Engaging Students through DICE: Design Thinking, Innovation, Creativity, and Entrepreneurship

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Abstract

DICE (Design Thinking, Innovation, Creativity, and Entrepreneurship) was a two-week workshop at POSTECH University, in South Korea. Professors from George Mason University (GMU) engaged a group of undergraduate students from GMU and POSTECH to work on global problem solving using DICE. The focus was on creating scholars with interdisciplinary interest and entrepreneurial streak, empowered to break down disciplinary boundaries for solutions of impact on pressing human needs. Students were teamed up and leveraged user-centered design to innovate in solving real-world challenges. Creativity and engineering concepts included brainstorming techniques, hands-on building and technology enhanced learning modules. For hands-on activities students were asked to present usable and useful projects. We discuss one such case study in this work involving the design of a chair cane. Another example of activity generated solutions to problems identified with glasses. Teams worked on a long-term project to come up with solutions to health issues in their respective countries. Pre and post-tests were applied and creativity level, analytical skills, and design approaches were evaluated.

Keywords

Creativity, design thinking, innovation, entrepreneurship, multidisciplinary

Introduction

It is critical to build initiatives that can identify and then develop the next generation of key innovators who have the potential to create significant breakthroughs, advances, and innovations that will impact society. Universities have long understood the need for innovation, as well as entrepreneurship, as a need in undergraduate education. Previous successful efforts in this field have been pioneered by design schools (Stanford University, Purdue, and MIT are the most prominent programs with multiple semester offerings for engineering students).[1-3] The capabilities of these innovators are not just limited to their analytical and scientific strengths in combination with verbal aptitude, but also life-long 21st century skills (communication, collaboration, critical thinking and creativity). Here we describe one such initiative, designed and implemented by us, called "DICE: Design thinking, Innovation, Creativity, Entrepreneurship". DICE is a collaborative intensive class between George Mason University (Fairfax, VA, USA) and POSTECH University (Pohang, South Korea) that was conducted in January 2015 at POSTECH. Through DICE, students from both institutions were able to collaborate and learn various brainstorming techniques such as 6-3-5 sketching, brain writing, scamper, affinity mapping, power voting, decision matrices, and De Bono hats. These techniques were leveraged to generate ideas and create feasible and the most beneficial solutions to real-world problems. DICE was a team-taught class by faculty from science and engineering and provided an iterative,

interconnected, and transformative module-based experiences for the students. Together the authors developed this course with the inclusion of the following experiences for the students:

Experience I: Design Thinking and Problem-Solving: The students were exposed through hands-on activities to the concept of design thinking, problem-based learning, and collaborative innovation. With the faculty, participants actively engaged in real-world problems, in a specific domain of research issues, e.g., global, bioengineering issues in healthcare devices, and environmental.

Experience II: Collaborative Research/Demo: Using the design thinking and the problem-based learning approach, participants worked on real-world research topics or problems of multidimensional nature, e.g., bioengineering, to build and demo solutions in collaboration with experts from across disciplines. During this process the participants were exposed to a variety of brainstorming strategies that helped in divergent/convergent thinking process.

Design Thinking

Design Thinking[4] is an iterative problem-solving process of discovery, ideation, and experimentation that employs various design-based techniques to gain insight and yield innovative solutions to real world challenges that focus on the needs of people, as consumers, clients or everyday citizens.

The process illustrated in Figure 1 was modified from previous papers[1,2], and includes five steps:

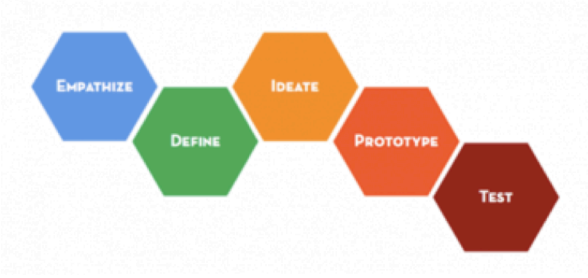

Figure 1: Steps in Design Thinking as taught during DICE (2015)[4,5]

- EMPATHIZE: This step is essential for any team to work together to fully understand the user experience for who a product needs to be designed. This is often done through observation, interaction, and immersing themselves in the user experiences.

- DEFINE: In this step, the findings from the empathy work are then processed and synthesized in order to form a user point of view that will address with the design that will be produced.

- IDEATE: This step allows the opportunity for participants to explore a wide variety of possible solutions by generating a large quantity of divergent possible solutions, allowing them to step beyond the trivial straightforward solutions and explore a range of ideas.

- PROTOTYPE: This step then helps the participants to transform their ideas into a physical form so that they can experience and interact with them and, in the process, learn and develop more empathy.

- TEST: In this step, the participants can try out high-resolution products and use observations and feedback to refine prototypes, learn more about the user, and refine your original point of view.

Example project: design of a chair cane

Canes typically support 25% of the patient's body weight and are used by people who suffer from arthritis, mild balance problems and foot and leg injuries. According to the United States Census Bureau's report on people with disabilities, in the United States, about 11.6 million people use canes, walkers, and crutches to provide them with mobility assistance. The group decided to create a cane that can be used by those who need a cane for medical reasons in addition to people who suffer from fatigue and would like to carry around our easy-to-carry, mobile chair. After doing research, the group found out that their idea was not completely original; Canes that transform into chairs exist. Although various cane chairs exist, the team's design had advantages over current designs since the chair part of the cane will be completely hidden within the cane's frame, it was less bulky and preserved the traditional cane style. Their product also was much more portable and easier to assemble than existing designs.

As a group, they were able to utilize strategies such as 6-3-5 sketching to produce ideas and also diverge to find the best idea. They utilized strategies such as a decision matrix to converge and narrow down the initial ideas. They then used various feedback strategies such as De Bono hats to further improve the initial idea. A simple prototype of the project was developed using tape and Styrofoam noodles. One of the concluding methods used during the thinking process for this project is called the deBono method[6]. It plays a large role in affecting group dynamics and allows external input to constructively influence decisions made on the development of a final product. This method helped the group to converge their thinking into a more productive, cohesive and effective manner, in the form of six (6) hats. These six hats, in the midst of the development process, helped discover key elements that included facts, feelings, cautions, benefits and creativity in the product, which students had originally not identified. After the timed deBono discussion with the Korean Team, a detailed underlying knowledge was made evident. There were aspects of the team's product that they had not yet examined and/or that they needed to recap by method of SCAMPER; they had to once again redesign their prototype with these new points in mind. As a group, new and external feedback is beneficial in creating a product that suits all user needs with defined parameters. Using this prototype and feedback from the deBono hats, they further improved on features of the chair cane. They also sought the help of a professional physical therapist from a senior care[4], for feedback on the prototype created and then were able to produce a second prototype based on the feedback using PVC and metal hinges.

Although walkers commonly have a chair feature, most canes do not. The existing chair canes are bulky and heavy compared to normal canes. This project focuses on developing a usable chair cane that is cost effective, lightweight and aesthetically pleasing. The Chair cane will appear like a normal cane and the user will be able to pull out the sides and easily assemble it into a chair without additional tools. Using research on previous designs of chair canes available on the market, the group has developed an innovative design prototype on the miniature scale and also on the AutoCAD software. This prototype is being developed further and will

eventually be tested by potential user to be improved further. The prototype will be developed using PVC pipes and hinges. This interdisciplinary project involves collaboration between students from various backgrounds as well as interaction with Korean students from POSTECH University.

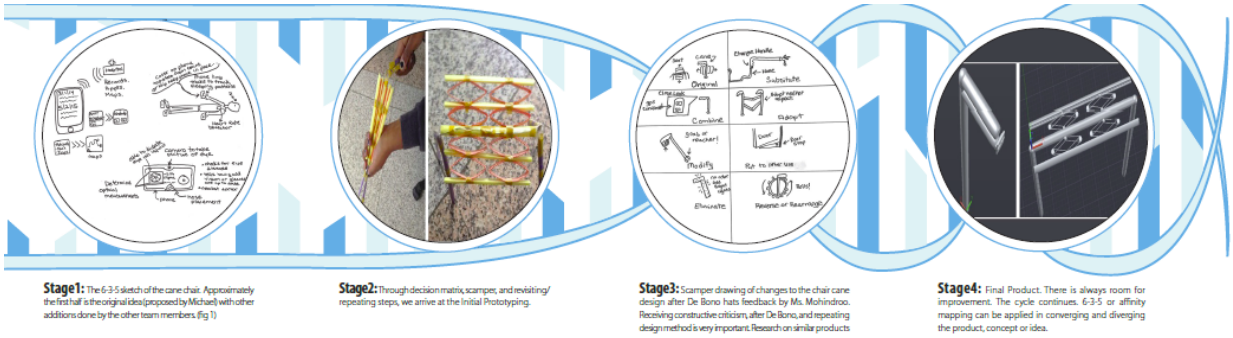

Figure 2. Examples of stages of the design.

Results and Conclusion

The DICE course helped to stimulate two diverse groups of students who were trained in two different educational systems, namely, the US and the Korean systems, to work together and learn from each other. During the face-to-face part of the course in POSTECH, the students had the opportunity to work on brainstorming activities together. When asked if the course enhanced their creativity, one of the American students commented: "*It's not the first time for me to take hands-on course. But it was the first course which foster creativity. Like convergent & divergent thinking, SCAMPER, etc.*" When asked what the students thought about the differences between Korean versus American educational approaches, one student commented "*Koreans are good at formulas and math, they have solid foundation e.g.Combination problems, while US students drew pictures. So this is not only cultural difference, but mainly because of educational systems*."

The group project that is discussed as an example in this paper yielded the idea of the chair cane, which currently has a second prototype. In addition to finding that the chair cane was lightweight and concealable, the group also worked on reducing the cost of the cane. This project was also a successful interdisciplinary and intercultural collaboration. Through this process the students were able to use the De Bono hats exercise to receive feedback on their initial prototype from their Korean classmates. The De Bono hats exercise yielded suggestions such as making the chair higher, using lighter material so it's not so heavy for a disabled user to maneuver, adjust and for and to add a buzzer so the user can call for help in case of emergencies. The group has currently developed a prototype that can be tested by people. The feedback will be used for further redesigning purposed. There are additional features being developed such as a flashlight and a step detector that can warn the user of lower surfaces. However, the prototype first needs to be tested as a minimum viable product to get the initial response of potential users before further developing additional features[7]. The work done for this project included brainstorming strategies such as 6-3-5 sketching, brain writing, scamper, affinity mapping, secretive voting, decision matrices, and De Bono hats, etc. The process of diverging and converging was

constantly being used and definitely helped make the group work more effective because members could individually brainstorm and share their ideas to a positive and open-minded team. Using feedback, the group is currently working on improving their design.

We have described a case study of an international, multidisciplinary effort to engage students from an American University interacting with a Korean University team. Our main objective was to explore project-based learning across two cultures. We have previously demonstrated hands-on activities at the middle school level[8], as well as project ownership when student-centered approaches are leveraged[9]. Here we expanded our observations to a multi-disciplinary and multi-cultural environment. Our results show a much deeper understanding of the project and the several iterations of prototypes show a higher degree of creativity (as measured with a Torrance-like test) than previously attempted efforts. Finally, as evidenced by the post-DICE interviews, students recognized the value of the teamwork, as well as the different perspectives when comparing their designs with designs from team members from the other country. Stipulating a diversity in teamwork in STEAM areas will probably enhance innovation, creativity, and performance in projects. We intend to test these hypotheses in the future.

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