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A Study of Design Thinking Adaptation for Maker Education Process

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Abstract: Recently, the Maker Movement has attracted more attention and has been one of the fastest-growing topics, due to contemporary technical and infrastructural developments. In this paper, we described a design thinking framework in Maker course through the 3D printer. In a case study of the public course in a university in Beijing, the students' creative process was trained and developed through learning and using design thinking. The future work is to construct an efficient framework for Maker education and to evaluate whether the design thinking is effective to cultivate and improve creative thinking.

Keywords: Maker education, design thinking, course design, 3D printing

1. Introduction

In the past few years, the Maker Movement represented a growing movement of hobbyists, thinkers, engineers, hackers, and artists committed to creatively designing and building material objects for both playful and useful ends. The rapid growth of this movement derived from advances in technology and new digital fabrication technologies that allowed the appearance of tools such as wearable computing e-textiles, robotics, 3D printing, microprocessors, and programming languages. Researchers proved that making, playing, building, and interacting with the real world were valuable ways of learning(J. Piaget, 1950; L.S. Vygotsky, 1978). There were growing interests among educators in bringing making into K-12 education to create more opportunities for students to engage in design and engineering practices. Nowadays, the Maker Movement plays an important role both inside and outside classroom, showing that it could be a part of classroom for offering a pattern of stimulation(A.R. Basawapatna, A. Repenning, C.H. Lewis, 2013; Kafai & Vasudevan, 2015; Searle & Kafai, 2015), and a part of outside activities, such as summer camps and libraries(Telhan, Kafai, Davis, Steele, & Adleberg, 2014), demonstrating that learning is feasible in any environment as long as it is well organized.

However, courses based on the Maker movement face with a series of problems such as lack of educational approaches, teaching and learning methods, and in-depth analysis of the effects. There is a need to understand how students can best utilize Maker movement strategies to achieve better learning goal, to bring up an impact on instructional approaches and lead to a more effective way of teaching and learning. In this study, we aimed to describe a design framework for the Maker course and activities by utilizing the 3D printing.

2. Framing Design thinking in Maker Course Design

Design thinking can be considered as a human-centered, creative, participative, exploratory and problem-solving process that values different perspectives of a problem(Brown, 2008; Dunne & Martin, 2006; Melles, G. and Misic, V., 2011). In our research, we adopted the Standford d.school process of design thinking which included empathize: to understand our users; define: to define clear project objectives; ideate: to explore ideas and solutions; prototype: to build and visualize ideas and solutions; test: to review and decide. The design action plan is an iterative process, and there are deliverable outcomes and worksheets of each action phase which will give students a point of reference when they

go through the process of iteration. In our research, students learn to adapt the design process for their product.

Technology enthusiasts belonged to the Makerspace movement often use communal space equipped with multiple 3D printers, laser cutters/engravers, and CNC machines. Now there is the recent availability of low-cost 3D printers, which permit ‘‘ordinary’’ users to create their objects at school and home. A variety of provocative research efforts in bringing 3D printing (and fabrication in general) into classrooms, have been or are being pursued(Glen Bull, Cleb Maddox, 2010).

The purpose of our study is to foster the learner’s creative thinking and design thinking experience of the product design by 3D printing in the Maker course. We focus on whether such a concept is suitable for university curriculum model, what problems will exist, how to design, and how do students experience design thinking within the product design and development, these are our investigation points.

3. Research Design

3.1 Setting and Participants

Participants (n=20; 60% females) were undergraduate students from different majors, and they were randomly separated into five groups. Students worked collaboratively to create and research maker topics under a project-based setting. The classroom layout was changeable with the movable desks and chairs, 3D printer, Arduino and wireless network work in it. They were all in one instant messaging group. All the participants in this group can share texts, graphs, audio, video, and other files.

3.2 Course Activities and Data Collection

In order to enable students to experience the maker activities effectively, we adopted the design thinking which included empathize, define, ideate, prototype and test in our course. The Course consisted of seven sessions, which includes Introduction and Maker education, Introduction of 3D printing and design thinking, SketchUp, Arduino, APP Inventor, Case study, Maker project. Participants were expected to expand at least 4 hours in a week for each session. In the final assignment, groups were required to submit a record file, including as follows: the previous group discussion records, design documents, previous prototypes’ iteration instructions, and ultimate digital artifacts and entities, personal summary, and group presentation videos. This study adopted a mixed-method approach to collect and analyze the following data: classroom observations, digital artifacts & entities, survey and individual student interviews.

4. Findings & Discussion

4.1 Class Engagement, Course Satisfaction and Reflections

The class was very lively interesting, and students were enthusiastic about it. It was delighted to see students learning fast, accepting the technology and methods very well. Some students had lots of creative ideas, and they obtained projects from the university financial Support. They said they would continue to follow the theme.

The survey aimed to analyze the students’ satisfaction with the course. All the items were about attitude on the instructional method and software application. It is found that most of the students (more than 90%) strongly liked the design thinking integrated into the course and their project process, and more than 67% to 80% strongly agreed that the learning strategies learned in the class would help them to learn better.

Student interviews offered details on the creative work in the design and development of 3D artifacts. They had a deeper understanding of the basic knowledge of 3D printing, open source hardware principles and categories, app mobile terminal development. Almost all students were able to

understand combination and complimentary about one of the design thinking core concepts (user ideas, empathy) and the Maker movement or activities (users' ideas could make activities more targeted).

4.2 Artifacts

At the end of the semester, each group created a product with the using of 3D printing and design thinking, and these artifacts were very creative and interesting, that include Kingfisher craft, The EclipticnArmilla, Teaching aid tools, Lamp of doom, and Three-dimensional globe.

5. Conclusion

The current research employed design thinking to develop a framework of the Maker education in 3D Printing. The main contribution of the research was multifold. First, through the combination of learning and practice, students had a good grasp of the content of 3D printing, open source hardware, and had a deep understanding of Maker spirit and idea. Second, design thinking framework was an effective teaching and learning for the 3D Printing curriculum. Third, design thinking can effectively help Makers create their projects and products, and the switch between divergent thinking and convergent thinking facilitated people get more logic and innovative ideas. In the future, we will construct an efficient framework that can integrate the Design Thinking into K-12 Maker education, and consider how to evaluate whether the design thinking in education is effective to cultivate and improve students' creative thinking

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