ideas can help stimulate students' imagination to produce good concepts.

Teoriya Resheniya Izobretatelskikh Zadatch (TRIZ) Theory and Method

Teoriya Resheniya Izobretatelskikh Zadatch (TRIZ) is an innovative methodology proposed by the late Russian inventor and engineer Altshuller and his research team. Among more than two hundred thousand patents from different parts of the world, Altshuller identified over forty thousand as with innovativeness; all the others were merely modifications. He thought it would be possible to deduce the rules of innovative design based on these over forty thousand patents in order to upgrade designers' innovative thinking and problem-solving efficiency. Many studies suggest application of TRIZ, established by analyzing a large number of patented products to identify the problem-solving modes adopted, will enable industries to learn from the modes and improve their problem-solving ability to develop innovativeness (Liang, Liang, & Wu, 2012). The part of TRIZ that is more related to and more suitable in industrial design is the 39 features of the contradiction matrix and the 40 principles of problem solving (Hsu, 2008; Kao, 2005).

However, the 39 features of Altshuller's contradiction matrix and the 40 problem-solving principles are a bit complicated. When applying them in product innovation, industrial designers may find them difficult to understand and use. Kao (2005) invited a number of mechanical engineers and industrial designer to complete a Delphi questionnaire survey and, according to the results, made the 40 problem-solving principles more precise and easier to understand and apply for designers. However, Hue (2008) took a further step and extracted 13 features that were more suitable for industrial design and these features are more appropriate to be incorporated in design courses to stimulate students' imagination.

Table 2. The main steps and contents of Persona

Steps of persona	Contents of the steps
Preliminary work	Collecting data on the target clientele, the behavioral patterns of such people and the corresponding demographic variable
Screening	Arranging the data collected in the preliminary step to screen out important information and define the persona prototype
Constructing	Making the final definition of the persona prototype to sketch out the personality of the character and also other characters to be classified according to the level of interests before more details are supplemented to complete the persona

Persona Theory and Method

Persona is a research method often applied in the field of design. Literally, the word means a character in a play, novel, etc. and the method is usually used in combination with the lifestyle research method and Scenario. By executing Persona, designers can depict the target clientele more precisely. However, to make the characters of the target clientele more vivid, the characters have to be depicted in detail from the interior to the exterior to trigger viewers' identification and participation (Chen, 2010). Through such character depiction, details about virtual target users are first established. Then, products meeting the needs of such users are designed in accordance with these details. In other words, it is a user-centered design approach adopted to create product users first to assure there will be people buying the product once it is marketed in order to reduce the risk of development failure. For this reason, it can also be called a goal-oriented design method (Calabria, 2004; Hollon, 2008; Mulder & Yaar, 2006).

Meanwhile, Grudin, and Pruitt (2002) think Persona is a communication medium, a channel to understand users and acquire information about them. Hence, as long as the design team can establish correct personas, they will be able to interact with them and learn more about their needs. Persona can stimulate designers' creativity and assure product innovativeness can really hit the right target clientele. It is mentioned in a publication by Goodwin (2009) that Persona includes three main steps, as shown in [Table 2](#).

Scenario Theory and Method

Conventional systematic design modes are mostly developed from the designer's angle for functional purposes based on the relations between objects (Lin, Xiao, & Tu, 2006). Yet, in such design thinking, the difference in product cognition between the designer and the user is often neglected (Norman & Nielsen, 2010). Moggridge (2002) points out continual use of conventional methods to design products will impede the development of students' imagination and creativity; therefore, only by understanding the needs of users and inferring the tendencies and feasibility of products in the upcoming five years, will designers be able to come up with insightful products. According to the abovementioned arguments, Scenario is exactly the innovative design method able to meet such needs. When applying the Scenario method, the designer uses an imagined story to depict the characteristics of the user and the relations between the product and the environment during product development, and even simulate future scenarios when the product is used. In the end, these scenarios are applied again to simulate and analyze the interaction between people and the product (Alexander & Maiden, 2004).

In addition, use of the scenario method can also guide personnel from different fields participating in design activities to view the product from users' angle through visualization and actual experience to come up with ideas for the product, assess whether such ideas comply with the design topic and also observe how users interact with existing products and provide the information to help the designer make improvements (Gomoll, 1990; Willis, 2009). Verplank et al (1993) propose a design process for the scenario method and suggest it should be divided into four main steps, namely observation, character establishment, scenario and invention. The arguments in the aforesaid studies are sorted out in this study, as shown in [Table 3](#).

Table 3. The advice for inserting the scenario in design courses

Steps in the Scenario Method Contents of Design Process	
1. Observation	To understand the actual needs of users, observers have to watch how users interact with existing products and also find out different ways of use.
2. Character Establishment	When defining the characters in the scenario, the designer has to consider how to incorporate elements such as human behavior, expectations, etc. in the new design and define different types of users. The background of the character of each member of the target clientele has to be concrete, including age, gender, occupation, personality, interest or shopping habits, and so on.
3. Scenario	The interaction between users and the product in the target environment and various ways of product use are depicted in detail. The process of the scenario has to be chronological and a number of storyboards each with a text to tell the story are also needed. In addition, the story needs to include people, events, time, locations and objects to have a complete storyline. Normally, a scenario begins with a description of the interaction between the user and existing products and problems encountered before the change taking place after introduction of the new product is depicted.
4. Invention	Based on the scenario developed, a number of drafts are established to indicate different solutions to be the concepts for the new product.

METHODS

This study first applies the imagination-inspiring methods that have been commonly used in design or innovation to organize the planning and design of imagination courses after the process of sorting and analysis. And then, this study need to find a University have a department of design with many years of design teaching experience, and also have a complete design college to cooperate to confirm that the samples of this experiment are sufficiently representative and meaningful. Based on this research method planning, a university industrial design department with more 15 years of history was selected and the second-year undergraduate students were studied. The three following phases of study were carried out on a required product design practice course: observing students' use of imagination in class, recording the results of use of imagination and analyzing the statistics established.

Planning of the Industrial Design Course to Stimulate Imagination

Five industrial designers each with at least ten years of experience in the field were invited to form an expert group to work with the research team and make plans to incorporate innovative imagination-stimulating theories and methods, including STEP Factors Analysis (be used in innovational trends' exploration and inspiring imagination concept), Image Mind Map (be used to expand the design concept of quantity and quality of stereoscopic modeling and solutions), TRIZ Method (be used in development of systematic and logical specific design solutions), Persona and Scenario (be used to describe and imagine users' needs and situations), in the design course to be conducted for one semester, 18 weeks. The course framework was founded on existing industrial design practice courses, including stages such as first draft initiation, second draft initiation, draft refinement, engineering drawing and model production, and completion of the product precision mold and presentation board. The expert group then discussed and also made reference to actual needs and experiences in the industrial design field to incorporate the said innovative theories and methods in the course to stimulate students' imagination. The syllabus initially completed was tested through simulation and modifications were made in accordance with the results of repeated discussions. **Figure 1** shows the process of the research team and the expert group discussing and planning the course.

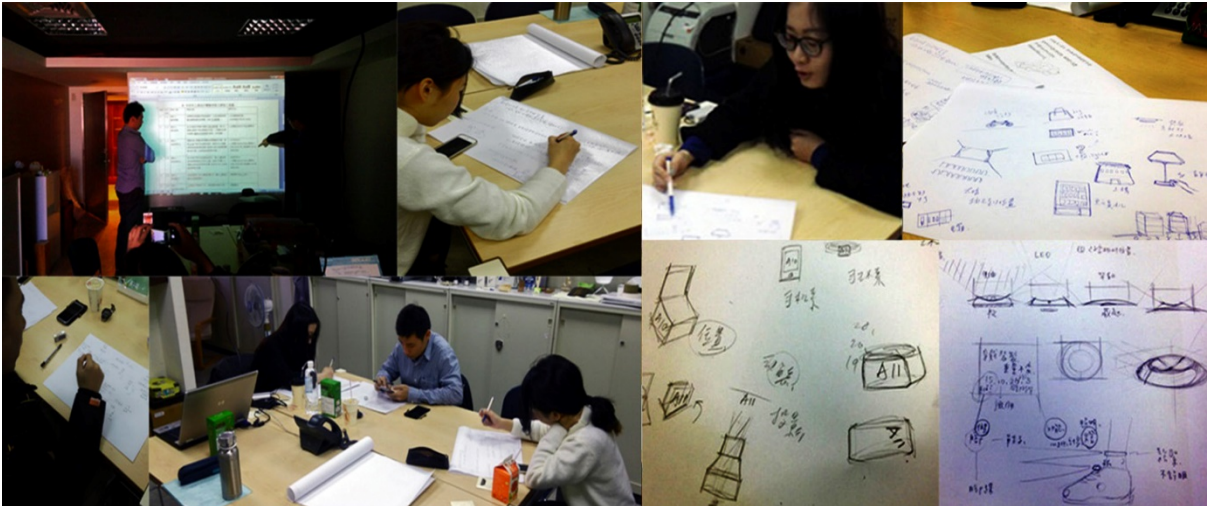


Figure 1. The process of the research team and expert group discussing, planning and designing the course

Recording of Experimental Teaching and Results of Students' Use of Imagination

The study was conducted on the second-year class of an industrial design department of a university. The participants are in a sophomore class and 52 students of industrial design in total. The class is observed five to six hours per week, depending on the class arrangement. In addition, the participants in the class were divided into two groups, each with 26 people. The experimental group attended classes in which the course designed to stimulate imagination was taught, whereas the control group took the original course. In this phase, the five experts continued to participate. They observed and recorded ten product design class sessions for one semester, 18 weeks (the time spent on explanation of class regulations, departmental evaluation and midterm and final examinations deducted). Each week the experts observed for five to six hours, depending on the class arrangement. They did not converse or interact with the teacher of students to assure the integrity of teaching and minimize external interference.

The imagination indexes proposed by Vygotsky (2004) in his studies and publications, including initiation, fluency, flexibility and originality, were adopted in the five-point Likert scale for evaluation of imagination and the experts rated and recorded the results of students' use of imagination in accordance with the said indexes. The ratings established each week were averaged and all the data were recorded for statistical analysis in the following phase of study.

Statistics on Results of Students' Use of Imagination

In this phase, the contents of observation and the recorded results established in the 18 weeks were quantified and analyzed to compare the results of use of imagination of the students in the experimental group and the control group. The main hypothesis was: The course designed to stimulate students' imagination has no significant influence on students' use of imagination (independent sample t-test).

RESULTS

Results of the Industrial Design Course Intended to Stimulate Imagination

After the research team and the expert group studied, tested and discussed, the 18-week industrial design course intended to stimulate imagination was divided into two stages, the first nine weeks and the second nine weeks. Innovative theories and methods established from review of related literature were incorporated in the course contents. The connection between the methods and the course is as shown in Table 4.

Table 4. The connection between the imagination-stimulating innovative theories and design methods and the design course

Items	Connection with the design course	Positive influence on imagination
STEP Factors Analysis	Examination of daily life aspects to identify future needs and tendencies	Exploration of and accumulation of sources of imagination
Image Mind Map	Conversion of initiated ideas into images systematically	Development of sources of imagination to create more imagination
TRIZ Method	Improvement of imagination and innovativeness of the product to be designed with innovative problem-solving principles	Development of sources of imagination to create more imagination
Persona	Definition of the looks of target users	Increase of imagination about user needs
Scenario	Depiction of the interaction between target users and the product to be designed	Increase of imagination about the elements of the product to be designed

Table 5. Planning of industrial design course contents to stimulate imagination—the first nine weeks

Week	Steps	Outline	Contents-1 (3 hours)	Contents-2 (3 hours)	Methods application
1	1-1	Problem observation	Description of first product design and performance of STEP Factors Analysis with students requested to discuss design problems based on daily life experience; each group (2-3 people) to come up with 30 problems	Initial discussion of the 30 problems	STEP Factors Analysis
2	1-2	Problem definition	Group report on 30 design problems and application of STEP Factors analysis; selection of 3 of the 30 problems after discussion with the teacher to serve as the basis of development; Image Mind Map introduction and case analysis (2-3 people a group)	Performance of actual work with Image Mind Map	Image Mind Map
3	1-3	Idea initiation	Group report on Image Mind Map contents with regard to the three problems; introduction of the 13 innovative problem-solving principles and case analysis; establishment of 30 design drafts	Use of the TRIZ Method to continue initiation of 30 drafts	13 TRIZ innovative problem-solving principles suitable for design work
4	1-4	Design initiation 1	Presentation and discussion of the 30 design drafts and selection of three drafts after discussion with the teacher	Development of two draft from each of the three drafts, six in total	Image Mind Map & TRIZ Method
5	1-5	Design initiation 2	Presentation and discussion of the detail designs of the six products from the six drafts; model production and description of examples	Selection of two drafts after discussion with the teacher to proceed with production of the initial models	practice
6	1-6	Model production 1	Presentation and discussion of the two initial models (modeling clay or PU)	Selection of one initial model as the final design after discussion with the teacher	practice
7	1-7	Model production 2	Presentation and discussion of the final design painted in white	Further detail modification and production	practice
8	1-8	Presentation board production	Contents of product presentation board and detail distribution	Presentation board production	practice
9	1-9	Product exhibition	General comments on product 1	General comments on product 1	none

Originally, the complete TRIZ Method contents were to be included when planning of industrial design course contents able to stimulate imagination was in progress in the first nine weeks. However, after trying the course, the experts unanimously thought the contents were too tedious and therefore difficult to be included in the course and suggested the 13 innovative principles proposed by Hsu (2008) for the design field would be more appropriate. The results of the work done in the first nine weeks are as shown in [Table 5](#).

The results of planning of industrial design course contents to stimulate imagination are as shown in [Table 6](#).

Table 6. Planning of industrial design course contents to stimulate imagination—the second nine weeks

Week	Steps	Outline	Contents-1 (3 hours)	Contents-2 (3 hours)	Methods application
10	2-1	Target clientele study and analysis	Presentation of the second design product and description of the Persona method and case analysis	Persona boards. Production of three Persona boards for the target clientele	Persona
11	2-2	Product study and analysis	Presentation and discussion of the three Persona boards and description of the Scenario method and case analysis	Performance of the Scenario method according to the Persona boards	Persona & Scenario
12	2-3	Idea initiation	Presentation and discussion of the three Scenario cases and initiation of 30 drafts based on discussion results	Initiation of 30 design drafts	Scenario
13	2-4	Design initiation 1	Presentation and discussion of the 30 drafts (selection of three drafts for further development after discussion with the teacher)	Selection of three drafts and development of two more based on each draft (six drafts in total) to present detail design	practice
14	2-5	Design initiation 2	Presentation and discussion of the six detail design drawings	Selection of two drafts to produce the initial models after practice discussion with the teacher	practice
15	2-6	Model production	Presentation and discussion of the two initial models	Selection of one model to be the final design after discussion with the teacher	practice
16	2-7	Prototype production	Production of the prototype of the final design and presentation and discussion of the result	Perfection of the prototype	practice
17	2-8	Presentation board production	Presentation board production and discussion 1	Presentation board production and discussion 2	practice
18	2-9	Product exhibition	General comments and exhibition of the works produced in the semester	General comments and exhibition of the works produced in the semester	none

Table 7. Teaching observation and design of imagination evaluation scale

Student Code	Evaluation of imagination (Index A~D) (5-point Likert Scale)							
	Week 2 Draft Initiation 1		Week 3 Draft Initiation 2		Week 4 Draft Refinement		Week 5-6 Model Production	Week 7-8 Product Precision Mold and Presentation Board
	Index A	Index B	Index A	Index B	Index A	Index B	Index C	Index D
a01								
a02								
a25								
a26								

(Index A = Initiation; Index B = Fluency; Index C = Flexibility; Index D = Originality)

Results of Observation of Teaching of the Imagination-Stimulating Design Course and Ratings of Students' Use of Imagination

The five experts used the imagination evaluation scale to record the design activities of the 52 students in the target class and the quantified data established covered the students' use of imagination in ten class sessions. The research team also filmed the process of each class session (Week 1 and Week 10 were the introduction; Week 9 and Week 19 were the presentation). After discussion with the expert group, the research team designed the imagination evaluation scale, as shown in [Table 7](#).

The results of this phase will serve as the data for statistical analysis in Phase 3. [Figure 2](#) shows the process of observation of teaching of the design course and recording of students' use of imagination.



Figure 2. The process of observation of design course teaching and recording of imagination ratings

Statistics on Results of the Imagination-Stimulating Design Course

In the light of the statistic data from imagination evaluating experiment, this study conducted a reliability analysis of the evaluation items. Firstly, the cronbach's alpha of experimental group are all with high reliability ($\alpha > 0.7$), respectively the step of draft initiation 1 ($\alpha = 0.89$), draft initiation 2 ($\alpha = 0.90$), draft refinement ($\alpha = 0.89$), and model production and presentation ($\alpha = 0.73$). Secondly, the cronbach's alpha of control group are all with high reliability ($\alpha > 0.7$), respectively the step of draft initiation 1 ($\alpha = 0.92$), draft initiation 2 ($\alpha = 0.88$), draft refinement ($\alpha = 0.93$), and model production and presentation ($\alpha = 0.87$). Base on the above statistical analysis results, the data that experts invited to evaluate in this study all have a high degree of reliability.

The statistical data on the experimental group (taking the imagination-stimulating course) and the control group (taking the original course) show that the students in the experimental group have better imagination in every stage of their design work, with the influence achieving a significant level ($p < 0.05$). The corresponding statistics are as shown in [Table 8](#).

Table 8. Statistics on the influence of the imagination-stimulating course on students' use of imagination

Items	N (total)	N (grouping)	M	SD	t	Sig. (two-tailed)
Experimental group—draft initiation 1: Initiation	52	26	3.25	0.66	3.974	0.000***
Control group—draft initiation 1: Initiation		26	2.55	0.60		
Experimental group—draft initiation 1: Fluency	52	26	3.44	0.79	5.970	0.000***
Control group—draft initiation 1: Fluency		26	2.26	0.62		
Experimental group—draft initiation 2: Initiation	52	26	3.27	0.80	4.257	0.000***
Control group—draft initiation 2: Initiation		26	2.47	0.53		
Experimental group—draft initiation 2: Fluency	52	26	3.32	0.96	5.480	0.000***
Control group—draft initiation 2: Fluency		26	2.16	0.50		
Experimental group—draft refinement: Initiation	52	26	3.14	0.71	5.063	0.000***
Control group—draft refinement: Initiation		26	2.24	0.57		
Experimental group—draft refinement: Fluency	52	26	2.92	0.82	4.385	0.000***
Control group—draft refinement: Fluency		26	2.07	0.56		
Experimental group—model production: Flexibility	52	26	3.32	0.76	3.178	0.030**
Control group—model production: Flexibility		26	2.67	0.72		
Experimental group—product precision mold and presentation board: Originality	52	26	3.31	1.04	2.595	0.013**
Control group—product precision mold and presentation board: Originality		26	2.72	0.54		

Table 8 shows that although incorporation of innovative imagination-stimulating theories and methods in design courses can have significant influence on students' use of imagination, the intensity of influence differs in different stages. From draft initiation 1 to draft refinement, the averages of ratings given according to imagination indexes are quite different. During the model production and product precision mold and presentation board establishment stages, however, the averages become closer (though the differences are still significant). This phenomenon can be explained. The imagination-stimulating design course contents designed by the research team and the expert group can indeed stimulate the students' imagination significantly during industrial design practice classes, especially in the earlier stages of initiation of design concepts. Nonetheless, whether there are better contents that can be included to enhance imagination stimulation will be a possible direction in further studies.

CONCLUSIONS

Imagination has been increasingly valued along with the growing demand for industrial design and product development experts and students in both the industrial and academic sectors. Design imagination is regarded an important indicator for industrial competitiveness in the future. Cultivation and training of design imagination used to be overlooked; therefore, how to incorporate innovative theories and methods able to stimulate imagination to improve cultivation of imagination in design courses has become a rather significant issue in design education. The outcome of this study proves it is possible to improve students' imagination in different design stages by including various innovative theories and methods in design courses, especially in the early idea initiation stage. This means use of such courses will help freshman and sophomore design students initiate design ideas when they are still not so proficient yet. They will quickly learn from such course contents the techniques and methods to exercise their imagination. Responding to the Introduction (Chapter 1) and literature discussed in the introduction, such results will support and improving the research problems, such as lack ability that can stimulate imagination and innovativeness, and the provided concepts still plenty of room for improvement in the user experience.

After the issues associated with stimulation and guidance of students' imagination in design education in university and the possibility of incorporating other contents are ascertained, course contents that can actually help cultivate and improve students' imagination are designed in this study. It is hoped that the framework of the said course contents can serve as a reference in research and implementation of design education to stimulate the

imagination of first- and second-year design students in university when they engage in practice work, so that these future designers can build up their soft power. More importantly, it is also hoped that the outcome of this study can make people understand fundamental research on imagination theories and teaching projects designed to stimulate imagination can actually improve the imagination of design students in university in Taiwan to make substantial contributions to the development of the industrial design industry in the future.

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