Informal Learning Pathways: Supporting Informed Decision Making in Makerspaces

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INTRODUCTION

In the domain of university engineering education, engineering design is an important but is highly complicated subject to teach and learn [1]. The primary pedagogy for teaching design is through project-based learning cornerstone and capstone courses. While these courses have strong learning outcomes, they are highly resource intensive, difficult to scale, and limited to a few semester-bounded interventions.

The emergence and growth of university makerspaces presents an opportunity to complement course work by supporting a different kind of design learning: learning through informal interest driven extracurricular or personal projects [2][3]. Being outside of the structure of a class, this learning has the opportunity to be more "life wide" and "life-long"[4] but also less scaffolded. Much of the literature focused on design learning in university makerspaces looks at student activities that are conducted in the makerspace, but are related to coursework. We know relatively little about students' processes and the role of makerspace support when pursuing work that is not informed by a course structure.

To understand how students navigate open-ended personal fabrication projects, we conducted a case study tracing the project trajectories of 7 undergraduates over a 10-week period through student-authored field notes. In this paper we examine student's decision of what project(s) to pursue and what resources and criteria they use to identify project ideas and make decisions. We elaborate on one student's experience and the role of the university makerspace as a resource.

METHODS

Our study takes place at a large public university where we focus on one of the campus's makerspaces open, free of cost, to all students and run by the university's innovation center. To obtain access to the space, students take a 30-minute safety training, pass a safety quiz, and sign a user agreement.

7 undergraduate students participated in a 10-week 2 credit research group in which they were asked to select a project that utilized the makerspace's sewing resources, execute that project however they saw fit, and capture their process. Students' process was captured through autoethnographic field notes, reflective journaling, and weekly group discussions. In the field notes, students report the dates, times, duration, and location of the project work, as well as provide photos, drawings, and descriptions of project work.

One researcher qualitatively analyzed the journal of one student (pseudonym Tom) through open coding and generation of themes. To contextualize Tom's experience, one researcher qualitatively analyzed the third reflection entry for all 7 students with attention to project choice and the criteria and resources that supported students' choices. The scope of this analysis is Tom's documented 23 field notes on 3 projects between September 26th and November 30th of 2017 and all 7 students third reflection entry.

FINDINGS

Students make a number of decisions throughout their projects, but one of the most foundational is deciding what project(s) to even pursue. Examining student project choice, we draw attention to the **projects** students chose, the **resources** they use generate potential ideas, and the **criteria** they use to select ideas. General findings across the students are presented and elaborated with examples from Tom's experience.

A. PROJECTS

While Students were instructed to pick one project to complete and document throughout the quarter, nearly all of the students pursued multiple projects to different degrees of completion. A few students explicitly planned to pursue multiple smaller projects. Tom does not indicate such a decision, but does describe three different projects in his journal.

Gloves (16 entries): Tom's primary project is constructing LED gloves that provide a turn signal for night biking by lighting up when the thumb and index finger are pressed together. Tom first conducts and internet search for e-textile projects in general before choosing this particular project. Tom finds DIY instructions for the project on the website of an artist he met in an e-textiles workshop earlier that year. He purchases electronic parts, prototypes the circuit on a pair of plastic gloves, and then attaches the electronics to store bought knit gloves. He also pursues knitting his own gloves. He adapts chopsticks to function as knitting needles, practices stiches with twine, buys yarn, and practices stiches with yarn.

HAT (1 entry): Tom briefly explores the idea of making a hat as his project. He is inspired by a character in a movie who is a hat maker. He describes three famous hats he is aware of from previous knowledge and decides that bycocket ("Robin Hood Hat" #4) would be the one to make, but he does not document pursuing the project any further.

Bag (3 entries): Midway through the quarter, Tom is in a location that uses compostable cups but has no easily accessible compost bins. This inspires him to think about building a portable bag to carry compost around until a compost bin can be found. Tom documents the initial conception of the idea and some searching for related information on the internet.

B. INSPIRATION RESOURCES

Students seek project inspiration through a number of different resources. Several students describe a general process of first looking for many ideas to choose from, then making a

selection. One student explicitly mentions brainstorming. Tom's follows a similar process when looking for e-textile projects and for the hat, but in the case of the bag and gloves, very quickly decides on a general project idea without searching for many alternatives.

Digital Searches: Most students cite the heavy use of digital resources such as Pinterest, Google, and YouTube tutorials to find many project ideas. Tom uses an internet search to look at potential e-textiles projects.

Physical Resources: Physical resources, such as pattern books or fashion magazines, are also mentioned as a source of ideas. One student mentions that having physical project examples in the space would be nice because information could be gained by interacting with the physical object.

Makerspace: Students largely do not view the makerspace as a place for inspiration. Lindsey mentions in her reflection "I honestly didn't even think about going to co-motion to come up with project ideas." Students see the makerspace more as a resource for tools and certain materials than for project inspiration. Tom is no exception. The only inspiration from the makerspace that Tom mentions is magazines in the space. "At the waiting area, they put stacks of a magazine called 'Make:' on the tables. I flipped through one and then put it down...I actually found it a little boring (#2).

Need: Several students mention need as a source of inspiration for project ideas. Tom's compost bag is inspired by a particular need he encounters. This project inspiration comes from a situation Tom is part of rather than top down need to have a project. "If there are not compost bins for me to use, then what if I carried one around with me?" (#12).

Experience: A few students mention past experience as a means of inspiring projects. Tom mentions that he remembers the Gloves from a previous workshop. "I just remembered it this morning and went there again for inspiration. She made something called 'Early Winter Night Biking Gloves' which are gloves with conductive thread sewn in and LED" (#2). Tom's hat relies on the knowledge of different hat varieties.

Movie: Tom's hat project is inspired by a movie. "I was watching Howl's Moving Castle tonight and Sophie the main character works in a hat shop. She is making hats in the beginning of the movie and I immediately thought about making a hat for a project" (#3). No other student's mention movies as a source of inspiration.

C. CRITERIA

The seven students mention a number of criteria and constraints that factor into project choice.

Include Sewing: One of the few specified project criteria was the inclusion of makerspace sewing resources. Two students explicitly mention this as a constrain for project choice, eliminating projects that do not have enough sewing. In contrast, Tom chooses a project that is within the family of fiber arts but not sewing. In constructing his project, he utilizes soldering equipment at the makerspace not the sewing equipment.

Utility: For several students, utility or need drives project decisions. Tom begins by wondering if there *"is there anything I need which I could make with the help of a sewing machine?"* (#1). He remarks that the gloves are a good project because they are *"functional"* (#1). For the hat, he discards the top hat as a viable option because he *"would never wear one"* (#3). The compost bag is very much driven by utility. "*What use is a compostable cup if I can't compost it in the facility where it is served?"(#12)*.

Reactions: Many students describe projects with vague general descriptors such as "cool", "exciting", or "interesting". Tom is no exception and often uses words like "cool" "sweet" or "awesome" to describe different project options.

Experience: One criterion seen across many students is the idea of matching their skill level to the difficulty of project. This manifested in examinations of project scope, time, and difficulty. For example, choosing a "small" project or eliminating a complicated because they are new to a domain or skill. Tom makes a somewhat different considerations identifying challenge as a meaningful criterion. "I have never sewn or knitted before, so I think this is going to be a pretty worthwhile challenge" (#2).

Instructions: Many of the students look for tutorials or patterns that instruct them on how to create their projects. While they make decisions, they are largely using example projects rather than designing custom projects. Students cite clarity of tutorials as a criterion for project choice. Tom also gives some consideration to his current knowledge and instructional resources when he is not sure if he will get access to the tutorial – "how am I going to learn. I started thinking about whether or not to pursue the project if it meant that I had to figure things out with less guidance." (#6).

Cost: One student mentions cost when looking at patterns, but otherwise cost is not a strong criterion for project choice. Cost comes up for tom when he is buying materials but not when choosing projects.

Tools and Material: Tools and material do not come up as a major criterion in relation to project choice.

DISCUSSION & FUTURE WORK

In examining seven students' approach to project choice, we see that the makerspace is not viewed as a resource for finding and selecting project ideas. While this is not necessarily surprising it does bring up questions about the role of makerspaces in supporting informal design learning.

Are we designing spaces with the expectation that students will show up with project ideas ready to be realized, or do we assume part of the academic role of the makerspace is to help students see what they can make and determine what is feasible for them to make? Who are we leaving out if we are expecting students come in with scoped project ideas? How might we design makerspaces that support informed design decision making for personal interest driven projects?

In future work we aim to expand this lens to look at decisions that students encounter beyond project choice. These findings open up an avenue of inquiry around why students don't view the makerspace as a resource for project choice, how widespread the view might be, and was in which other university makerspaces might be addressing the support of project inspiration and choice.

REFERENCES

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