

A Case Study on the Development of Pre-Service Teachers' Design Thinking

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Abstract: This study aimed to understand the learning effect of design thinking activities of college students in an undergraduate class. The results showed that after experiencing the design thinking activities, the participants successfully created their course product (i.e., online learning courses in the prototype form) through online discussion, reflection and peer feedback under the guidance of knowledge-building pedagogy. It is also found that students had a slightly improved gain in terms of technological pedagogical content knowledge & technology-integrated design knowledge and their design belief of teachers.

Introduction

Design thinking, a praxis model of learning by doing, has recently been recognized as an effective teaching and learning strategy. In the present study, design-thinking activities under the guidance of knowledge building pedagogy was found to facilitate students' design of a course project/product, i.e., an online course in the form of a prototype (Toshiaki, 2013) and to help them develop creativity in an integrated, cross-disciplinary manner (Goldman, Estrada, 2016). Not only were the learners able to collaboratively build new knowledge by addressing a challenging, ill-structured design problem together in the knowledge building community, but they were also benefited from improving their integration ability that is required as a part of their pre-service teacher preparation and training program (IDEO, 2017).

Online learning has been an important part of the K12 landscape in Taiwan, but the field still has some issues to be further researched. For instant, most of the online learning content in Taiwan are decontextualized; as such, what is learned online can easily become inert knowledge. To address this issue, teachers can strengthen their design knowledge and design thinking capacity to guide students to use learning material and content more authentically and meaningfully to solve some real-life tasks. Previous research has claimed that learning together as a community, effective use of discussion, group reflection, and peer feedback can greatly help improve learning outcomes (Jim, 2010). By incorporating and implementing these activities together into a design cycle, this research is trying to examine the effect of design thinking activities, as guided by knowledge building pedagogy, on students' TPACK and design beliefs.

Method and data

This case study adopted a design research method with two design iterations. The experiment was carried out in an authentic environment without a specific control group. The participants were 38 teacher-education students who took a course in a Taiwan's university concerning the use of educational media for education. Students were randomly divided into 10 groups (each group containing two to five persons). They were then asked to work collaboratively to develop an online learning course which should at least contain three class time periods, and should include contextualized learning content for their target users/learners to learn independently online without teacher aid. In the entire semester, design thinking activities, with the guidance of knowledge building pedagogy, were adopted as the main instructional activities in the course. There was also a mid-term and a final-term presentation for students to test their designed online course as a prototype and to give feedback to one another so as to improve one another's prototype design. For data analysis, students' online interactions and the process of their design thinking were analyzed using coding schemes progressively emerged from data (open coding) with the help of the software NVivo 12. Then, a descriptive statistic was calculated within each of the groups. Moreover, two seven-point Likert-scaled questionnaires (i.e., Technological Pedagogical Content Knowledge, & Technology-Integrated Design Knowledge and Design Belief of Teacher; both Cronbach alpha >.90) were employed before and after the course and then a t-test was performed.

Results

The implementation of this research was based on a course that required class students to design an online learning course in a prototype form. As such, the participants need to work in teams and discuss their design project in an

online forum called Knowledge Forum (KF). The KF can auto-record the entire process of all online activities. To analyze the online logs, firstly, it was found that the participants' action of the note-reading ($M=505$, $SD=241.15$), note-revising ($M=133.3$, $SD=114.37$), note-creating ($M=39.3$, $SD=11.91$) showed a good design pattern that supports user-centered learning after repeated modification via within-group revision and between-group idea-exchange. Secondly, the results concerning the groups' design thinking activities showed progress at each of the activity stages (see Fig.1, left), including empathy ($M=5.06$, $SD=0.90$), define ($M=8.53$, $SD=2.19$), ideate ($M=13.13$, $SD=1.69$), prototype ($M=13.47$, $SD=1.19$), test ($M=9.81$, $SD=1.72$) and feedback ($M=10.86$, $SD=1.08$) stages. After the first design iteration, a screenshot of a mid-term presentation was captured (Fig.1, mid), and the final design result showed a better and completed final design interface (Fig.1, right). Thirdly, regarding the two questionnaires, including TPACK & T-IDK ($M=-5.60$, $SD=1.36$, $t=-13.02$) and DBT ($M=4.30$, $SD=1.45$, $t=-9.37$) they both showed improvement from pre-test to post-test.



Figure 1. Design thinking process (left); a screenshot of the mid-term report on the interface design presented by one group (mid); a few screenshots of the final-term design interface presented by the same group (right).

Discussion and conclusion

With the rapid development of technology, various walks of life have changed their approach to dealing with issues with digitalization. In particular, the educational field has tried to keep up with the times in supplying different teaching methods for current digital native learners. Accordingly, for teachers to learn and design new learning sources before they enter the teaching workplace, they should change their fixed mindset about “learning” and “knowledge acquisition” by developing a growth mindset that highlights design and knowledge creation. By engaging students in design thinking activities as guided by knowledge building pedagogy in this course, it was found that their TPACK knowledge was enhanced. The results also showed that they could come up with interesting design ideas and translate them into actions to improve their final projects—online learning courses. More importantly, it is also clear that the knowledge building environment employed in this study allowed students to generate and advance their ideas that served as an indispensable part of their learning to support their design thinking.

In addition, during students' design thinking process, it was found that their discussion, reflection, and feedback-giving activities have great influence on the finally designed online product/project. In particular, the “feedback” activity have helped students to perform better in the “ideate” and “prototype” stages. Moreover, as students were engaged in actual hands-on learning experience of product design, they were able to actually solve many different practical, ill-structured, and contextualized real-life related problems. Such active-inquiry activities not only give the participants learning opportunities to integrate their design knowledge and TPACK knowledge (in particular, technology-related TPACK knowledge), but they also help them to adapt their traditional teaching views to accepting more diversified ways of thinking about teaching. For further research, we will try to analyze in-depth the participants' behavior sequence in order to strengthen the evidence.

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