

# Experiential Learning: Teaching Math Modelling

*Dr Sergey Kushnarev  
Senior Lecturer, SUTD*

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# Outline

- Experiential Learning
- Math Modelling
  - What is it.
  - How is it taught.
- Math Modelling as Experiential Learning
- Challenges/Issues.

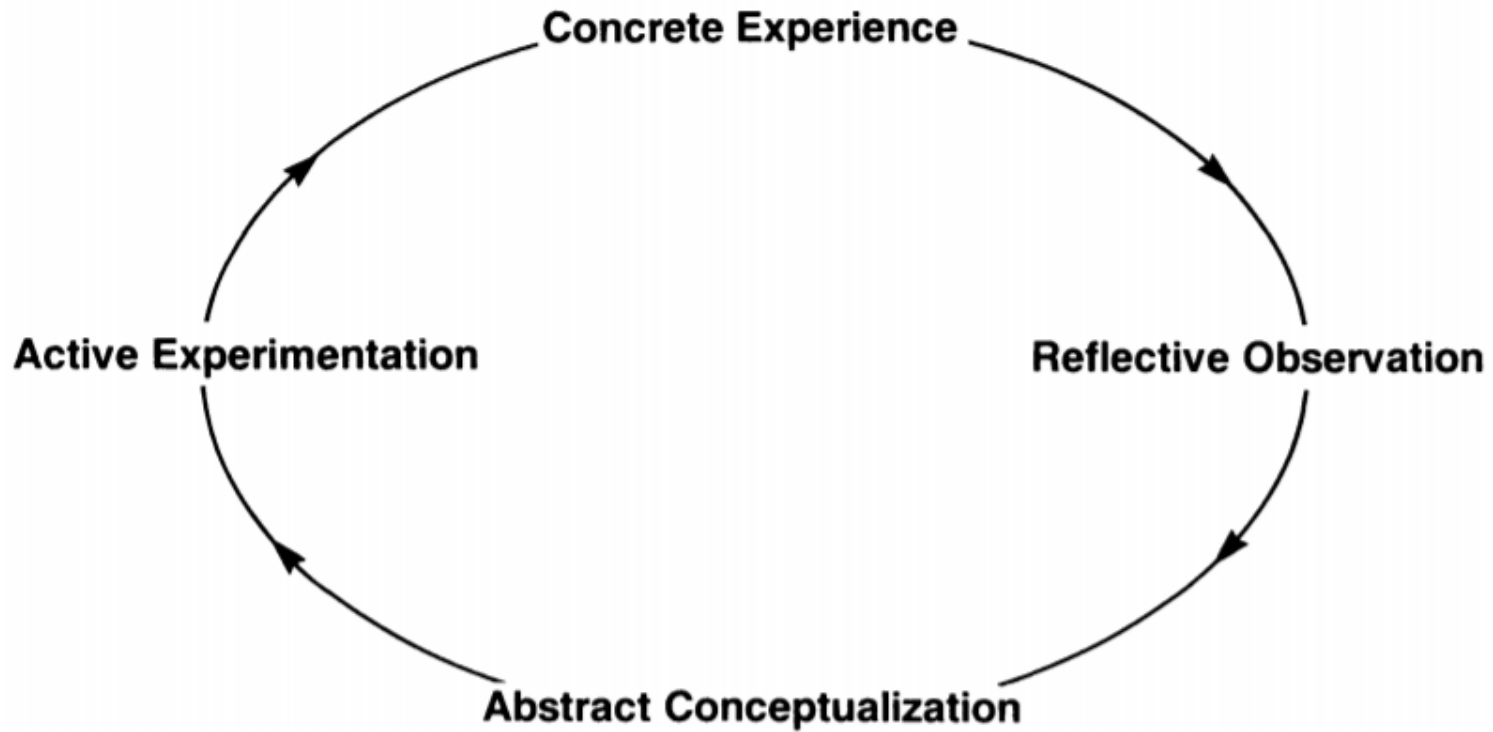
# What is Experiential Learning?

## Kolb Learning Cycle:

- Student's personal involvement through *concrete experience*;
- Student *reflects* on this experience, looking for meaning
- Student *applies* this meaning to form a logical conclusion;
- Student *experiments* with similar problems, which results in new concrete experiences

Then the learning cycle begins again (Hartman, 1995, Kolb, 1984)

**Figure 1. Experiential learning cycle**



Svinicki, Dixon, 1987

**CONCRETE EXPERIENCE**

Laboratories  
observations  
primary text reading  
simulations/games  
field work  
trigger films  
readings  
problem sets  
examples

**ACTIVE EXPERIMENTATION**

simulations  
case study  
laboratory  
field work  
projects  
homework

**REFLECTIVE OBSERVATION**

logs  
journals  
discussion  
brainstorming  
thought questions  
rhetorical questions

**ABSTRACT CONCEPTUALIZATION**

lecture  
papers  
model building  
projects  
analogies

**Figure 2. Instructional activities that may support different aspects of the learning cycle.**

# Motivation

- Engages students in the mathematics
- Enhances metacognition
- Improves students' retention of content
- Prepares our students for careers:
  - Ability to work with open-ended scenarios
  - Teamwork skills
  - Communication skills

# What is mathematical modeling?

- Is a process that uses math to represent, analyze, make predictions, or provide insight into real-world phenomena.
- A mathematical model is a representation of a system/scenario that is used to gain qualitative and/or quantitative understanding of a real-world problem and to predict future behavior.

# Math Problem vs Modeling Problem

- 1. The population of Singapore is 5.5 million, and 35% of its citizens recycle their plastic water bottles. If each person uses 9 water bottles per week, how many bottles are recycled each week in Singapore?
- 2. How much plastic is recycled in Singapore?
- *we usually do not have complete information when trying to solve real-world problems!*



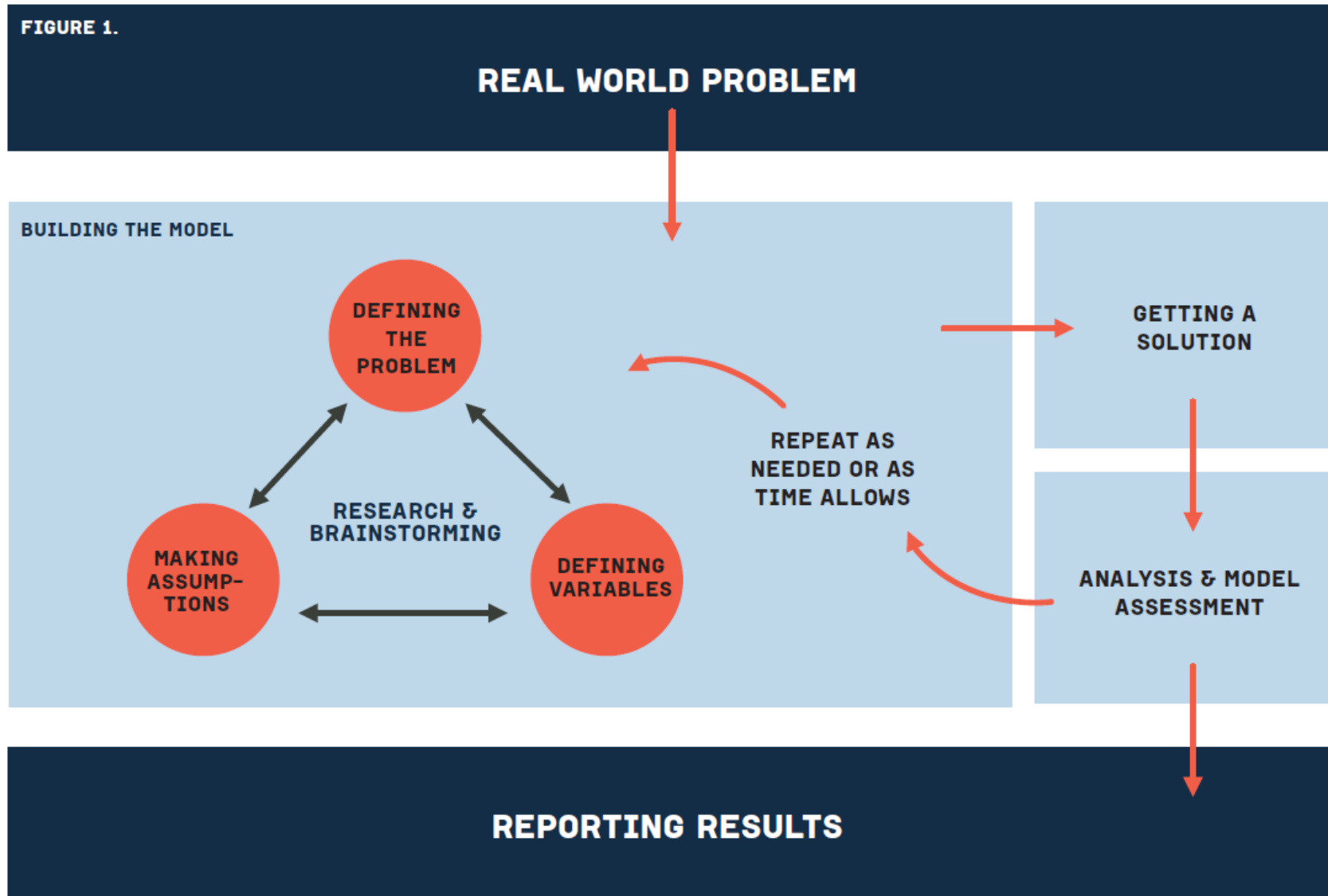
# A Solution VS The Solution

- People solving modeling problem may have different approaches and will come up with different, **valid alternative** solutions.
- **Pitch to students:**
  - *Mathematical modeling questions allow you to research real-world problems, using your discoveries to create new knowledge.*
  - *Your creativity and how you think about the problem are both valuable in finding a solution. This is part of what makes modeling so interesting!*

# Modeling Steps

1. Defining the Problem Statement
2. Making Assumptions/ Defining Variables
3. Getting a Solution
4. Analysis and Model Assessment
5. Reporting the Results

FIGURE 1.



# Logistics

- Math modeling was taught to 1<sup>st</sup> year engineering students in Term 2 Advanced Math class
- Whole cohort (400-500 students) is divided into 8-10 classes of ~50 students each.
- 5 steps of Math Modeling were introduced in the first 5 classes of the term (30mins).
- Students were split into groups (3-5pax) and brainstormed on the whiteboards.
- They submit their work via piazza.com on the same day and receive online feedback from faculty.
- Each step was graded by participation (1% per step, 5% total)

## Math Modeling Activity 4 (1% of the grade)

Split into teams of **3-5 people** (2 is too little, 6 is too many).

Designate one student to **submit work on Piazza by midnight today**. This is to give your cohort instructors time to give feedback before the next class.

Indicate in the corner of the whiteboard/paper all the members of your team (Names and Student IDs). And sketch out the mind map/discussion of the problem.

**In the end you should have a precise mathematical reformulation of the problem written.**

The Math Modeling problem will be revealed in the class.

## Math Modeling Activity (1% of the grade)

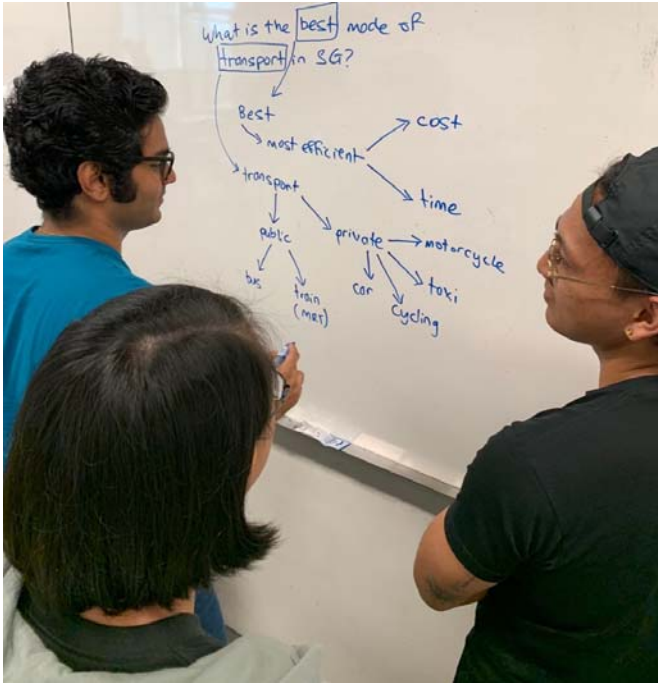
A new personal mobility device startup is asking SUTD students to create a mathematical model that would describe how Singaporeans choose their mode of travel within Singapore.

**Take the picture of your work (make sure names and student IDs of students are visible). And upload as a post within your cohort group on Piazza (read the Piazza instructions).**

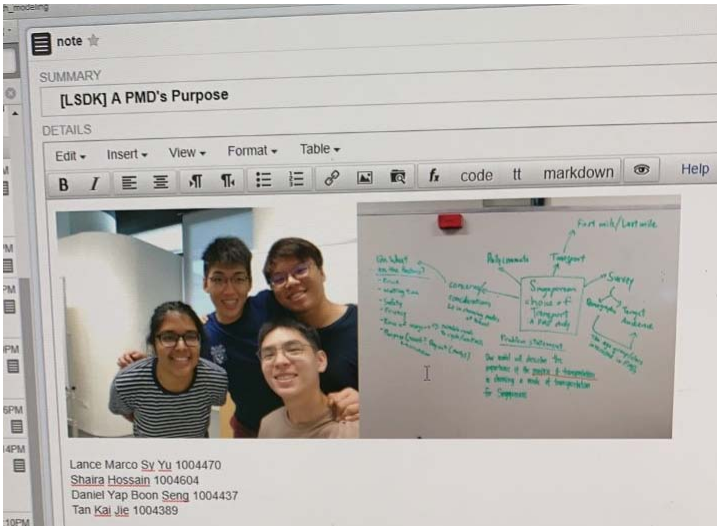
Upload **two photos**: a team selfie (wefie), and a picture of your thought process containing the concise restatement of the question.

You won't be graded on the correctness, so don't worry!

Let your creative juices flow!







# Brainstorming for "Defining the Problem Statement"



## Project (Weeks 3-6): less guidance, more freedom

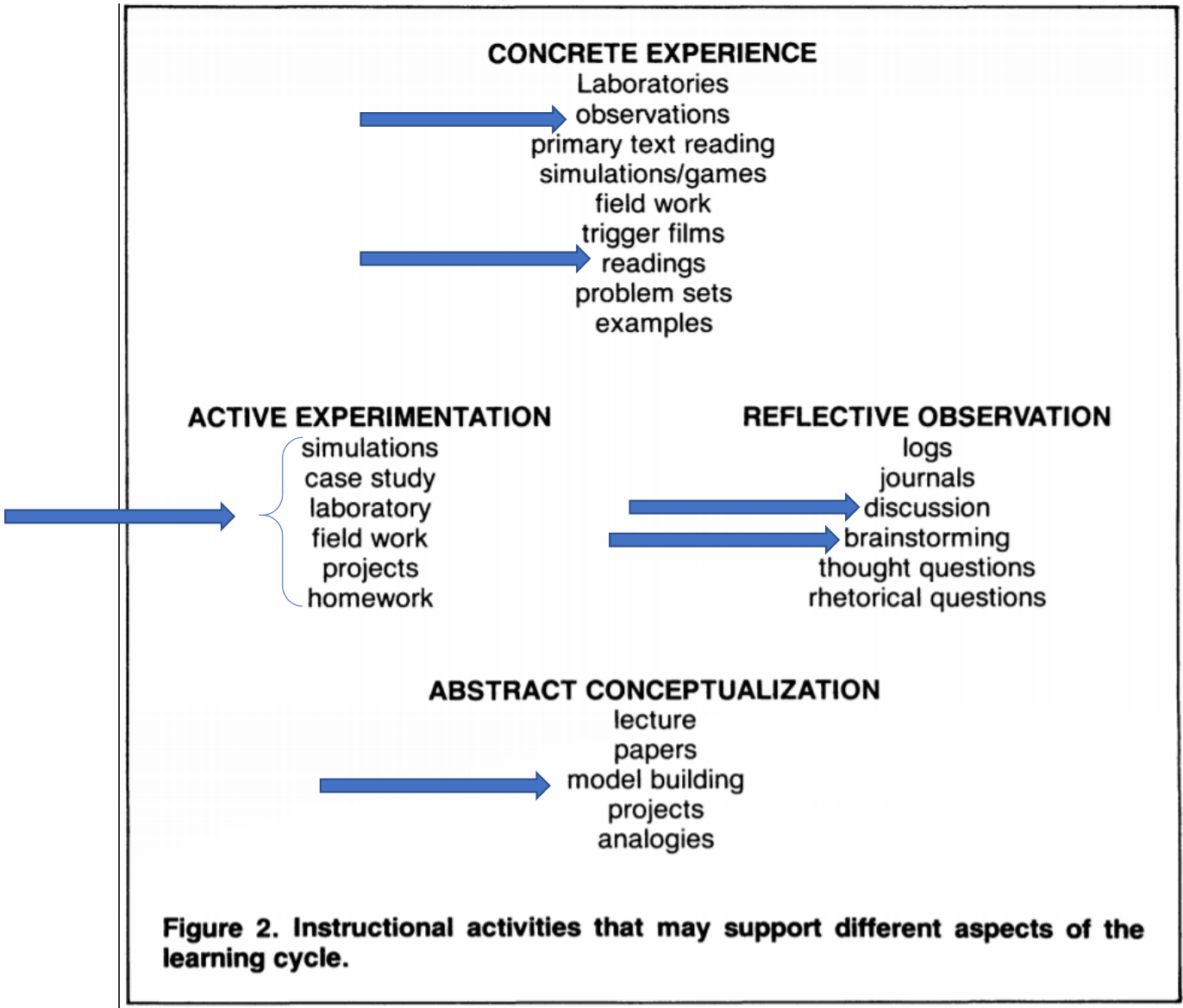
In the Week 3 students were assigned a Math Modelling project (due in Week 6):

- 2018: “**define the notion of a well-airconditioned room.** Determined whether the room in the data provided is well-airconditioned or not”
- 2019: “Civil Aviation Authority of Singapore (CAAS) has recently established Aviation Studies Institute (ASI) at SUTD. In light of this article, ASI tasked SUTD students to **model the impact of airplane noise on Singaporeans.**”

## Final project (Weeks 8-13): even more freedom, even less guidance.

- In Term 2 students are engaged in “Introduction to Design” class.
- They build a prototype of an object which solves a certain need/issue (each year there is a theme)
- Students need to come up with their *own math modelling question and solution* to address the issue at hand.
- Deliverable: a Technical Report and an Executive Summary of their work

**Math modelling is a perfect example of  
Experiential Learning!**



Svinicki, Dixon, 1987

# Challenges in Teaching Math Modeling

- Open-ended approach: There is no “right” answer.
- Instructor creativity and ability to think on their feet is needed.
- Often instructors need to be taught Math Modelling AND How to teach Math Modelling.
- Consistent grading across different instructors is a challenge.

# Thank you

- Any questions?