Board 115: Development of the Draw-An-Engineering-Teacher Test (DAETT) (Work in Progress)

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Introduction

Much can be learned about one's personal beliefs by studying the mental images that a person holds in relation to a particular topic. Instruments such as Draw-A-Scientist Test [1] and Draw-An-Engineer Test [2] have been used to assess both student and teacher perceptions of scientists and engineers. Likewise, the Draw-A-Science-Teacher Test (DASTT) was developed to "illuminate the knowledge and beliefs preservice elementary teachers construct prior to coursework in elementary science teaching methods," [3] and the Draw-A-Mathematics-Teacher Test was developed to investigate pre-service teachers' perceptions of what it looks like to teach mathematics in the classroom [4]. DASTT has also been used to identify changes in pre-service teachers' beliefs about teaching science that take place over the course of completing science education methods courses [5]-[6].

Studies have reported that elementary teachers hold stereotypical views about engineers [7]-[9] as well as misconceptions about who can become an engineer [10], describing the profession as only appropriate for super smart people [11] and not appropriate for students from lower socioeconomic backgrounds [12]. Some of these perceptions may result in teachers unintentionally reinforcing stereotypes that have perpetuated the lack of gender and ethnic diversity in STEM fields. Studies employing the Draw-an-Engineer (DAE) instrument [2] highlight that children are much more likely to create drawings of white, male engineers who are working alone than drawings of women, minorities, or people working in groups [13]-[17]. DAE studies also indicate that children often have a narrow view of the work of engineers, often drawing them as laborers who build and fix things [14]-[18].

The development and use of a Draw-An-Engineering-Teacher Test could provide pre and in-service teachers with the opportunity to capture their mental images and reflect on what they believe engineering does or would look like in their classrooms. These depictions could aide education faculty and professional development providers in identifying these potential misconceptions and give participants the opportunity to reflect upon how they can develop engineering learning experiences for their classrooms that are not exclusionary to traditionally underrepresented students.

The current study works to add to the previously mentioned set of Draw-A-Teacher Tests by developing a Draw-An-Engineering Teacher Test (DAETT) to identify teachers' mental images of engineering teaching. Specifically, the study seeks to answer the following research questions:

1. What mental images do participants hold of themselves teaching engineering at the elementary level?
2. How do pre-service teachers' mental images of teaching engineering change after completing a semester long science methods course that includes engineering-focused components?

This project is a work in progress and the current paper reports on the initial inductive coding of the pilot data from the DAETT completed on the first day of the semester, as well as describes next steps of the project.

Participant Demographics

The instrument is being piloted with 71 pre-service elementary teachers at Montana State University who are enrolled in a K-8 science methods course during the 2018-2019 academic year. Participant demographics are presented in Table 1. Students enrolled in the class were at least Junior level standing and were required to have completed nine college level science credits (3 life, 3 physical, 3 earth/space) prior to enrollment in the methods course. Three of the students were classified as post-baccalaureate, one was an army veteran working toward her first degree, and the rest were traditional undergraduates.

Table 1. Participant demographics

	Number	Percentage
Gender		
Male	9	12.68
Female	62	87.32
Ethnicity		
American Indian or Alaskan Native	2	2.82
Hispanic	2	2.82
White	66	92.96
More than One	1	1.41

Drawing Procedures

The DAETT is modeled after the DASTT and instructs participants to draw themselves teaching engineering on the front of a sheet of paper. On the back of the paper, participants are asked to "Describe what you are doing." and "Describe what the students are doing." Participants were given approximately 10 minutes to complete the drawing. All participants completed the DAETT on the first day of their K-8 Science Methods course and have or will complete the instrument again on the last day of the course.

Analysis

When scoring the drawings, the following aspects were considered: the physical appearance of the teacher, the physical appearance of the classroom, the physical appearance of the students, the implied actions of the teacher, and the implied actions of the students. The researchers completed the first round of coding by examining the drawings to determine if they were teacher-centered or student-centered. The DASTT checklist and scoring process used by Thomas et al. [3] was used as a basis to determine if the drawings depicted teacher-centered or student-centered environments. Drawings classified as teacher-centered depicted the teacher at the center of learning, while those that were student-centered depicted the teacher as more of a facilitator as the students took responsibility for learning. After this initial round of coding, the researchers completed a second round of coding during which they looked for evidence of engineering design. When coding for engineering design, the researchers used the code list from the Engineering Design-Based Science Teaching Observation Protocol [19].

Findings

Drawings revealed that 57.8% of participants depicted teacher-centered classrooms, 32.4% depicted student-centered classrooms, and 9.8% fell in an intermediate state between teacher-centered and student-centered. Examples of teacher-centered and student-centered drawings are presented in Figures 1, 2, and 3.

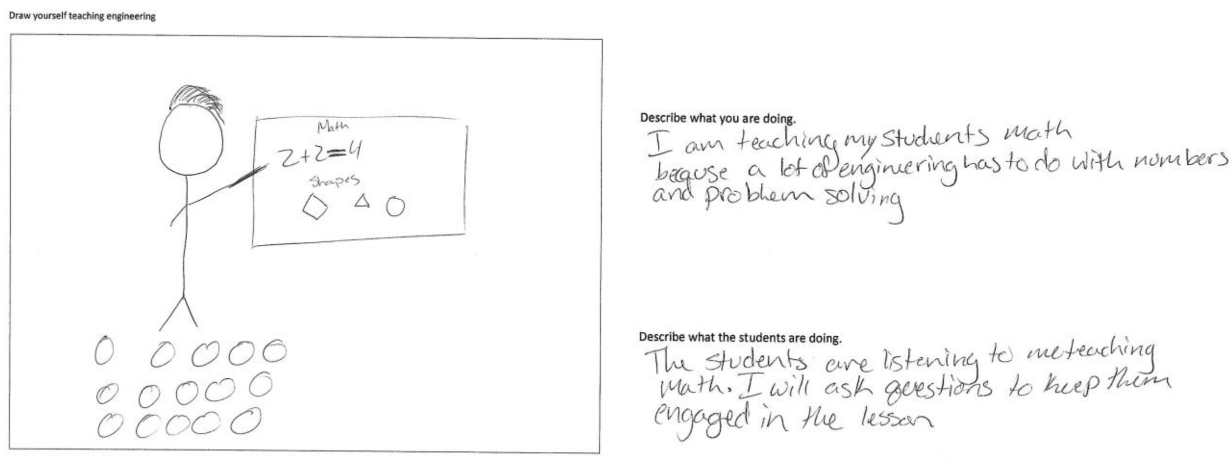

Figure 1. Example of a teacher-centered drawing illustrating a mathematics themed lecture.

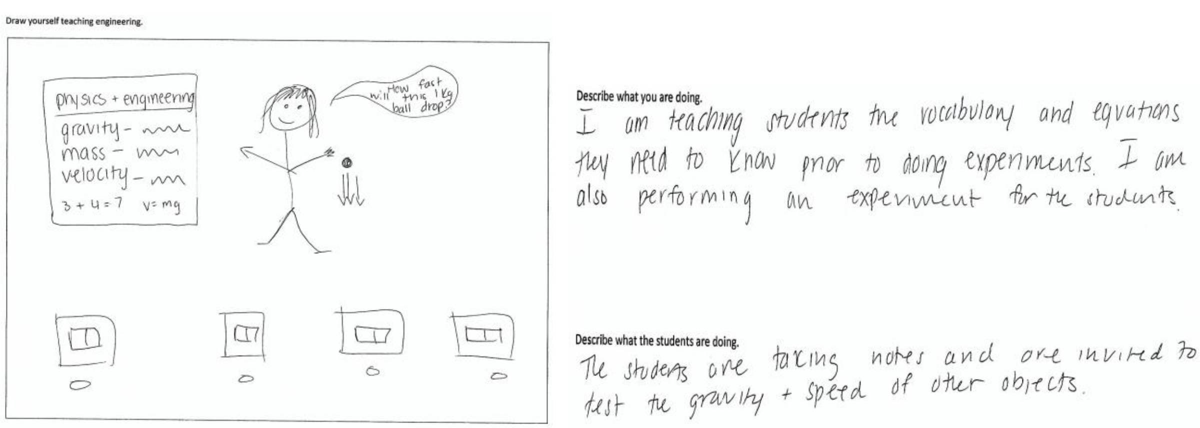

Figure 2. Example of a teacher-centered drawing illustrating demonstration of science concepts rather than engineering design.

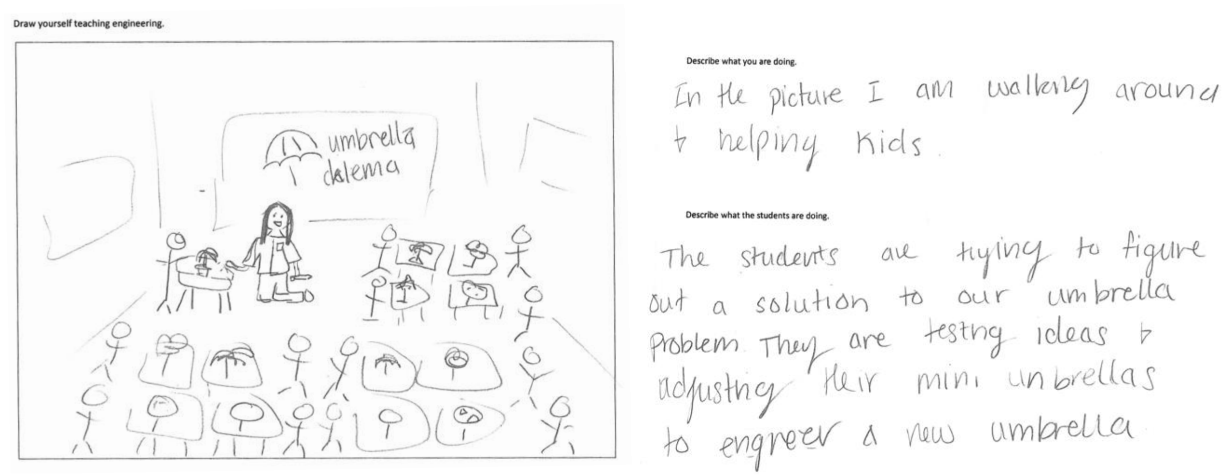

Figure 3. Example of a student-centered drawing. Students are testing and redesigning solutions to a problem.

To help characterize differences between teacher-centered and student-centered drawings, the researchers examined the words and phrases that were present in open-ended responses. Table 2 presents a list of words and phrases used by participants in their open-ended responses. Phrases used in teacher-centered responses, such as giving instructions, leading a lesson, and teaching vocabulary, indicate that pre-service teachers viewed themselves as responsible for transmitting knowledge to their students rather than facilitating knowledge construction. Similar findings were reported by Utley and Showalter [4] in their work with pre-service math teachers.

Table 2. Words and phrases used by participants in the open-ended responses.

Describe what you (teacher) are doing		*Describe what your students are doing*	
Teacher Centered	Student Centered	Teacher Centered	Student centered
•Asking questions	•Walking around	•Building	•Looking at structures
•Demonstrating	•Answering questions	•Listening	•Building
•Giving instructions	•Helping students	•Taking notes	•Drawing ideas
•Describing	•Observing students	•Working math problems	•Working in groups
•Teaching math		•Being confused	•Problem solving
•Leading a lesson		•Repeating the experiment	•Collaborating
•Teaching vocabulary			•Testing ideas
•Describing variables			•Creating
•Performing an experiment			•Adjusting (designs)
			•Recording findings
			•Investigating
			•Self-discovery
			•Applying knowledge

Various components of engineering design were identified in the drawings as well as the written statements. Table 3 present the engineering design related codes that were identified in the drawings and open-ended responses and the frequency with which they appeared in participants' drawings.

Table 3. Engineering design-based codes identified in drawings and open-ended responses (based on [19]).

Engineering design phase	Description	Frequency
Problem Scoping – Teacher	Teacher provides the context of the problem	9.9%
Problem Scoping – Student	Students define and/or identify problem context	1.4%
Solution Formulation	Students develop plans	12.7%
Student Production and	Students build their prototype	19.7%
Performance	Students test their prototype	8.5%
Communication and	Students evaluate their testing results	4.2%
Documentation of Results	Students communicate results with others	0%
Optimization	Students identify ways to improve their design	4.2%
Engineering design not present	Engineering design activities not apparent	50.7%

Conclusions and Next Steps

More than half of the drawings did not contain any recognizable aspects of engineering design-based teaching. Drawings in this category consisted mainly of images of teachers lecturing while students took notes (see Figure 1), or images of teachers lecturing about a science concept or demonstrating a science experiment (see Figure 2). Of those participants whose drawings did include engineering design-based teaching, 28.2% included building and testing prototypes. Further, an additional 11.3% of participants' drawings depicted students building things without any type of problem to solve (ex. playing with Legos or tinker toys) and 4.2% depicted teachers demonstrating step-by-step instructions for building a structure. This, taken together with the limited number of drawings depicting problem scoping (11.2%), suggests that many pre-service teachers equate building things with engineering and they may not fully understand the importance of designing solutions to problems. Further, none of the participants' drawings depicted students' sharing or communicating their designs with others. This could indicate that pre-service teachers are unaware of the ways in which engineers communicate with each other and others involved in the overall problem solving process (e.g. clients, technicians).

The DAETT is still in the initial steps of development. Think alouds are currently being conducted with a subset of the study participants to determine how well the DAETT instrument captured what the participants intended to share. Results of these think alouds will be available to share during the ASEE annual meeting. Next steps in the DAETT development include creating a pilot score sheet that can be used to assign quantitative values to individual drawings; partnering with additional institutions to gather instrument data on a more diverse group of participants; and analyzing post-course drawings to identify any changes that occurred over the course of the semester.

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