# Transforming a Makerspace into a Breakerspace: Performing Dissections of Everyday Objects with STEM Teachers

ISAM 2022 Poster No.: 107

6th International Symposium on Academic Makerspaces

Rob Rouse[1] and Juan Torralba[2]

[1]Rob Rouse; School of Education, Southern Methodist University; e-mail: rrouse@smu.edu

[2]Juan Torralba; W.E. Greiner Exploratory Arts Academy, Dallas Independent School District: e-mail: jtorralba@smu.edu

## Introduction

Over the past several years, makerspaces have become increasingly common on university campuses and in K-12 schools. Two reasons for this rise in popularity are that makerspaces can position students as agents of their own learning and makerspaces can promote hands-on teaching of science, technology, engineering, and math (STEM) [1].

Research on teaching and learning in makerspaces has increased significantly in recent years and new findings have resulted in a better understanding of how to effectively equip, operate, and plan instruction in university and K-12 makerspaces [2]. However, several open questions remain. For example, how can professors use university makerspaces to help in-service (i.e., practicing) K-12 teachers more effectively use makerspaces located in their own schools?

With this poster, we describe a pilot investigation designed to introduce in-service teachers to the concept of using a makerspace as a "breakerspace." We use the term breakerspace for a makerspace in which participants learn how artifacts work by disassembling, inspecting, hacking, and repurposing existing parts. These activities mimic hands-on engineering activities implemented in the past [3]

## Objectives

Our overarching objective for creating the breakerspace activity was to introduce practicing teachers to the possibility of using breakerspace activities in their own instruction—and in their own makerspaces. More specifically, we sought to provide in-service STEM teachers with a model for how to plan and implement a breakerspace activity as well as a process for helping them consider what STEM content they could reasonably connect to during such an activity.

Importantly, we also designed the breakerspace activity so that participants could complete it without needing to use the complex tools (e.g., 3D printer, laser cutter) that sometimes characterize makerspaces. These complex tools can represent a skill bottleneck for teachers working in K-12 makerspaces. In addition, these tools may not be available in some schools due to high cost. Finally, we reasoned that dissecting everyday objects would be a novel instructional approach and perhaps inspire participants to engage in learning through experimentation and failure.

## Context

The breakerspace activity occurred in a graduate-level course offered through the School of Education at a university in the southern United States. The title of the course was: Designing and making in STEM education and the activity stretched across one three-hour class period. The instructor was a professor in the School of Education and had extensive experience working in university-based makerspaces and providing professional development related to makerspace instruction to teachers in surrounding K-12 schools.

The participants in the class ($N$ = 7) were all in-service teachers who taught a variety of STEM subjects across a range of grades (e.g., elementary, 9, 11). None of the participants had any formal experience with dissecting everyday objects to consider how they worked, and although none were designated as makerspace teachers, several had access to makerspaces in their schools.

The makerspace in which we conducted this activity was located in the School of Education and was equipped with a 3D printer, Glowforge, flexible seating, and a variety of tools and technologies dedicated to virtual and augmented reality. In addition, the makerspace was stocked with tools such as wire cutters, screw drivers, pliers, and hammers. In the past, the makerspace had been used flexibly (i.e., as a traditional classroom and/or as a traditional makerspace) by members of the faculty of the School of Education.

## Design Principles

The breakerspace activity consisted of three parts. First, participants dissected two different retractable ballpoint pens known as "clicky pens." One of the pens was activated by twisting the top and bottom parts of the pen in opposite directions and the other was activated by pressing down on a plunger at one end of the pen. Second, participants dissected electronic greeting cards of their choice that had either motion, light, or sound effects (or some combination of these three). Third, participants dissected obsolete mechanical or electrical objects sourced from their own homes.

Our rationale for selecting pens and greeting cards as objects for dissection was to model that breakerspace activities should use common but variable materials that are relatively easy to find and disassemble and are made up of easy-to-see components. Additionally, we emphasized that worthwhile observations and discussions can occur even if—and perhaps especially if—objects contain very simple mechanical or electrical parts. Our rationale for asking participants to bring in obsolete objects was to give them agency and make the activity relevant and interesting.

Additionally, we also structured the breakerspace activity so that there was an emphasis on the process that one might go through to make a similar activity especially meaningful for K-12 students. With this in mind, we asked participants to keep written records, brainstorm content connections, and reflect regularly throughout each of the three parts of the activity (i.e., clicky pens, greeting cards, obsolete objects). Participants carefully dissected objects using whatever tools they needed and added sketches and text labeling the unique attributes of the different parts that helped objects function correctly. Throughout the process, we took pictures, recorded reflective notes, and collected participant-created artifacts.

## Findings

Overall, participants found the activity to be engaging and reported that there were opportunities for exploring relevant STEM content. Participants also reported that they would be open to doing similar activities with their own students—with the caveat that several felt it may be difficult to enact similar activities given the pressures they faced to prepare students for end-of-year exams. Furthermore, most participants reported that the activity aligned with the open-ended and hands-on style of instruction they routinely sought to implement in their class. Below, we summarize the three parts of the activity and share images of objects and artifacts.

### A. *Clicky Pens*

In part 1, participants dissected two different clicky pens. Fig.1 shows an example of how one group kept records of the process of dissecting the pens and recorded how they worked.

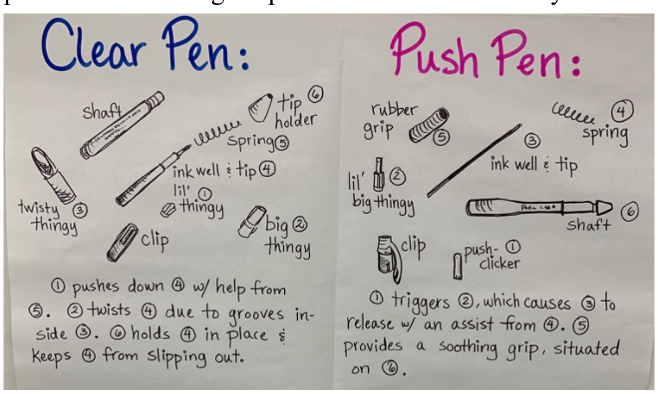


*Fig.1 Comparing the anatomy of two different clicky pens*

### B. *Greeting cards*

In part 2, participants dissected electronic greeting cards that incorporated light, sound, and/or motion. Fig. 2 shows an example of how one group dissected and kept track of the parts of an electronic greeting card that played the happy birthday song and lit several candles using LED lights.

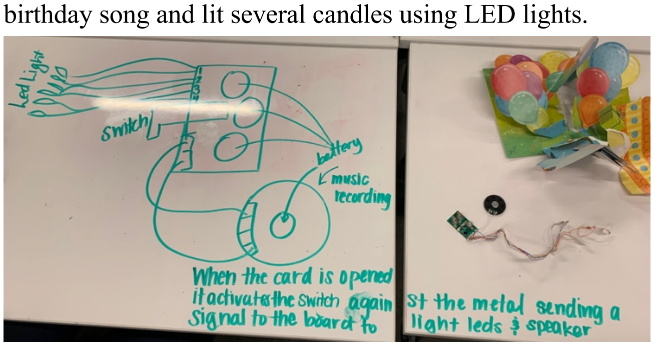


*Fig.2 Keeping taps on the parts of an electronic greeting card*

### C. *Obsolete objects*

In part 3, participants dissected obsolete objects. Fig. 3 shows the inside of a broken hand-held vacuum cleaner one group brought in to dissect.

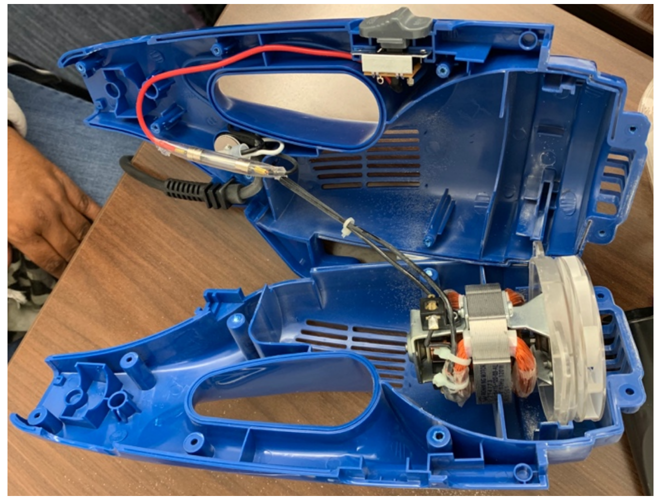

*Fig.3 Obsolete objects included a hand-held vacuum cleaner*

## Discussion

This pilot investigation demonstrates how transforming a makerspace into a breakerspace represents one way professors can use university makerspaces to potentially impact how practicing K-12 STEM teachers conduct makerspace instruction in their own schools. We were particularly encouraged that participants found the breakerspace activity engaging and made connections to grade-level-appropriate content. This indicates that similar activities could potentially be useful for teaching STEM content in the future.

Next steps include developing a greater range of breakerspace activities using appropriate materials (i.e., common yet variable, easy to find and disassemble, made from easy-to-see components) and explicitly mapping how these activities align with specific STEM standards. Taking these two steps will allow the STEM teachers we work with in the future to select from a library of breakerspace activities that make concrete connections to the STEM standards they are responsible for teaching. Finally, as our work progresses, it will also be important to transition to working with students in K-12 makerspaces as they complete breakerspace activities so that we can measure student engagement and learning.

## References


[1] R. Rouse & A.G. Rouse, "Taking the maker movement to school: A systematic review of preK-12 school-based makerspace research," Educational Research Review, 35, 100413, 2022.

[2] T.W. Barrett, M.C. Pizzico, B. Levy, R.L. Nagel, J.S. Linsey, K.G. Talley, C.R. Forest, & W.C. Newstetter, " A review of university maker spaces," Presented at the 122nd. Seattle, WA: *American Society for Engineering Education Annual Conference & Exposition*, 2015.

[3] S.D. Sheppard, "Mechanical dissection: An experience in how things work," In *Proceedings of the Engineering Foundation Conference on Engineering Education: Curriculum Innovation & Integration*, 1992.