Learning by Constructing at the Graduate Level: Transforming Occupational Therapy Learning through a Makers' Perspective (Short Paper)

Boris Ivinder
University of Haifa
Boris.ivinder@edtech.haifa.ac.il

Sharona T. Levy
University of Haifa
stlevy@edu.haifa.ac.il

Tamar Weiss
University of Haifa
plweiss@gmail.com

למידה מתוך בנייה בתואר השני: טרנספורמציה של למידת ריפוי בעיסוק דרך נקודת מבט של מייקרס (מאמר קצר)

בוריס איבינדר
אוניברסיטת חיפה
Boris.ivinder@edtech.haifa.ac.il

שרונה ט' לוי
אוניברסיטת חיפה
stlevy@edu.haifa.ac.il

תמר וייס
אוניברסיטת חיפה
plweiss@gmail.com

Abstract

This study investigates how to transform a graduate-level course so that conceptual learning - related to the profession, technology and design - is advanced in light of constructionist theory. The work explores occupational therapy graduate students' learning when they collaboratively design and construct profession-relevant 3D-printer-manufactured objects for patients. A course on assistive technologies in the Dept. of Occupational Therapy was redesigned for project-based learning, via designing and constructing in a simulated Makers' environment. A three-dimensional (3D) printer was the main tool as it affords construction of unique and complex objects using methods of computer aided design (CAD). The students learned about theoretical issues related to the topic, explored practical problems in the domain, and designed and built devices to solve clinical problems using a 3D printer, while reflecting on the process during the course. Research tools included interviews, intermediate and final design plans, and artifacts. Results showed significant growth in use of "engineering thinking" by the end of the course as a result of several iterations of tinkering to complete the final project as well as the need to write down and present the process of design and the final device.

Keywords: Maker, Constructionism, 3D printing, Occupational therapy, Assistive technology.

Background

This research concerns strengthening theory and practice relationships in higher education learning, without losing the theoretical structures that comes with academic learning. Two out of five graduates contend there is a gap between the education they received and the knowledge, overall skills, abilities, and work habits that are expected of them in the work force (Hart, 2005).

The means by which this research strengthens theory-practice connections is by transforming a graduate level course on assistive technology in occupational therapy by combining theoretical learning with a constructive process of designing and building artifacts[1] (Simon, 1996) in the form of project-based learning.

While some research has been carried out on conceptual learning while constructing artifacts with young students (Levy, 2012), or based on students' prior knowledge (Yu, Lin, & Fan, 2015; Frank, Lavy & Elata, 2003) there has been little work on the topic (for a review see Williams, Ma, Prejean, Ford, & Lai, 2007). Today's higher education students need to develop and apply an expert-like view of their domain, capture meaningful patterns of information, with reasoning organized in ways that reflect a deeper understanding that cannot be reduced to isolated sets of facts (National Research Council, 2000 in a challenging and ever-changing environment (Betz, 1997).

Based on ideas in constructionism and related research (Papert, 1980; Harel & Papert, 1991), the working hypothesis was that nurturing a makers' culture within maker spaces in higher education is a fertile opportunity for developing not only motivation and procedural knowledge, but also related conceptual knowledge. Through a more open process, using a functional design approach, which emphasizes the teaching and study of design functions rather than predetermined stages (Mioduser & Dagan, 2006) aimed to influence the culture of learning.

This study addressed: How can we characterize the processes of learning through such a course by identifying focal points where there is an increase in the use of conceptual knowledge, and relating them to the advancing project, social interactions, and teacher interventions?

Methods

This research included 11 graduate students who are registered in the Occupational Therapy graduate program of the Faculty of Social Welfare and Health Sciences at the University of Haifa. The students came from different religious and socioeconomic backgrounds, with all having experience as occupational therapists. The name of the course was "3D printing as a paradigm in learning design and manufacturing assistive technology".

During the course, which was held in the spring semester 2018, students were given different tasks that enabled the students to explore engineering and 3d printing concepts (Figure 1). The main task was a course project that started from exploring their own professional world.

[1] In terms of philosophy and history of technology, an artifact is anything that is purposefully made by humans for any function (Simon, 1996).

Figure 1. Course assignments progression.

Findings

This analysis focused on the qualitative analysis of student product design and thinking via categorical section analysis, using coding of interviews, questioners and assignment submissions. The coding method chosen is "bottom up", which means that codes were created for each interview separately and then the codes were consolidated for the purpose of targeting the list.

The analysis was divided into two sections; first the analysis of interviews and questionnaires as midterm analysis, and the final project submission where analyzed as end of the term analysis, each section was analyzed separately and then crossed section in order to identify the process of learning.

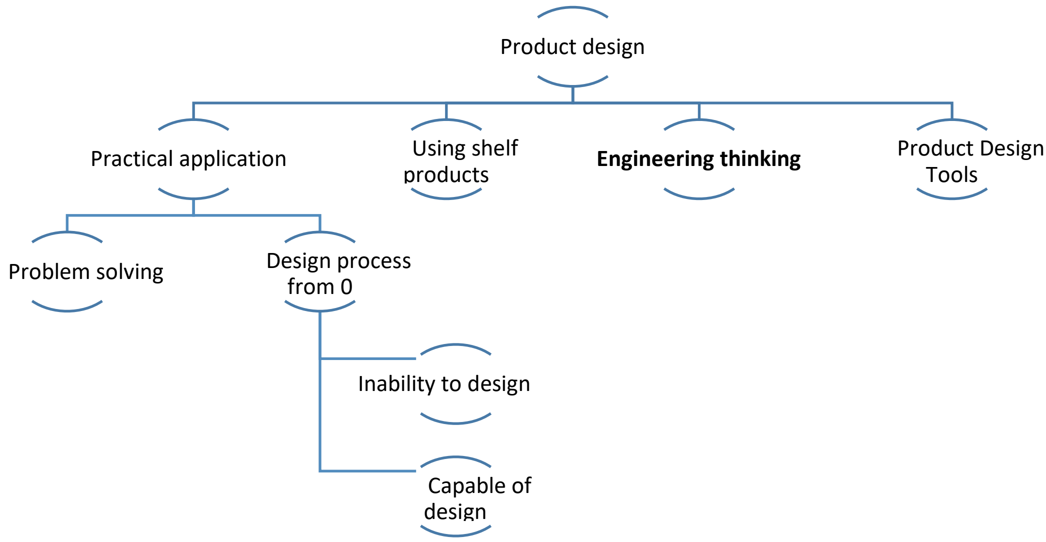

Figure 2. Product design category tree.

This tree included all the major uses that students described on topics related to product design and process of design. In the midterm analysis this category tree appeared active with 39 uses across the interviews and questionnaires, with Problem solving excerpts appearing 10 times and Product Design Tools 13 times the two most mentioned categories, while engineering thinking appeared only 3 times.

Engineering thinking was coded as a way students used to describe different processes of design in terms of engineering concepts and not the concepts themselves, comments such as "Materials that can be done with elastic as hard, level of density of matter that affects the shape of the part off of this printer is that it affects" were used in the midterm interviews. In contrast, more complex and larger number of comments(20) were made during the final project. Comments such as "Constantly reassess the product and make changes accordingly to achieve a stable enough product" and "In this section there is a star-shaped groove, selected to allow the moving object number of different angles"

Discussion

From the partial analysis of the category we saw an increase of six-fold in excerpts related to "engineering thinking". This growth appears to be an outcome of self-reflection when students described their process of design in their own words, addressed the problems they faced and how they overcame them; they started using a much richer language that accumulated during the course's final weeks.

It's also assumable that because the major growth in use of "engineering thinking" was at the end of the course, the final tinkering of design and printing had a big effect on student learning and understanding, after a few trails their project started working, and even thaw throughout the course students build themselves a new "engineering" language and concepts.

The results show that there was major growth in the students' use of "engineering thinking" by the end of the course as a result of several "tinkering" iterations of the final project, and the need to write and present the process of design. These two aspects along with the freedom of design appear to be necessary to achieve change in the student's understanding of the process and in their performance.

References

Betz, C. L. (1997, 04). The gap between learning and doing. Journal of Pediatric Nursing, 12(2), 65-66. doi:10.1016/s0882-5963(97)80025-5

Frank, M., Lavy, I., & Elata, D. (2003). Implementing the project-based learning approach in an academic engineering course. International Journal of Technology and Design Education, 13(3), 273-288.

Halverson, E. R., & Sheridan, K. (2014, 12). The Maker Movement in Education. *Harvard Educational Review, 84*(4), 495-504. doi:10.17763/haer.84.4.34j1g68140382063

Harel, I., & Papert, S. (1991). Constructionism`1: Research reports and essays, 1985-1990. Ablex.

Hart, P. (2005). Rising to the challenge: Are high school graduates prepared for college and work. Study conducted for Achieve, a nonprofit organization for education reform, Washington, DC. Retrieved From http://www. achieve. org/rising to the challenge.

Levy, S. T. (2012, 02). Young children's learning of water physics by constructing working systems. International Journal of Technology and Design Education, 23(3), 537-566. doi:10.1007/s10798-012-9202-z

Mioduser, D., & Dagan, O. (2006, 12). The effect of alternative approaches to design instruction (structural or functional) on students' mental models of technological design processes. International Journal of Technology and Design Education, 17(2), 135-148. doi:10.1007/s10798-006-0004-z

National Research Council (2000). How people learn: Brain, mind, experience, and school: Expanded edition. National Academies Press.

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. Basic Books, Inc.

Simon, H. A. (1996). The sciences of the artificial. MIT press.

Williams, D. C., Ma, Y., Prejean, L., Ford, M. J., & Lai, G. (2007). Acquisition of physics content knowledge and scientific inquiry skills in a robotics summer camp. Journal of research on Technology in Education, 40(2), 201-216.

Yu, K. C., Lin, K. Y., & Fan, S. C. (2015). An exploratory study on the application of conceptual knowledge and critical thinking to technological issues. International Journal of Technology and Design Education, 25(3), 339-361.