A Non-Engineer's Discovery of Design Thinking

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Abstract
Design Thinking is a human-centred Engineering Design method that aims to find creative solutions to problems and encourages empathy, collaboration, and experimentation. This paper will introduce Design Thinking and relate the writer's discovery of it as a non-Engineer who taught an Engineering English course based mainly around the Scientific Method. I will demonstrate how, in response to students' apparent lack of enthusiasm for the lesson content, I adapted lessons to include Design Thinking alongside the Scientific Method. The paper will include examples of the activities used and the results of an informal questionnaire showing students' overwhelmingly positive reaction to the introduction of Design Thinking into the lessons. Finally, the paper will conclude with recommendations for incorporating Design Thinking into language lessons.

Keywords: Design Thinking, Engineering, English

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Introduction

International College of Technology, Kanazawa is a five-year technical college. Students enter aged 15 and study high school level courses for three years, then university level courses for two years, before either going directly into employment aged 20 or going on to further education. In their fourth year, all students must study an English course taught by a non-Japanese teacher. The course is called Advanced English I, but it is divided into four streams, one of which is called Engineering & English, which I taught during the 2018-19 academic year, despite my lack of background in Science, Technology, Engineering, or Mathematics (STEM); my background is in Modern Foreign Languages and Education. The main focus of the course was making things in short experiments, usually done in pairs, then writing the experiments up using the Scientific Method of purpose, hypothesis, steps, data collection, and conclusion.

The first few weeks of the course covered how to write a lab paper by introducing each aspect of the Scientific Method one by one and practicing them by doing small experiments such as making a balloon car, a lemon battery, a catapult, and several others. Students seemed to enjoy the course initially but their enthusiasm began to tail off as the year progressed. This might have been due to a lack of enjoyment itself caused by writing the lab papers, or maybe because they wanted more choice over what experiments they did. Around this time, I read in *The Introspective Engineer* that "engineering is a significant part of what we are, and an indispensable part of what we seek to be. Engineering can also be great fun—to learn about as well as to do" (Florman, 1996, p6). This struck me as important and relevant to the situation: there had to be a way to make learning about Engineering (and English) more engaging.

Having recently been involved in facilitating Open Campus events and workshops for visiting students, I was present for several Introduction to Design Thinking workshops conducted by Engineering Design teacher colleagues for the benefit of the visitors. While reflecting on those workshops, Design Thinking stood out as a method of increasing students' motivation, active learning, and English use. The following sections contain an explanation of Design Thinking, the activities used and the students' reactions to them, the adjustments made based on that feedback, and the feedback that followed the adjusted lessons. The paper concludes with recommendations for incorporating Design Thinking into other learning and teaching contexts, and a call for more research into Design Thinking and language learning.

Design Thinking

Design Thinking is a human-centred Engineering Design method that aims to find creative solutions to problems and encourages empathy, collaboration, and experimentation. The focus on real problems in the everyday lives of humans means that "innovation is powered by a thorough understanding, through direct observation, of what people want and need in their lives" (Brown, 2008, p.86). Collaboration is a key component of Design Thinking. Collaboration requires communication; they are interdependent. Similarly, the Advanced English I Engineering & English course takes as its basis the interdependence of Engineering and English, as indeed does the school's entire curriculum. Design Thinking's emphasis on collaboration and experimentation also promotes active learning and English use. To be active, learning

requires students to “read, write, discuss, or be engaged in solving problems” while also attempting “higher-order thinking tasks [such] as analysis, synthesis, and evaluation” (Bonwell & Eison, 1991, p.iii). The link between Design Thinking and active learning can be partly demonstrated by a series of activities designed for aiding discussion of social issues (Taylor, 2018).

Activities

The following sections outline the activities used in classes to introduce Design Thinking to students. In order to prepare students for projects later in the course, most introductory activities were designed to practice Stages 2 (Interpretation) and 3 (Ideation), as these would be most relevant and useful later.

Stage 2: Interpretation

Students completed three activities for Interpretation. The first activity was What? How? Why?, in which they look at a photo and must complete a worksheet that is divided into three columns (Figure 1). Students start with the “What?” column, and write who they see, what they are doing, and other details, without guessing. In the “How?” column, students write how the people are doing what they’re doing, their facial expression, body language, using as many adjectives as possible. The final column, “Why?”, requires the students to guess the motivations and emotions of the people in the picture, which is where the empathy aspect of Design Thinking comes in.

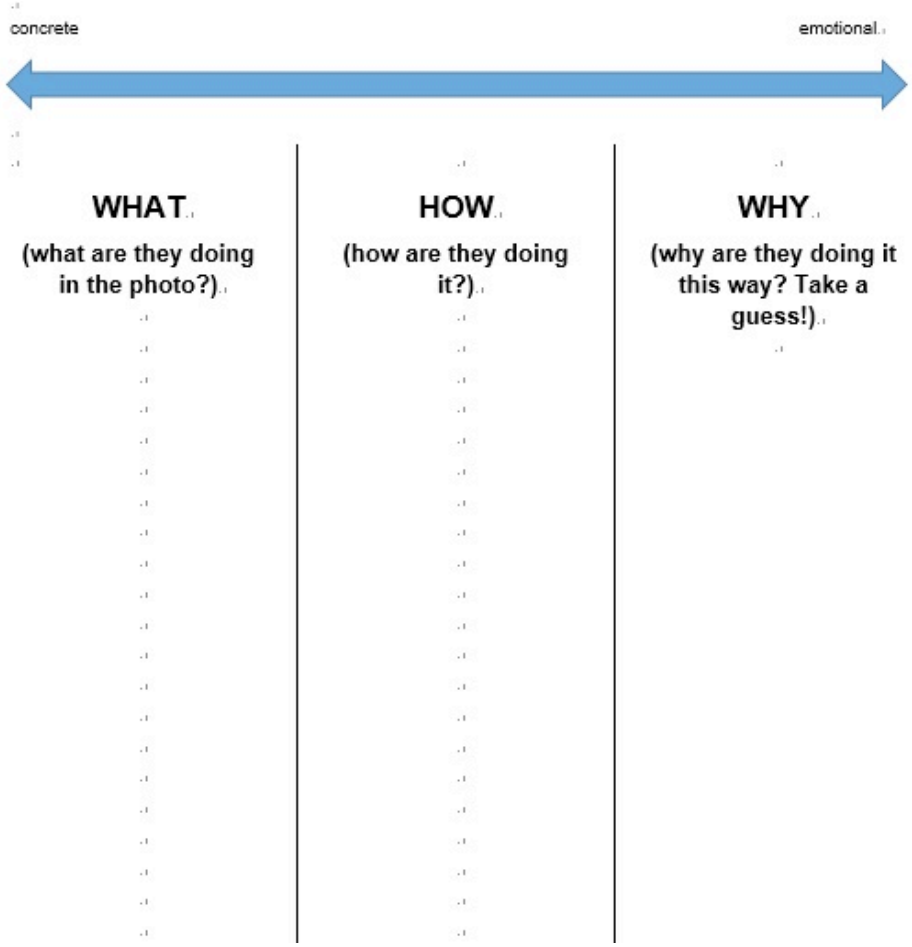

Figure 1: What? How? Why?

The second Interpretation activity was POEMS (People, Objects, Environment. Media/Messages, Services). For this activity, students received a worksheet with a column for each of those five categories (Figure 2), considered the classroom and wrote down what they could see in the room. When they had finished, they had to evaluate the experience of the classroom users (themselves) overall as positive or negative.

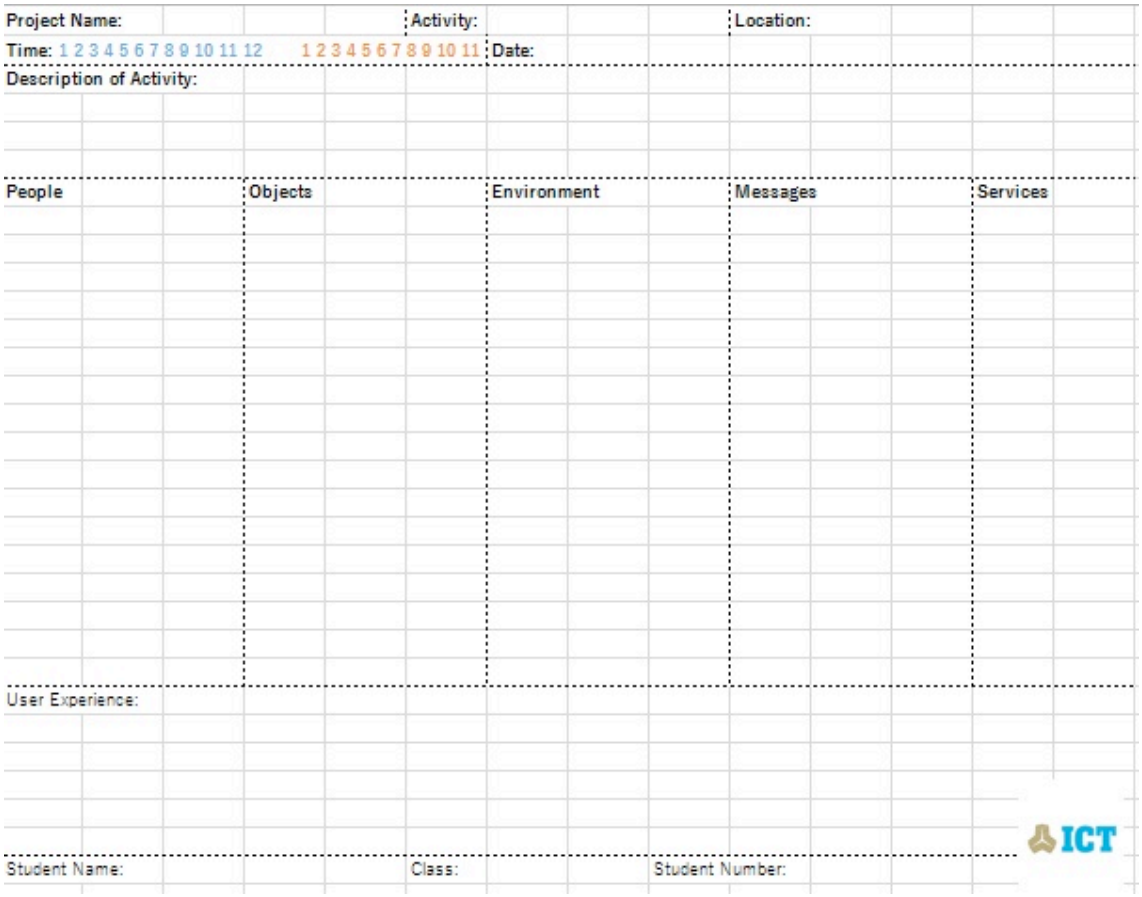

Figure 2: POEMS

The final Interpretation activity was Journey Mapping. This activity required students to consider their morning routine from waking up to arriving at school, and to plot their emotions on paper as the morning progresses (Figure 3). The rationale behind this activity is to consider aspects of their morning routine that cause negative emotions, which would then lead to an exploration of potential improvements to the routine.

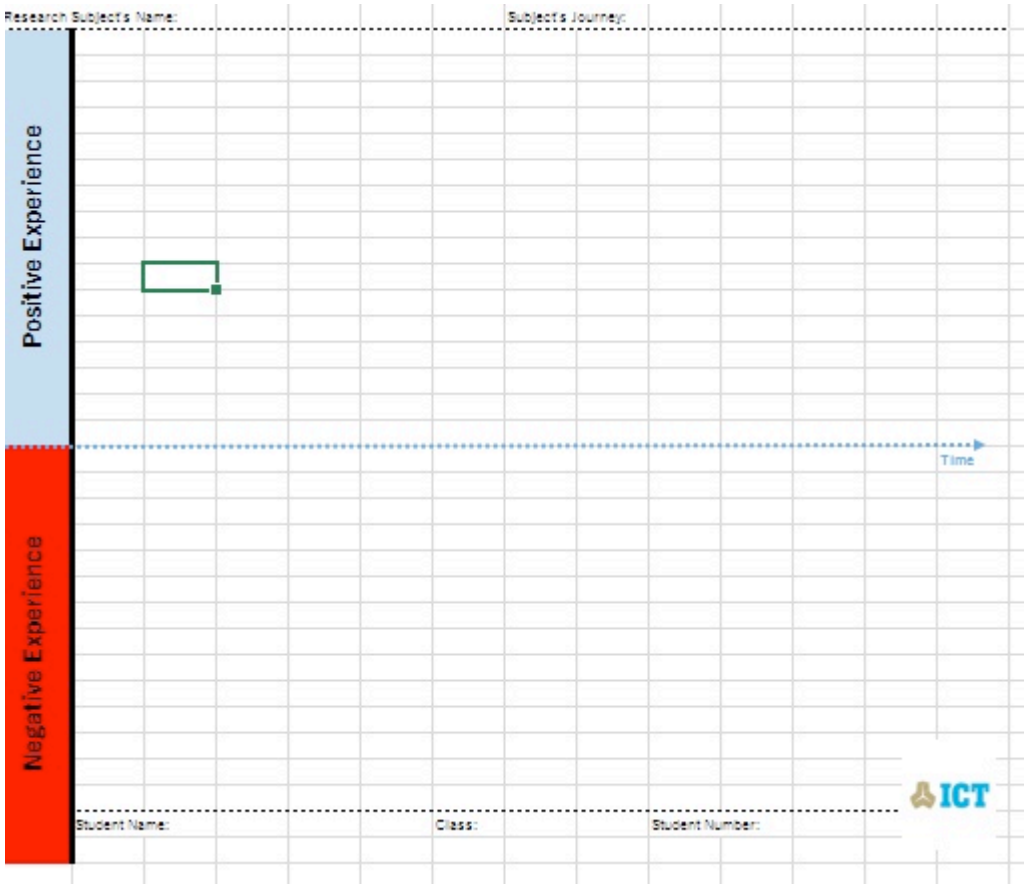

Figure 3: Journey Mapping

Stage 3: Ideation

After completing the Stage 2 activities, we moved on to practice Stage 3. This section, Ideation, focuses on techniques for brainstorming. Before beginning ideation, students were divided into groups. Each student received Post-It notes and a marker pen, and a piece of A3 paper was attached to the wall near the group, so students would have to be physically active in order to share their ideas. Students were also made aware of the rules for ideation: we wanted quantity over quality – we were not concerned with whether an idea was good or bad, as that stage comes later – and students were not required to use correct spelling, as long as they tried to use English. The class had a situation or problem, a time limit (usually 10 minutes), and students brainstormed possible solutions to the problem, following the rules of ideation. Students worked through five situations:

1. The layout of this classroom isn't very user-friendly. How can we improve it?
2. Monkeys keep entering my allotment and eating the vegetables. What can I do to stop them?
3. Venice is very popular for tourists but cruise ships are too big for Venice Port. What can be done?
4. There are many elderly people living alone in Kanazawa. It is difficult for them to go to the supermarket or to the doctor, etc. How can we assist them?
5. Every day, restaurants and shops throw away food they didn't sell. How can we reduce the food waste?

These scenarios were designed in order to require students to consider the everyday lives of other humans and empathise with others as they were considering how to solve the problem. To some extent, the scenarios also "expose[d] students to the situations that engineers encounter in their profession" (Crawley, et al., 2007, p.6).

When the time limit for ideation had expired, each group was given another A3 paper, this time with a 2x2 matrix with "Possible/Impossible" on one axis and "Desirable/Undesirable" on the other (Figure 4). By transferring their ideas from the first paper to the 2x2 matrix, students were able to evaluate their ideas and narrow their focus to those that were desirable and possible.

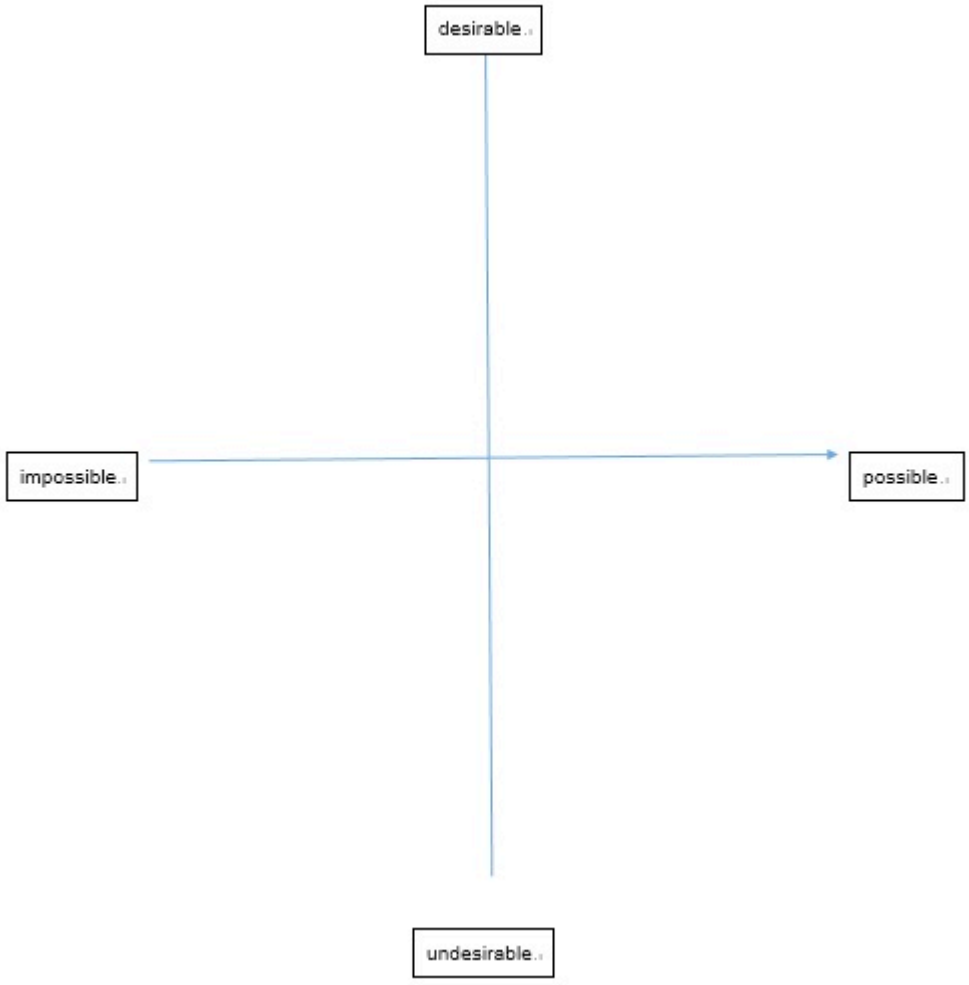

Figure 4: 2x2 Matrix

Stage 4: Experimentation

Students also had the opportunity to practice the Experimentation stage by choosing their most desirable and possible idea from one of the five ideation sessions and building a quick and simple prototype using materials available in the classroom.

The following section will explain the students' responses to these activities.

Students' Responses

Following the lessons introducing Design Thinking, students completed a short, informal questionnaire consisting of five questions to gauge their reactions and preferences (see Appendix A). Ten students out of 14 responded positively to the early lessons using the Scientific Method, but the comments were revealing: some thought it was hard to understand and repetitive. Twelve out of 14 responded positively, with comments praising the usefulness of the method for other classes and for improving communication. Given a choice of Scientific Method only, Design Thinking only, or a mix of both, seven students opted for Design Thinking and 7 opted for a mix of both.

The next section outlines the adjustments made to the structure of lessons in the second half of the year.

Adjustments

With the results of the informal questionnaire in mind, and despite being constrained to some extent by the fact that projects were already enshrined in the syllabus, adjustments were made to the lesson structure in the second half of the academic year. Instead of merely informing students of what they would build, I created scenarios that would give them freedom to ideate before beginning to build prototypes. Thus, when students were required to build a mechanical arm, the scenario was that they worked for The Japan Aerospace Exploration Agency and they were part of a team that had to design a robot arm to fit on a Mars rover to collect rock samples. When the syllabus stated that students had to build a pump, the scenario was that the school's new campus needed a water feature. In each case, students spent time on the ideation process before prototyping, and they had to complete a lab paper during and after the projects.

The final few weeks of the year were individual projects, but students worked in pairs for the initial ideation stage, in which they had to choose a problem in their everyday life – at home, at school, in their neighbourhood, or daily routine – and think of potential solutions, then evaluate them using the 2x2 matrix. Students had to choose one desirable and possible idea, make and evolve a prototype, and finally reflect on whether they think they solved their problem. Students considered a variety of problems, and prototypes included a smartphone app linking the bus timetable to an alarm so the student would not miss the bus, a smartphone speaker, an alarm clock with a robot arm to hit the student when it was time to wake up, and a combined smartphone holder and charger, which the student successfully made with a laser cutter and LEDs (Figure 5).

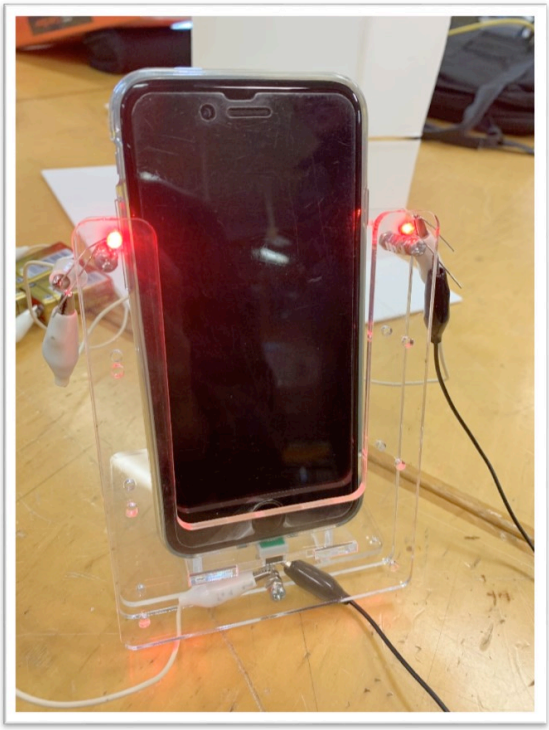

Figure 5: Student-made smartphone holder and charger

Students' Responses

At the end of the year, students completed another brief, informal questionnaire (see Appendix B). The responses were again mostly positive. Students enjoyed the opportunity to do more Design Thinking as they liked making things and trying to solve problems in that way. In terms of completing tasks, some students said that Design Thinking was not helpful due to time constraints, but again most students were in favour, with words like "useful" and "important" repeatedly appearing in responses.

Conclusions & Recommendations

The fact that Design Thinking is collaborative, creative, and human-centred means that it encourages active learning and is suited to many learning contexts. There are some similarities with task-based language teaching, but Design Thinking – particularly the Interpretation and Ideation stages – could also be used to some extent in language courses that discuss social issues (Taylor, 2018) or do critical thinking, or into language lessons that focus on the four skills. Design Thinking has many benefits, it is versatile and simple to implement, even for non-experts and non-engineers, and it was popular with students, who appreciated the opportunities to improve communication and share ideas with others.

To date, little research has been conducted into Design Thinking and its potential connection to or effects on language learning, group dynamics, and creativity. More insight into such areas would be enlightening and valuable to language teachers.

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Appendix A

1. What did you think of the lessons that used the Scientific Method?
2. Why?
3. What did you think of the lessons that used Design Thinking?
4. Why?
5. If you had to choose one type of lesson, which would you choose: Scientific Method, Design Thinking, or a mix of both?

Appendix B

1. We did more Design Thinking and less Scientific Method in Autumn and Winter. What did you think about this?
2. Do you think Design Thinking helped you to complete tasks? Why or why not?