IMPORTANCE OF DESIGN EDUCATION IN K-12

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1. INTRODUCTION

Design education is the teaching of theory and application in the design of products, services and environments. Traditionally, industrial design education was object oriented. Many industrial design programs still resemble the Bauhaus, whereas much of the student’s time was focused towards the development of their craft. (Kolko, 2005). This skill development is crucial at the post secondary level for those pursuing a professional career in design. However it’s not necessarily the skills and craft that is important in K12. Since the Bauhaus, design has shifted towards a user-centered approach. Designers now must take into consideration the user; including their needs, limitations, and prior experience. Design thinking is a process in which the designer establishes an understanding of the problem, develops multiple creative solutions, creates prototypes to establish function and aesthetics, and creates a plan to implement a single solution. (Brown, 2009) The process of design is what is important to K-12 students.

2. WHY TEACH DESIGN IN K-12?

Creativity can be defined as the invention of original thought. Young children are the most free at expressing their creativity. Whether it be through imaginative play, drawing, etc. Creative expression and play are essential to a child’s development. (Ginsburg, 2007) However as students advance through the public education system, the opportunity for creative expression inversely diminishes. Creativity expert Sir Ken Robinson argues that “we are educating people out of their creative capacities.” Adding further: “we don’t grow into creativity, we grow out of it. Or rather, we get educated out of it.” (Robinson, 2006) As students reach their final years in the system, having accumulated a wealth of knowledge and skills, they are given very little opportunity to draw on this education and use their creativity in developing innovative solutions to real world problems.

Post-secondary industrial design programs perform their function amazingly well: to educate and train skilled graduates as innovative leaders. However, less than .05% of high school graduates are estimated to attend and graduate a four year industrial design program. In 2010, 3,304,000 young people graduated high school in the U.S., yet only 1,432 graduated with a bachelor in Industrial Design. Whether by ignorance or lack of means, this small window of opportunity to study design at the post secondary level closes after graduation for millions of bright and innovative young people. To capitalize on this pool of creativity, the time to teach design begins in K12.
Students in courses that employ problem based learning methodology, and encourage design thinking, however have a tremendous advantage academically and professionally than those who are not. These students participate in hands on, real world projects which increase engagement and sense of purpose to learning. Design thinking has been shown to increase understanding in core subject areas as well as build cognitive and social skills. (Carroll, 2010) In addition, students gain critical thinking and problem solving skills which were reported by Fortune 500 CEO’s to be among the top ten most valued characteristics in an employee. Students also gain soft skills such as communication, collaboration, initiative, and adaptability. When courses are conducted in this manner, the traditional role of teacher shifts to that of a facilitator. Students are encouraged to be self-directed learners. Experimentation and failure is encouraged, when students are able to reflect on their process, learn from mistakes, and move forward in a more informed direction.

Schools and the surrounding communities can also benefit from design education. Design projects are very well suited for service learning. Since design education inherently entails problem based learning, solutions to school and/or community problems can be realized through student projects. (Image 1)

Image 1. Modular planting boxes designed to grow fresh herbs for the culinary arts kitchen and be maintained by special education students.

Lastly, teaching design to K-12 students can also be good for business. Through supporting design projects and student mentorships, local industry can form strong community relations, promote advocacy of the profession, and participate in the development of curriculum. Which can directly impact their future workforce.

3. WHAT DOES DESIGN EDUCATION LOOK LIKE IN K-12?

Some programs recognize the value of design thinking in education and when successfully implemented the results are astounding! Prior to 2009, Irving High School did not offer any classes in design, nor engineering. In the 2009 - 2010 school year, two engineering courses were offered to 45 students (4% female). Three years later, in 2011-2012, ten sections of engineering classes with over 200 students (10% female) were offered. Currently, Irving High School offers three courses in design and engineering:
• Concepts of Engineering & Technology (9th grade) provides an overview of the field of engineering and various disciplines within, including: educational & career exploration, professional development (leadership, communication, teamwork), mechanical systems, materials and manufacturing, energy and electrical systems, biotechnology, computer systems and automation.

• Engineering Design & Presentation (10th grade) builds on the previous overview course with an emphasis on problem solving and solution visualization. Topics include: intellectual property, design process, sustainable design, universal design, hand sketching (perspective, scale, shadows/lighting), two dimensional technical drawing (orthographic, isometric), three-dimensional solid modeling (Autodesk Inventor, Solidworks), rapid prototyping, and model building.

• Problems & Solutions in Engineering (11th-12th grade) is an independent study for advanced students in which a problem is identified and, by working through the entire design process, a solution is developed. Students are required to provide full documentation of their process and present final products to a jury for critique.

The design process, when simplified into four steps: 1) understanding, 2) ideation, 3) development, and 4) revision, is the foundation for a structure of these technical skills. However, a thorough understanding of the process is required. Following is a brief synopsis of how this is accomplished.

3.1 UNDERSTANDING

To effectively understand the problem they are trying to solve, students first identify the stakeholders involved. From there, user research is conducted in the form of observation or surveys. Next, students attempt to build empathy to understand the user better. (Image 2) Finally, to summarize the problem students develop a problem statement, which follows the form: 1) what is the problem, 2) who does it affect, 3) how does it affect them.
3.2 IDEATION

Once understanding of the problem has been established, students brainstorm both individually and in groups to maximize the quantity of ideas. Wild, crazy, and even unconceivable ideas are encouraged. The large quantity of ideas are then filtered based upon limitations and constraints, narrowing down to only a few. Sketches are created to aid in concept visualization.

3.3 DEVELOPMENT

Students take final concepts and create technical drawings with dimensions and notes, either by hand or computer-aided-design (CAD) software, such as AutoCAD. Prototypes are created both virtually and physically to establish proper function and aesthetics. (Image 3)
3.4 REVISION & DOCUMENTATION
After testing, and receiving initial feedback, students make required revisions. Finally, students develop presentation materials documenting their work. This can be in the form of printed presentation boards or video. All documentation materials, including a project reflection, are uploaded to each student’s e-portfolio (electronic portfolio) webpage.

4. CASE STUDY PROJECT: EMERGENCY HOUSING
Immediately after receiving news of the destruction caused by the earthquake and subsequent tsunami on March 11, 2011 off the Pacific coast, a project idea was devised for students currently in Engineering Design & Presentation. The project consisted of small groups, three to four students, working collaboratively to design emergency housing for victims. The shelter was to be constructed of four shipping containers to house six individuals for an indefinite period. Students first established who the six users were and created scenarios, establishing relationships, for each. Based on the determined location of their shelter, they researched local culture and customs to understand user needs. From here students started creating layout sketches of their group’s design. Structural stability of the container, use of natural light, and passive heating and cooling were all taken into consideration. After a final design was decided upon by the group, each student was responsible for developing floor plan, elevation drawings, and a three dimensional virtual model. (Image 4)
5. **CASE STUDY PROJECT: ADAPTIVE DEVICE DESIGN**

To effectively illustrate to students how to build empathy for a user, students were given a project to design an adaptive device for a disabled student at our school. They were given three categories of impairment to choose from: vision (fully blind), mobility, or hearing (fully deaf). In their small teams, two to three students, they first developed a list of challenges they assumed this student would face in a typical day at school. Next, each student was artificially impaired in an effort to gain empathy for their user. Blindfolds and canes were used to simulate blindness, a wheelchair was borrowed to simulate impaired mobility, and noise canceling headphones simulated a loss of hearing. After gaining empathy for the user, and considering their documented list of limitations, students developed a problem statement. Students next brainstormed to develop possible solutions. Sketches were created illustrating each idea. Groups then decided on one solution to move forward with, and began creating prototypes (Image 5). Given the time limitation, and extent of lesson (understanding user needs), students finally documented their work in a digital presentation and uploaded onto their e-portfolio.
6. MOVING FORWARD

During the past three years in the classroom, several lessons have been learned on how to effectively use design methodology in instruction, specifically in high school engineering courses. Following is a list of notes regarding aspects to consider moving forward:

- While brainstorming should not be limited in any way, before deciding on a final solution students need to perform more thorough research of existing products. This could include patent searches, market research, etc.
- State education boards have mandated knowledge and skills curriculum requirements for each course. However, assessment is still very broad and vague. Standard assessment measures should be developed to ensure consistency among students.
- Documenting student work is essential for both the student and instructor. Students currently use eportfolios to keep a digital collection of their work. This is beneficial to them when applying to a university or for employment. This single source location for student work is also helpful to the instructor during assessment. And having the best work documented is essential to marketing the program. However with time constrained between units, proper documentation does not always occur. A balance between the two is desired.

Design and visualization technology is rapidly developing. Several new tools are being developed which could alter the methodologies design education has traditionally engaged. One tool currently being explored to assist in visualization of virtual prototypes is augmented reality. Once a student completes the creation of their virtual model, it is loaded into an augmented reality software program. One being currently tested is called BuildAR Pro, created at the University of Canterbury’s Human Interface Technology Lab. The model is matched to a target that then superimposes it onto a video stream, from a webcam, of the target. As the target moves in three dimensional space, the virtual model reacts accordingly. This technology has been used for students to visualize projects from a restaurant interior (Image 6) to a prosthetic leg (Image 7).
Image 6. Student using augmented reality to visualize a themed restaurant's interior.
7. CONCLUSION

The meaning of design differs greatly depending on one's experience. While the current state of the field could be determined by asking professionals: What does design mean to you? The future of our industry, and quite possibly that of society, might be answered by asking today's youth: What does design mean to you?

Design education in K-12 is much more than a class or curriculum. It's an opportunity for students to employ their education and skills in developing innovative solutions to real problems. Ask a student: What does design mean to you? Their answer could be: an opportunity to change the world.

REFERENCES


