## A preliminary study on integrating design thinking into the high school education

Yi-Hwan Shyr \*, Yuan-Haw Cheng \*\*, Fei-chuan Chen \*\*\*, Chien-Chung Jeng \*\*\*\*

\*Associate Professor in Department of Industrial Design, National United University, yhshyr@gmail.com \*\* Department of Industrial Design, National United University, chengyuanhau@gmail.com \*\*\* Associate Professor in Graduate school of Technological and Vocational Education, National Yunlin University of Science and Technology, chenfj@yuntech.edu.tw \*\*\*\*Dept. of Physics, National Chung Heing University, asign@phys.gehu.edu.tw

\*\*\*\*Dept. of Physics, National Chung-Hsing University, ccjeng@phys.nchu.edu.tw

Abstract: Today, high school education still emphasizes division of education. Taiwan's education system has seriously advocated the concept of academic advancement. The long-term accumulation of indoctrination even causes deviation of the development of high school education in Taiwan and the worsening situation leads to the unemployment among the highly educated. Under the rapid changes in the social environment, companies need multi-discipline talents, and the cultivation of multi-discipline talents calls for general education in which the key lies in the design discipline. In UK, USA and many advanced countries, they have found the importance of the generalist education. Therefore, UK government set the Design and Technology courses as a compulsory one in their 1992 National Curriculum Programme. Students need to explore their own definition of the problem, learning assessment system thoughts and concepts, and use of technology to develop specific programs, or even complete prototype creation. The Industrial Designers Society of American (IDSA), in cooperation with the State Education Department, also put design into secondary school teaching. In the joint efforts of education sector and the design community, they have generated a lot of successful stories, such as Project Interaction of Katie Koch in New York City, Frog Design in Austin, Texas branch to promote Teach Design, etc., which have cast significant influences.

In this study, through the National Science Council (NSC) vision project, we attempt to develop design thinking into a high school education project plan in Taiwan. The case study method will be adopted through the analysis of successful stories and Delphi method of expert interview to set a clear core competencies and metrics for related course. And the major cases illustrate physical and art education curriculum for high school to explore the design thinking into the high school education.

The main purpose of this study is double-fold: (1) to explore the logics and theoretical basis of integrating design thinking into the high school curriculum; (2) to develop criteria for the cultivation of design thinking ability.

In this study, through case studies, we have reached the following three conclusions:

(1) Design thinking is human-centered, hands-on prototyping and other characteristics, the characteristics of the target application and high school courses in life match, and therefore can be integrated into the high school curriculum education and various fields.

- (2) Using design thinking to Integration into the high school education need to corresponding to the measure index of design thinking ability and the index for syllabus by Ministry of Education, find out characteristics in line with the applied life, people-oriented.
- (3) It is suitable to apply the eight measure index of design thinking ability for the curriculum intended curriculum planning and development

### Key words: Design thinking > Design Education > Design case study

## 1. Introduction

In the last thirty years, It is a serious advocate of "exam-oriented" for the education system advocating the testing standards to measure students in Taiwan. There are many parents and teachers, who are long-term ideological indoctrination to students, it caused the thinking direction of the students tend to coping the examinations of logical thinking. Therefore, student can't exercise creativity in the workplace and even lead to the highly educated unemployed serious situation in Taiwan society. Now, Taiwan has experienced a tremendous structure change of industry, over the past traditional manufacturing talent cultivation has been ineffective rapidly changing environment in today. Current industry needs not only professional skills of personnel, but also be able to have these people with Interdisciplinary human-oriented "design thinking". In the past, the ability of "design thinking" is dedicated to designer's thinking policy. But, in the knowledge economy era, the design and methods of thinking does not belong to designers, but universal core competencies. Therefore, how to develop student's ability to "design thinking" is very important, it is desperately needed to design energy to enhance industry for Taiwan.

The same education industry in advanced countries in Europe and America were also highly valued. Swanson (2000) thought about that rapid technological progress in most of the existing work will disappear within 15 years, Shaw (1997) believes that today's students learn in school during their professional skills will be just entering the job market would be outdated, Friedman (2002) even stated that the existing education were 50% of the transfer of knowledge will become obsolete in the next five years. Therefore, since the era of the knowledge economy, the United States and the European Union, a high degree of economic development of countries have realized the importance of secondary school science and technology education reform.

Above all, how to make the students have actively to find the key factors and the ability of knowledge creation solutions has become the national competitiveness in the face of globalization and the coming of knowledge economy era. But the "Interdisciplinary" talent cultivation is not a single course can be completed, it must be integrated thinking ability training as the center of the "liberal education" approach to training. This kind of learning process in order to develop comprehensive integration to solve the problem is the design.

## 2. Research purposes

The purpose of the present study is based on the successful cases in Europe and the United States to the improvement of Taiwan high school education. In this study, it will be presented to the National Science Council (NSC)-design into the high school science and technology education, the implementation of the National United University and Chung-Gang Senior High-school results. Expect to be able to integrate design activities into the

high school education. Expectations to enhance student through doing by learning understand and application of knowledge and cultivate people-oriented problem solving ability. Expect by this plan to implement, to find out the specific operating modes about the design thinking integrate into the high school education for the design education in our country.

The purpose of this research is to integrate the following three points:

- (1) To explore whether the design thinking can integrate into the high school curriculum?
- (2) To find a viable operating factors and mode, about integrate design thinking into the high school curriculum development.
- (3) Develop the measure index of Design thinking ability.

## 3. Literature Review

## 3.1 Design thinking

The innovation process is like a series of spatial overlap each other space, rather than a bunch of ordered steps (Tim Brown., 2010). The first phase of the design process is to identify important limitations, and then establish an evaluation framework. The design thinking is to create a successfully concept of three guidelines, anyone must consider important factors. Include: (1) feasibility: Application on the feasibility of the product function. (2) viability: Products may become the important part of sustainable business model in the company. (3) desirability: It valuable to the user, and



Figure.1 Three guidelines of design thinking

## 3.2 The case analysis

can captivated the hearts of users.

The mainly important case about integrate design into the science and technology education is in the United Kingdom and the United States. The major difference is that The integrated program attempts to UK, "Design and Technology" program of the National Curriculum (National Curriculum) as the core; The United States through folk-top design company combined with the State Government's Department of Education to integrate design into the science and technology experimental education. As follows:

### **United Kingdom**

In 1992 the United Kingdom to develop clear rules "Design and Technology" (Design & Technology, DT) is a required course in the Programme of the National Curriculum (National Curriculum). The high school students must choice technology category of personal design project to be completed in two years. Students need to explore their own definition of the problems in the real world, learning by thinking and assessment concept, and to use technology to develop specific programs, and to complete the creation of the prototype in the workshop.

## **United States**

Some design companies in the United States, the Industrial Designers Society of America (IDSA) pull strings with some of the State Board of Education will co-design into secondary school teaching. Following Project Interaction case, for example:

## **Project Interaction**

Initial in New York City Project: Interaction is a 10-week extra-curricular thematic course. Its purpose is use the design to improving the community. Students can learned some precious design skills in this plan. Through the curriculum, put the design thinking into a habit of technology. Such as: story-telling, interpersonal communication, creative thinking and problem-solving. The students are encouraged to pay attention to the problems associated with them, and propose feasible solutions, it is also enable students to design as a potential of opportunity or his career planning. Design through discussion of daily living environment through design workshops, specific examples and manual activities to enable students understand the concept of design thinking through this process.

## 4. Method

In this study, Case study is applied as a research method. Single or numbers of cases are selected as the subjects of study. By collecting multiple data and analyzing detailed contextual information, logic and rules could be revealed. Case study is a logical thinking process to provide the solutions for problems. (Gerring, J, 2004).

In this research process of this case is divided into three stages of design thinking into the school curriculum development:

- (4) The expert interview according to foreign successful cases and by the design thinking to develop training design thinking ability index.
- (5) Use the design thinking to plan high school physics and art curriculum.
- (6) Use the design thinking to operate a high school physics and art curriculum.

The case in this study we choose Chung-Gang Senior High-school (CGSH) as research object. To carry out the development of integrate design thinking into the high school curriculum, and to explore the actual import Curriculum Development and Practice planning. And the end of the project we will trying to find out the operable model.

## 4 Results and analysis

## 4.1 To set a definite " measure index of Design thinking ability".

To set a definite "design thinking ability evaluation metrics, through success cases data analysis and use the "design thinking" book for the expert interviews content. The significance of the eight measure index of Design thinking ability indicators are following the table. (as Table 1.)

Index	Definition
Human-Oriented Thinking	Any thoughts are not parochialism, but thinking user-center and their stakeholders.
Observation	Looking for the object of observation of their behavior context to users and the stakes are. So as to discover the real needs of their behind behaviors.
Empathy	Targeted to users and their stakeholders, and put yourself to try to figure out each other's feelings.

 Table 1. The eight measure index of Design thinking ability:

Insight	Further to find the context the behavior from the things surface, be able to analyze the relationship between people and products, and then extended to the analysis the relationship between people.	
The forward thinking?	Can use the brainstorming to find the solution to solve the problem. And can use the method of critical style to refine the solution, let the problem can be solved.	
Prototype Making	Best to make the concept concrete. Including: sketches, models, function simulation. The purpose is to give the idea a concrete shape, informed that the idea of the strengths and weaknesses, to determine the direction of the next step, and to make a more refined prototype for facilitate testing.	
Experience Design (Ability)	Fully understand the user's question, not only in the completion of a function is but also experiencing some experience. The emphasis on experience design force of design thinking necessary to create user thrilling experience. Including: Envision product function, understanding the user's feelings, and to continuous improvement.	
Story-Telling (Ability)	Makes the concept of problem-solving can be contextualize and meaningfully.The main function of story-telling ability including:Smoothly to verbal expression of the creative process.Writing smoothly to express the creative process.Persuasive expression.	

## 4.2 To design and planning of the integrated "eight measure index of Design thinking ability "

## into the high school "Physical" and "Art" courses.

Find the right entry point, through "the eight measure index of Design thinking ability" understanding the Ministry of Education's high school syllabus and the teaching goal. The following table shows the basic capabilities of the Index for Syllabus by Ministry of Education. (as Table 2.)

Title	identity		
Self-understanding and	By careers planning and exploratory courses to fully understand self-interest, aptitude and ability.		
potential- developing	Appropriateness of differentiation and development potential, and establish a confident that the formation of the correct values.		
Career planning and Lifetime learning	Actively unified whole careers information, make full use of social resources, play to their potential, establish the direction of Life development in response to changing social and environmental and culture of lifelong learning ability.		
Appreciation, manifestation, and Innovation.	To observe and appreciate the environment conservation, Culture and artistic beauty. Performance traits and potential use of surrounding resources. Positive innovation to enhance the quality of everyday life.		
Expression, Communication, and Sharing.	Effective use of the variety of symbols and tools to express self-thoughts, feelings and ideas. Can communicate with others, share information, experience or insights		
Respect, Care, and Cooperation.	Have respect for self, others, different ethnic groups, different cultures and different views of democratic maturity, caring for the community, the environment and natural. To comply the rule of law and organizations norms, and play to the spirit of teamwork.		
Cultural learning and International Understanding.	Understanding of the country and the world history and culture. Recognize the concept of the global village, cultivate their interdependence, mutual trust and mutual aid worldview		
The Application of information and technology.	To development of a proper, safe and effective use of information and technology. Through collecting, collating, analyzing, analysis, integration and using information to improve learning effectiveness and life quality.		
Aggressive exploring and	Stimulate the curiosity of learning and observation. Initiative to explore and		

research.	identify problems, and actively apply the knowledge to the discovery of the	
	innovation in the life.	
Independent thinking and	Learning to think independently, introspection and systematic judgment.	
problem-solving.	Make a habit, and can be an effective solution to the problem.	
Planning Organizing and	With planning and organizational skills. Through the hands and brain and with the	
A garaging Execution	principle of doing things with qunce ability to actively serve the people and	
Aggressive Execution	society.	

## High school physics course goals:

- Cultured the cognitive and interests of the natural sciences.
- Cultivate good scientific attitude, to familiarize them with the scientific method to explore the theorems, laws and problem-solving abilities.
- Realize the impact of science and the development of human life and the environment and its importance.

Inspire students the abilities of create and problem-solving.

## High School Arts curriculum goals:

- Understand the significance of the Art, functionality, value and its relationship with the social and cultural.
- Cultured the development of the imagination, creative performance, creation and the basic capabilities of appreciation.
- Cultivate interest in art, and rich aesthetic connotations, humanities accomplishment, and the value of life.

## The figure below shows is to find the appropriate entry point for practical operation mode. (Figure 2.1)

The eight measure index of Design thinking ability	The Index for Syllabus by Ministry of education:	New curriculum design
<ul> <li>Human-Oriented Thinking</li> <li>Observation</li> <li>Empathy</li> <li>Insight</li> <li>The forward thinking?</li> <li>Prototype Making</li> <li>Experience Design (Ability)</li> <li>Story-Telling (Ability)</li> </ul>	<ul> <li>Self-understanding and potential developing</li> <li>Career planning and Lifetime learning</li> <li>Appreciation, manifestation, and Innovation.</li> <li>Expression, Communication, and Sharing.</li> <li>Respect, Care, and Cooperation.</li> <li>Cultural learning and International Understanding.</li> <li>The Application of information and technology.</li> <li>Aggressive exploring and research.</li> <li>Independent thinking and problem-solving.</li> <li>Planning, Organizing, and Aggressive Execution</li> </ul>	<ul> <li>High school "Physical" courses</li> <li>Course A</li> <li>Course B</li> <li>Course C</li> </ul> High school "Art" courses <ul> <li>Materials/Documents to be Reviewed</li> </ul>

Figure.1 Three guidelines of design thinking

# In the study, it will be combined local resources with the high school physics course to design three experimental courses (as Table 3.):

Table 3 The new high school physics course

Course A	The course of the physical experiments "angle" combined with the high school facilities for flag station to enforce the rainwater collecting experimental courses and practical thoughts.
Course B	The course of the physical experiments "rotation " combined with the Life & technology experiments "energy" to enforce the wind speed measurement experiment courses and practical thoughts.
Course C	The course of the physical experiments "The reflection of light " combined with the Life & technology experiments "energy" to enforce the simple LED lighting design courses and practical thoughts.

In order to the high school students of the university entrance audition requirements, it includes three experimental courses in the new high school art courses. In the three courses, students prepared the reviewed documents by understand the target information from the target school. Learned who is the recipient for the prepared reviewed documents? What is the audition teacher want to see? Learn to observe and understand the context and stakes. They will learned the measure index of Design thinking ability: People-oriented, Empathy, and the Insight.

## 4.3The result of the operation, use the new high school physics course B for example:

In experimental courses of the new high school physics courses B, Students are executing the experiment of wind speed measurement (shown in Figure 2) Teaching through the experimental combination of environment, students are fully aware of the environmental characteristics of the local. In the course they will learned the measure index of Design thinking ability: People-oriented, Insight and forward thinking. Through their own life: Continuation of the flag platform redesign "application. In the concept of students, they think the small wind generator can be erected above in the flag platform. To produce electricity for the flag platform of LED lights as night lighting. (shown in Figure 3)



Figure.2 wind speed measurement



Figure.2 Small wind generator

## The possible modes of operation for integrated " Design thinking " into the high school courses.:



## 5. Conclusions

Through the education experimental teaching in integration design thinking into the physical and arts curriculum, Students through doing by learning to study scientific and technological knowledge, and application of knowledge to practice, let the Design fills the entire course. The one hand, to enhance the student's emerging technological literacy, the other hand, to enhance students the concern of the environment and people. The task of this study is to put the design into the purpose of education.

Though the case study, we have reached the following conclusions:

- (4) Design thinking is human-centered, hands-on prototyping and other characteristics, the characteristics of the target application and high school courses in life match, and therefore can be integrated into the high school curriculum education and various fields.
- (5) Using design thinking to Integration into the high school education need to corresponding to the measure index of design thinking ability and the index for syllabus by Ministry of Education, find out characteristics in line with the applied life, people-oriented.
- (6) It is suitable to apply the eight measure index of design thinking ability for the curriculum intended curriculum planning and development

## Acknowledgments

The authors would like to thank the National Science Council, Taiwan for research resources supporting this research under Contract NSC 101-2514-S-239-002.

## 6. Examples Citations

- [1] Brown, T. 2010, Change by design: How design thinking transforms organizations and inspires innovation, Linking Publishing, Taipei, Taiwan.
- [2] Bilton, N. (2010). I Live in the Future & Here's How It Works: Why Your World, Work, and Brain Are Being Creatively Disrupted. New York: Crown Business.
- [3] Friedman, K. (2002, April). Design curriculum challenges for today's university. 2002 RCA Design Education Conference: Enhancing Curricula-Exploring Effective Curricula Practices in Art, Design and Communication, London.
- [4]Swanson, G. (2000). Is design important? [Online]. Reinventing design education in the university. International design education Conference. Retrieved July 22th, 2011, from http://www.humanities.curtin.edu.au/html/des/DesEd2000/preconference04.htm

[5]Shaw, J. (1997). Design education's paradox: is it to lead or to follow? A commentary on After School-a discussion of design education: parts one and two. Curtin School of Design Journal, 4.

[6]Project: Interaction. Retrieved September 26, 2010, from http://urbanomnibus.net/2010/09/project-interaction/

[7]Gerring, J. (2004). What is a case study and what is it good for? The American Political Science Review, 98(2), 341-354. Retrieved from http://search.proquest.com/docview/214412110?accountid=8011