Explorable Instructions: Crafting Designerly DIY Tutorials

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Abstract

The Maker and DIY craft movements promote values of democratization, creativity, and customization [12]. While the associated informal learning structures - makerspaces, workshops, and DIY tutorials - support fabrication, they do not necessarily scaffold design learning [27]. Here, I present my work on design learning in formal and informal contexts and propose the re-design of DIY instructions to better support and understand informal design learning.

Author Keywords

Explorable instructions, design literacy, maker-movement, informal learning, design documentation.

CSS Concepts

- Applied computing~Interactive learning environments

Introduction

In the age of the Anthropocene, where human activity is the dominant influence over our environment, professional designers have immense power to structure the world we live in through designed objects that imbue and support their values [10]. **Design literacy** is, therefore, imperative to support agency of non-professional designers in this design dominated world.

Research Questions

Broad Research Question:

How might we design learning structures that support design thinking for beginning makers engaged in informal making experiences that are widely accessible?

Narrow Research

Question:

How might we design DIY Instructions that support systems thinking, divergent thinking, and design decision making for beginning makers engaged in informal making experiences (such as baking, laser-cutting, and sewing) that do not rely on substantial access to an expert or tacit knowledge?

Research Interests: My broad research interests are in the design of learning structures that support design literacy for beginners engaged in informal project-based making experiences that stretch across time, communities, and contexts. For example, engaging in a craft like woodworking over the course of a lifetime.

In pursuing lines of inquiry related to this broad topic of design in informal education, I have narrowed to a specific subproblem: How might we re-design DIY instructions to better support design learning and what might we learn about beginning makers notions of design by doing so? In this context design literacy can be seen through the lens of informed project decision making and divergent thinking. Here, I highlight my current work and future plans to explore this problem.

Background

Formal Design Learning: Opportunities for design learning in formal education, such as certificate or degree programs in disciplines like engineering, are often inaccessible to general audiences. Within these programs, design is recognized as both difficult to teach and learn [8]. One canonical form of design pedagogy is project-based learning through capstone and cornerstone classes. While capstones support a number of desirable design learning outcomes, they are highly structured, resource intensive and unscalable even within formal education [8].

Informal Project-Based Design-Learning: Outside of formal education, the informal DIY Craft and Maker Movements provide potential opportunities to engage non-professionals in design through interest driven physical fabrication projects [20][12][5]. There has been a rise in public access to digital fabrication tools

and information due in to a decrease in the cost of tools and increase in access to online information sharing.

Due to the inherent unstructured nature of informal learning, less scaffolding exists for learning than in formal contexts. Three common ways a beginning maker might engage in a new craft are: going to a **makerspace**, [7][21] attending a **workshop**, or using a **DIY instruction set**. While these structures support fabrication, they do not necessary support design literacy or design thinking.

Documentation Practices: Design is a complicated process that unfolds over time making it difficult to document and understand. Research methodologies such as verbal protocol analysis [3][9][16] and video ethnography have been used to try to understand the design process. While these provide detailed understanding of design they capture design in a lab setting rather than “in the wild”. While self-documentation practices may be used to capture design in more authentic contexts, a number of cognitive and organizational limitations exist [4][6][15].

In informal contexts, makers see documentation as important but difficult and in conflict with design [27]. Most documentation is completed retrospectively and leaves out much of the messiness the design process [27][28][26]. The goal of instructions is primarily efficiency and accuracy not deeper learning [14][13]. My work aims to address this gap by exploring how DIY instructions might support design learning.

Phase 1: Formal Design Contexts

I have engaged in a number of projects exploring engineering design experiences in **formal contexts**

A few Informal Learning Structures

Makerspaces: Makerspaces are physical spaces and communities that provide makers with a common space and shared tools in which to engage in making information exchange. Makerspaces provide tools, but due to the diversity of tools and people it is difficult to scaffold design learning.

Workshops: Short workshops (1 – 3 hours) are often available at low cost to novice makers. In these settings, an expert works with a small number of novices to complete a project in a certain location at a certain time. However, students are not necessarily able to replicate these skills outside of the context of the workshop.

DIY Instruction Sets: Tutorials and instruction sets provide accessible scripts to help new makers replicate a particular object.

such as higher education and professional design groups. Through these the projects, described below, I developed the concept of parameterized ***spaces of possibilities*** as a means by which we might aid novices in making ***informed design decisions***.

IdeaSpace: Through a multi-month video ethnography of a professional design team, we analyzed idea generation practices across multiple timescales ranging from 3-months to 2-minutes. At the 2-minute scale we characterized the teams' behavior as generating an ideospace – a parameterization and consideration of different dimensions and options rather than fully formed alternative [23][24].

Reflective Practice in Engineering Education: Through the Consortium for Promoting Reflection in Engineering Education, we collected student and educator accounts of numerous reflection activities designed and used in engineering classrooms. This allowed us to identify and parameterize the reflection experiences of students and the instructors designing these activities [29][25].

Design Process Worksheets: Through a verbal protocol analysis with engineering students and expert engineers, design processes were captured and parameterized to create timelines of design activities [2]. We used these timelines as a teaching tool to aid students in seeing patterns across different quality design process by providing a visualization of a space of 6 possible design processes [1].

Phase 2: Informal Making

In parallel to my work in formal contexts, I investigated students' design experiences in ***informal contexts***

such as ***makerspaces, workshops, and DIY instructions***. This work aimed to 1) collect students' informal making trajectories throughout a DIY project, 2) assess the resources students used and how these informal learning structures supported their design process and decision making, and 3) co-create documentation practices that would allow students to document and reflect on their design process as they unfolded rather than retrospectively.

Methods: In this 3-year qualitative study I used a combination of ethnographic methods, material inquiry [18][17], collaborative inquiry, and autoethnography to capture a breadth of experiences. This included communities of students as well as adult makers and looked at a breadth of fabrication domains including glassblowing, ceramics, electronics and physical computing, digital manufacture (laser cutting and 3D printing), sewing, and baking.

Findings: In many ways, informal structures such as makerspaces, workshops, and DIY tutorials do not support design learning for beginning makers. A group of 7 students engaged DIY sewing projects in a campus makerspace self-reported feeling that the space better supported fabrication than design and that they must come to the space with fully formed ideas [22]. Most students chose to use DIY instruction sets rather than design "from scratch" because they did not feel confident making design decisions themselves. Many of these students, however, did make small decisions throughout their projects, often where instructions did not provide sufficient information.

Parameterization of Process Space

I have identified 7 preliminary dimensions of process space that may help new makers see choices and tradeoffs. For example, might naming tools allows us to think about how tool choice might relate to who is making, the time it takes to make, or what material one might use to make.

Processes are defined as a network of actions that transform raw materials into final products. **Actions** (*cut, glue, move*) transform materials. Actions unfold over **time**. Different **tools** (*hammer, lasercutter, etc.*) are used to transform materials. Actions take place in specific **locations**. A number of different **materials** may be considered. Different **people** may be involved in making.

Phase 3: DIY Instruction Sets

Limitations: DIY instructions are widely used as an accessible means by which new makers can engage in material fabrication with limited domain knowledge. For example, while some knowledge is needed, one does not need to be a professional chef to bake chocolate chip cookies from a recipe. These instruction sets support replication, but they do not necessarily support design via systems thinking, creative informed decision making, or divergent thinking.

Design can be characterized by a series of divergent and convergent activities whereby one generates many possible options and decides which to pursue based on success criteria. Instruction sets are inherently convergent - they present one way to make one thing, often with no explicit rationale for why these options were chosen. When looking at large sets of instructions or examples, divergent possibilities become more apparent but are not easily aggregated to see patterns of tradeoffs between these divergent options.

Explorable Instructions: I propose a new model of DIY instructions aimed at supporting design thinking (systems/divergent thinking and design decision making) by visually presenting a divergent space of possibilities from which one can explore different choices and patterns among options. Based on the previously described work documenting informal design experiences, I have defined three connected possibility spaces, identified five key principles required to support creating possibility spaces, and defined key dimensions and options for these explorable instructions.

3 Possibility Spaces: DIY making projects can be described as choices in three intersecting spaces

containing dimensions and options 1) artifact space – what can I build?, 2) process space – how might I built it?, and 3) criteria space – what am I trying to achieve?

I have identified five components required to define Possibility Space. **Parameterization** – Possibility spaces are multi-dimensional spaces made up of parameterized dimensions each containing a number of options. Dimensions of process space are described in the left-hand column. **Aggregation** – To create a space of multiple options, different making experiences must be aggregated together into a common reference frame. **Visualization** – To make sense of these many possibilities, information should be visually encoded in expressive and effective ways [19]. **Interaction** and **Abstraction** – To discover patterns across different choices, makers must be able to explore the space of possibilities across different levels of abstraction.

Future Work. Future work will use Research through Design (RtD) [11][31][30] methodology to explore the following questions through the construction and deployment of 3 explorable instruction (laser cutting, sewing, and baking) prototypes. How might we design DIY instruction sets to better support design learning through the articulation and presentation of possibility spaces? What might we learn about beginning makers conceptions of design by doing so? I aim to make methodological contributions by testing a framework for instructions and empirical contributions that will add to our understanding of beginning makers conceptions of design and ability to make informed design decisions.

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