DESIGNERS ARE MAKERS: INTERDISCIPLINARY CURRICULUM IN A DIGITAL DESIGN STUDIO

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ABSTRACT:

This paper intends to explore how to integrate interdisciplinary teaching in digital design studio. This paper concludes a teaching framework of interdisciplinary curriculum in digital design studio through three years teaching experience. "Designers are Makers" is the main concept in the interdisciplinary curriculum, students are trained to become a maker who can integrate interdisciplinary knowledge, and making creative things by using digital tools. A cycle process of Learn -> Make -> Share is applied in the interdisciplinary digital design studio.

Keywords: Makers, Interdisciplinary curriculum, Digital Design Studio

1. INTRODUCTON

"Learning by doing" is the main teaching method in design education. Students enable to accumulate design knowledge, skills and experience through the process of "making" and problem solving. Currently, many industries have been designed toward interdisciplinary cooperation mode of operation. However, there is lack of interdisciplinary teaching methods in design education. Therefore, interdisciplinary curriculum become an important issue in design education. (Tang and Lin,2011)。

In addition, "Maker Movement" is a trend lately due to the general application of digital design tools. The use of digital fabrication in education has gained a growing popularity in university and schools (Blikstein, 2013). This trend encourages design students to learn interdisciplinary knowledge, such as mechanical engineering, electronic circuit (Arduino), and CAD / CAM fabrication techniques. It is believed that educational approaches embedded with "making" and digital fabrication could foster inventiveness and creativity. This educational approach has been empowered by the recent development of low-cost digital fabrication tools (Gershenfeld, 2007) as well as the open-source Arduino board.

2. OBJECTIVE

This paper explored methods of teaching interdisciplinary topics in a digital design studio. To achieve more efficient interdisciplinary design teaching methods, an interdisciplinary curriculum for use in the digital design studio, which was used for three years, was introduced. Through this curriculum, we analyze and explore how to guide the design

students entering engineering threshold and train them to effectively understand, absorb and gain knowledge from other disciplines. Finally, they can implement the integration of engineering and design in their creative works.

3. TEACHING METHOD

"Designers are Makers" is the main concept in our curriculum, and students were trained to be "makers," those who can integrate interdisciplinary knowledge in creative designs using digital tools. In the digital design studio, an interdisciplinary curriculum was applied based on the three main ideas proposed by the "Maker Movement": Learn, Make and Share. This interdisciplinary curriculum was supported by the basic technical courses: 1. Digital Fabrication (CAD/CAM), 2. Interactive Design (Arduino), and 3. Mechanical Design (Figure 1)

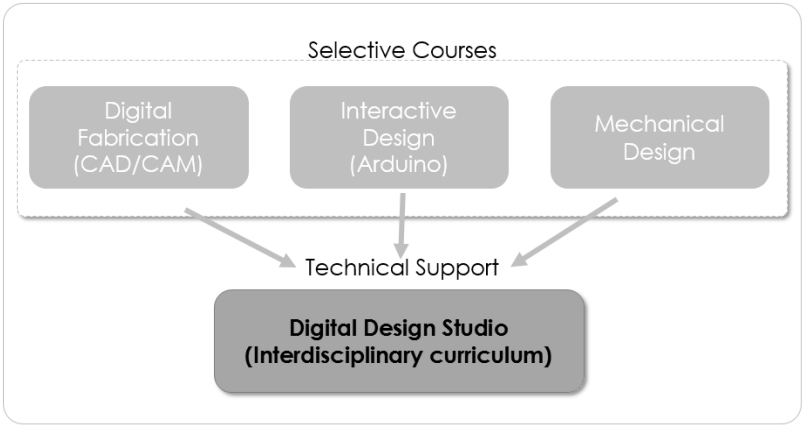

Figure 1: Interdisciplinary curriculum is supported by three elective courses.

3.1 FIRST YEAR TEACHING EXPERIENCE

This interdisciplinary curriculum was used in a design studio for second-year students in the Department of Art and Design at YuanZe University for three semesters. There were 12–15 students in the studio each semester. This interdisciplinary curriculum was first introduced in a design topic in the spring semester of 2008. The given design task was "An interactive design object for better daily life." To become interdisciplinary "makers," students were required to comply with the following principles:

- Learn: by participating in an extra technical workshop.
- Learn: through a case study.
- Make: multiple models (mechanical model, form, structures) every week.
- Make: a full-scale model for the final project.
- Share: by posting the design process on the course blog every week.
- Share: by including the final model in the Exhibition.

The lecturer spent four weekends in the extra workshop teaching students mechanics, digital fabrication and Arduino. It was a technical mini-workshop, which lasted for 4–5 hours every week (Figure 2). In this mini-workshop, a modular technical teaching method was adopted: "Arduino interactive modules" (Figure 3). These modules were used to simplify learning

Arduino electronics. Schematics and circuits were introduced in four modules, and students used a combination of different modules and changed the parameters based on design conditions. The aims of the technical workshop emphasized design implementation rather than technical issues.

Figure 2: Technical mini-workshop.

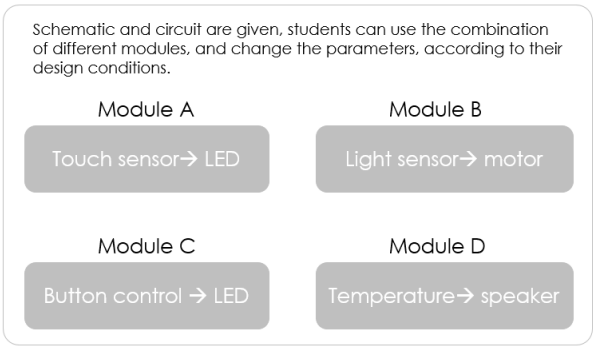

Figure 3: "Arduino interactive modules".

Students presented multiple design models and digital drawings in class and posted their design process on the course blog every week (Figure 4). The interdisciplinary design studio was completed in two months. There were 10 full-scale interactive design works completed in the studio and presented at the off-campus exhibition (Figure 5). The course outcomes were satisfied, and this confirmed that the interdisciplinary digital design teaching method could be used with second-year students. However, the students were exhausted by the intensity of this design studio, as they learned interdisciplinary knowledge in very short period and solving the technical problems took a lot of time. Furthermore, due to time restrictions, the implementation of mechanical designs in the studio was limited.

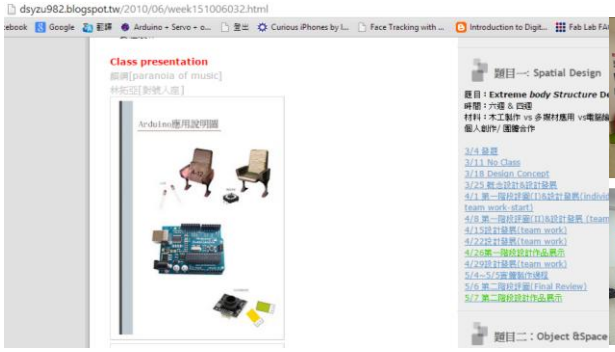

Figure 4: Course blog.

Figure 5: Full-scale interactive design exhibition.

3.2 SECOND YEAR TEACHING EXPERIENCE

Based on the first-year experience and student feedback, the interdisciplinary curriculum in a digital design studio was applied in second year. We developed an elective course, Digital Fabrication, to support the studio. An addition to the course was visits by experts, who were invited to give a talk and share with the students. The design topic was "Biomimicry Structure Design" for this semester. The "Designers are Makers" training principles were modified to the topic as follows:

- Learn: by taking the elective course (Digital Fabrication) and listening to the experts' talks.
- Learn: by listening to TED talks and giving a brief presentation every week.
- Learn: through a case study.
- Make: multiple models (mechanical model, form, structures) every week.
- Make: a full-scale model for the final work.
- Share: by posting the design process on the course blog every week.
- Share: by including the final model in the Exhibition.

Students were more familiar with the use of digital fabrication in the model-making process due to the support offered by the elective course. In the Digital Fabrication course, they learned to use CAD/CAM digital tools, such as Grasshopper, the laser cutter, CNC, 3D printer and 3-D scanner. Figure 6 shows the designs produced by the class. In addition to the course contents, students were encouraged to learn individually online through "Learning by TEDtalks"; students were required to listen to TED talks, give a brief presentation every week, and share on the course blog weekly (Figure 7). Figure 8 shows the 12 completed designs that met the qualifications for the biomimicry concept and the high-quality full-scale models. Student work was presented at an off-campus exhibition (Figure 9).

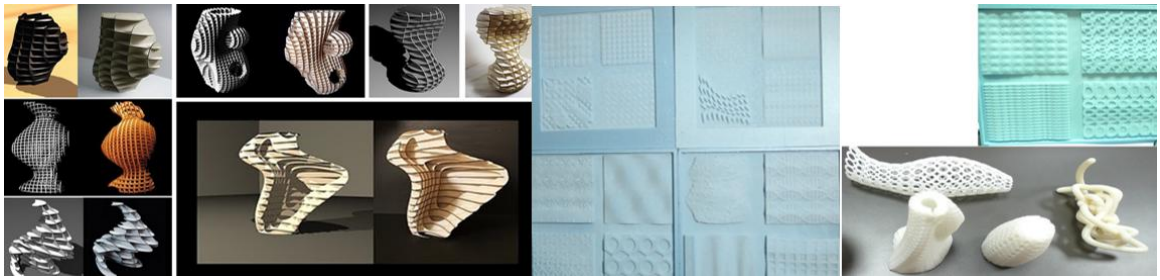

Figure 6: The outcomes of the elective course: Digital Fabrication.

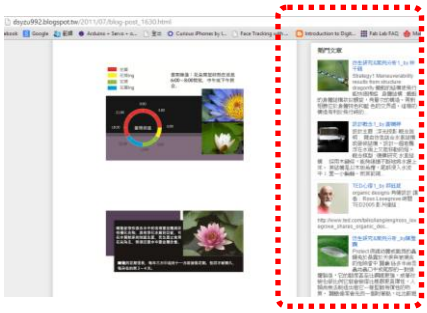

Figure 7: Share TED talks on the blog.

Figure 8: Design outcomes

Figure 9: Exhibition

The implementation of CAD/CAM digital fabrication in model-making enhanced students' abilities. In addition, students attempted to design mechanical elements to allow the models to move to match the biomimicry concept. However, only a few of the designs were created using Arduino in this semester. The sharing of TED talks every week in the class and blog enhanced the interest and motivation for interdisciplinary learning. The exhibition encouraged students and increased their confidence.

3.3 THIRD YEAR TEACHING EXPERIENCE

The improvements in the interdisciplinary curriculum in the second year allowed the program to continue for a third year. To train students become comprehensive interdisciplinary "makers," three elective basic technical courses were offered: 1. Digital Fabrication (CAD/CAM); 2 Interactive Design (Arduino); 3. Mechanical Design.

The design topic for the third year was "Form and Mechanism Interactive Design: *from Da Vinci to Design.*" Students were asked to design an interactive object inspired by Da Vinci's mechanical designs or theories. Some Da Vinci mechanical and Automata toys were used as teaching aids, which allowed students to explore their mechanical operations (Figure 10). The "learning by playing" teaching method was used in the studio as well and this enhanced the efficiency of interdisciplinary learning. The Arduino technical course used the previous modular technical teaching method, "Arduino interactive modules" (Figure 2), and was extended to more advanced and implementation-oriented teaching. Some easy-to-use programming tools, such as Scratch (Resnick et al., 2009) and NetLogo (Wilensky, 1999), were taught; students learned by developing fun assignments in teams (Figure 11). We noticed that teamwork enabled students to solve the technical problems quickly and enhanced learning effectiveness, especially in the technical courses.

After taking the elective courses and implementing the knowledge gained in the digital design studio, students presented more complete and integrated design projects, as shown in Figure 12.

Figure 10: Teaching aids: Da Vinci mechanical and Automata toys.

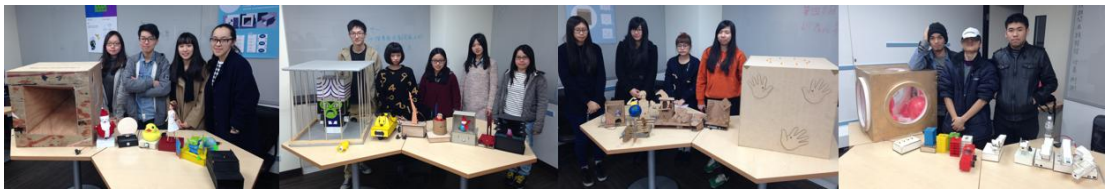

Figure 11: The outcomes of the selective course: Arduino Design (team work & fun assignments).

Figure 12: The outcomes of the interdisciplinary digital design studio.

From the outcomes, it was clear that the students already familiar with mechanical theory and operations and found it easier to implement into their interactive designs.

The "Designers are Makers" training principles in this semester was modified as follows:

- Learn: by taking the elective course (Digital Fabrication, Interactive Design, and Mechanical Design) and listening to the experts' talks.
- Learn: by listening to TED talks, giving a brief presentation every week and taking advantage of network learning opportunities on Google, YouTube, or other internet resources.
- Learn: through a case study.
- Learn & Make: by playing through making toys.
- Make: multiple models (mechanical model, form, structures) every week.
- Make: a full-scale model for the final project.
- Share: by posting the design process on the course blog every week and in discussions with the Facebook community.
- Share: by including the final model in the Exhibition.

4. INTERDISCIPLINARY CURRICULUM IN DIGITAL DESIGN STUDIO

Consequently, from these experiences, we propose the following teaching framework for an interdisciplinary curriculum in a digital design studio.

1. LEARN

a. Internet learning (TED talks, YouTube, Facebook, Google)

b. Case study stimulus

c. Expert talks

2. MAKE

a. "Making" begins at "playing" (Da Vinci mechanical or Arduino toys as teaching aids)

b. Easy-to-use tools: Scratch, NetLogo, Grasshopper

c. Teamwork to solve problems

d. Fun assignments (interest design topics)

e. 1:1 full-scaled work

3. SHARE

a. Community sharing and discussion

b. Reviews of experts

c. Blog

d. Exhibition

The Learn->Make->Share curriculum described is not only linear but is also a cyclical process. We received positive responses and comments from both engineering and design experts/professors in the studio reviews and exhibitions. In addition, the feedback from students indicated that the program was gradually accepted and an interest in interdisciplinary learning was developed. Therefore, the cross-disciplinary curriculum described in this paper can be the basis for teaching interdisciplinary design courses.

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