

# Teaching and Evaluating Design Competencies in the 21st Century

Julia Kramer, Euiyoung Kim, Danielle Poreh, and Alice Agogino

**Keywords:** human-centered design competency, Engineer of 2020, engineering education

**ME 250, "Human-Centered Design Methods", uses human-centered design methods to provide students hands-on real-world experience in developing innovative and customer-driven solutions.**

The course aimed to support students in building competencies in various dimensions of "design" and used theDesignExchange, a web portal of over 300 design methods aiming to provide design education tools for both academia and industry, as a framework for structuring the course in five design categories:



Research



Analyze



Ideate



Build



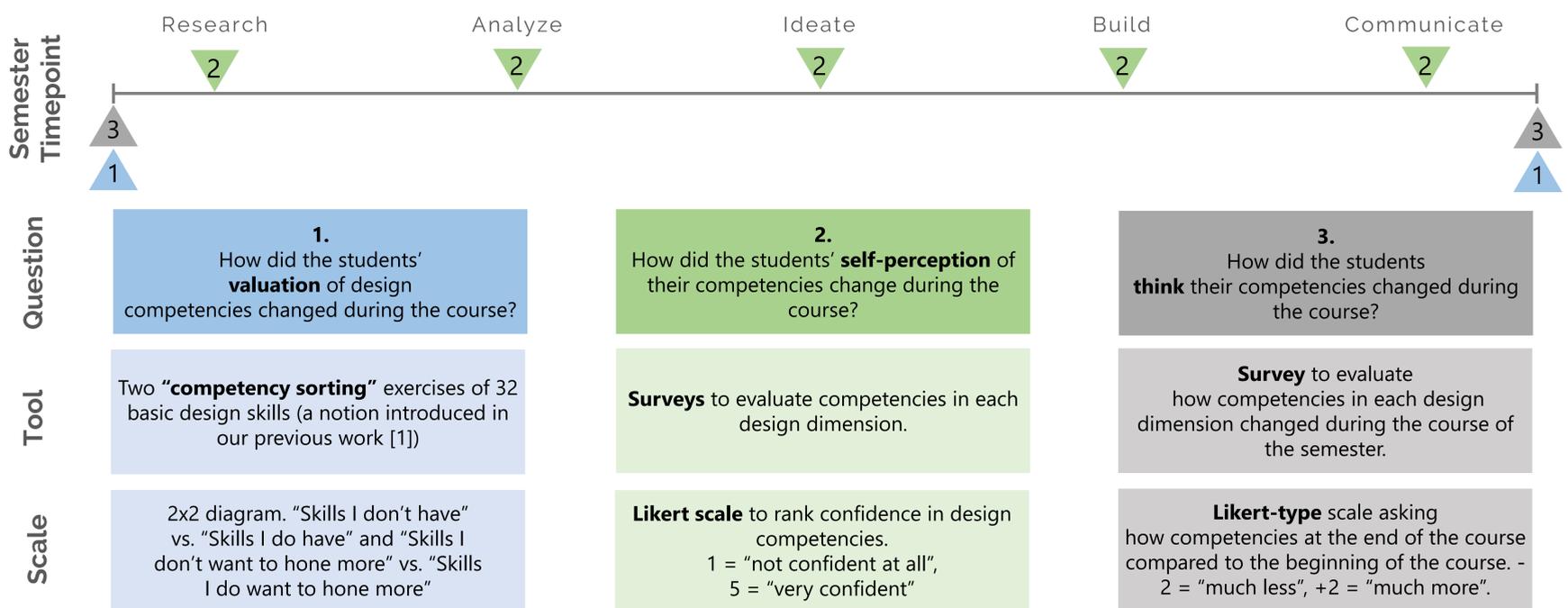
Communicate

**DESIGNEXCHANGE**

www.theDesignExchange.org

## Research Methods and Data

52 of 58 enrolled ME 250 (Primarily Graduate) students completed all of the surveys and exercises. Seventeen students are female and 35 are male.



## Research Findings

**Questions:** "How confident are you in your \_\_\_ skills and abilities?" with each of the rows in Table 1 below filling in the blank. The responses to these questions are in columns 2 and 3. We also asked "How does your confidence level in your \_\_\_ skills and abilities now compare to your confidence level at the beginning of the class?"

Figure 1: Sample response of Question 1

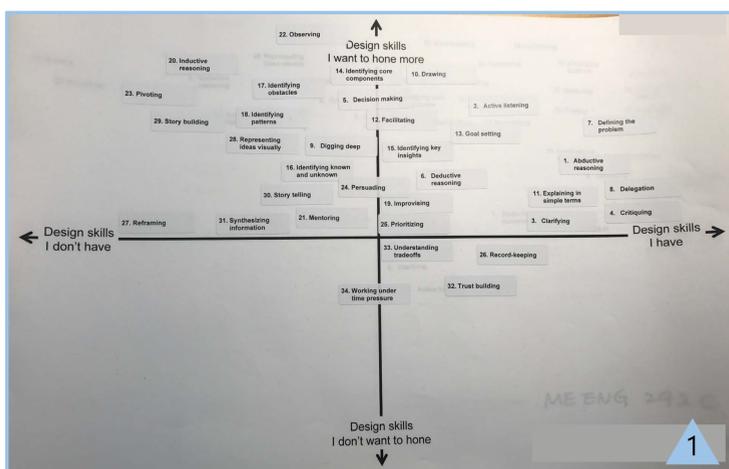


Table 1: Confidence ratings among six dimensions of design competencies

	Average Initial Confidence Rating	Average Final Confidence Rating	Absolute Change in Confidence Rating	Perceived Change in Confidence Rating
<b>General Design</b>	3.60	4.27	0.67 **	1.29 ^^
<b>Design Research</b>	3.35	4.17	0.83 **	1.21 ^^
<b>Analysis and Synthesis</b>	3.79	3.98	0.19	0.96 ^^
<b>Concept Generation</b>	3.40	4.15	0.75 **	1.10 ^^
<b>Prototyping and Building</b>	3.67	4.08	0.40 **	0.83 ^^
<b>Visualization and Communication</b>	3.77	3.90	0.13	0.94 ^^

Two-sample paired t-test ( $H_0: \mu_{\text{final}} - \mu_{\text{initial}} = 0$ ) \*\* - significant at  $p < 0.001$   
 One sample t-test ( $H_0: \mu_{\text{perceived change}} = 0$ ) ^^ - significant at  $p < 0.001$

### Beginning of Semester

#### Skills wanting to hone

1. Identifying key insights (45 students)
- 2-3. Decision making, Digging deep, Pivoting, and Representing ideas visually (44).

#### Skills perceived to have

1. Observing (39 students)
2. Defining the problem (38)
3. Identifying obstacles (38)

#### Skills *not* wanting to hone

1. Working under time pressure (29)
2. Record-keeping (26)
3. Delegation (25)

#### Skills perceived to *not* have

1. Pivoting (34)
2. Critiquing (30)
3. Story building (29)

### End of Semester

#### Skills wanting to hone more

1. Abductive reasoning (47)
2. Critiquing (45)
3. Persuading (45)

#### Skills perceived to have

1. Observing (42)
2. Working under time pressure (42)
3. Decision making (41)

#### Skills *not* wanting to hone more

1. Mentoring (25)
2. Identifying known and unknown (24)
3. Record-keeping (23)

#### Skills perceived to *not* have

1. Drawing (28)
2. Mentoring (25)
3. Pivoting (25)

## Implications for Engineering Education

The Engineer of 2020 attributes are inherently transdisciplinary and notably not specific to engineering. Similarly, design transcends disciplinary bounds, and brings together engineering, business, social sciences, and creative practices. ME 250, as a hands-on project-oriented design class, supported students in **gaining more confidence in their design abilities**. They became more confident in each of the design phases we identified. Students gained competency in skills identified in the Engineer of 2020 report [2][3], relevant both inside and outside the design context.

[1] Kramer, J., Agogino, A. M., & Roschuni, C. (2016). Characterizing Competencies for Human-Centered Design. In ASME 2016 IDETC-CIE.

[2] National Academy of Engineering. (2004). *The Engineer of 2020: Visions of Engineering in the New Century (Phase I)*. National Academies Press.

[3] National Academy of Engineering. (2005). *Educating the Engineer of 2020: Adapting Engineering Education to the New Century (Phase II)*. National Academies Press.

We gratefully acknowledge the support of NSF award 1334267