WORLDWIDE PERSPECTIVES OF ADAPTING ENGINEERING EDUCATION TO CHANGE

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Outline

1. Engineering Programmes at PolyU
2. Lecture Format – Mode of Instruction
   i. Project-based learning
   ii. Online course
   iii. Flipped classroom
3. Capstone Project / Design Project
4. Trends in Engineering Education

Engineering Programmes

- Four-year undergraduate programme
- Minimum credit requirement for graduation: 120 credits
  - General University Requirements (GUR): 30 credits
  - Discipline-Specific Requirement (DSR): 66-102 credits
- Award options:
  - A single discipline Major
  - A Major plus a Minor
  - Double Majors
  - Joint Degree

Engineering Programmes

- The 30 credits GUR distribution:

Areas	Credits
▪ Freshman Seminar	3
▪ Language & Communication Requirements (LCR)	9
○ English	(6)
○ Chinese	(3)
▪ Leadership and Intra-personal Development	3
▪ Service-Learning	3
▪ Cluster-Area Requirements (CAR)	12
3 credits from each of the following 4 cluster areas	
○ Human Nature, Relations and Development	(3)
○ Community, Organisation and Globalisation	(3)
○ History, Cultures and World Views	(3)
○ Science, Technology and Environment	(3)
and of which	
○ A minimum of 3 credits on subjects designated as "China-related"	
▪ Healthy Lifestyle (non-credit bearing)	Nil
Total GUR credits	30

Engineering Programmes

- Highlights
  - Freshman seminar
  - Language training (GUR and DSR)
  - Leadership and intra-personal development
  - Service learning
  - Healthy lifestyle
  - Engineering projects in every year of studies
    - Freshman seminar (include a simple engineering project), mini-projects in various subjects, integrated/multidisciplinary project, final-year/capstone project

Engineering Programmes

- On-line eLearning for Mathematics
  - In addition to help desk, consultation sessions, additional tutorials, etc.
- Sandwich training
- Exchange

Provide a Holistic Education to Our Students

Lecture Format – Mode of Instruction

- Current lecture format
  - Ignore the academic variation among students
  - Technology has become an integral component of university education
- Contemporary alternatives to the lecture format
  - Project-based learning
  - (Massive open) online course
  - Flipped classroom

"Science education: Spare me the lecture," Nature, September 2003.

Lecture Format – Mode of Instruction

- **Project-based learning**
  - A real-world problem is presented
  - Guiding students toward a possible solution in a structured manner
  - Usually expensive

Lecture Format – Mode of Instruction

- For example, “Integrated Project”
  - Software + Hardware
  - Embedded systems and control theory
  - Competition at the end of the course
  - Good project teams will be trained for international competition

Lecture Format – Mode of Instruction

- **Online courses**
  - Massive open online courses (MOOCs)
  - Advantage: video achieving of instructor's presentations enables students to digest new material at their own pace
  - Passive
  - Lack of face-to-face interactions
  - Usually, drop-out rates of MOOCs are high
  - But video lectures are useful teaching materials

"MOOC Adventures in Signal Processing," IEEE Signal Processing Magazine, July 2016.

Lecture Format – Mode of Instruction

- **Flipped classroom**
  - Popularized in K-12 education by the advent of Khan Academy (www.khanacademy.org)
  - A balance between the high-overhead of project-based learning and the overly passive nature of online courses in engineering education
  - Video-based instructions + project-based learning

Allow students to learn key concepts before and after lectures

Use class time for activities

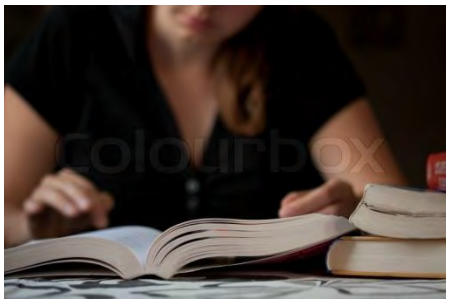
"On Flipping a large Signal Processing Class," IEEE Signal Processing Magazine, SP Education column, July 2017.

Lecture Format – Mode of Instruction

Traditional Classroom

Content delivery from the instructor to students takes place in a mostly **passive** fashion during **scheduled class** periods

Most of the learning is expected to take place **outside** the classroom, through both assigned homework exercises and instructor office hours



Flipped Classroom

Content delivery from the instructor to students takes place **outside the classroom** through **video lessons** and **reading**

Most of the learning is expected to take place **inside** the classroom, through **class activities** and **collaborative work**. This also enables the instructor to remedy students' shortcomings in real time.

Lecture Format – Mode of Instruction

- Classrooms for active learning

Lecture Format – Mode of Instruction

- Flipped learning for large engineering courses is a big challenge
- Require more than one person to guide students during in-class activities

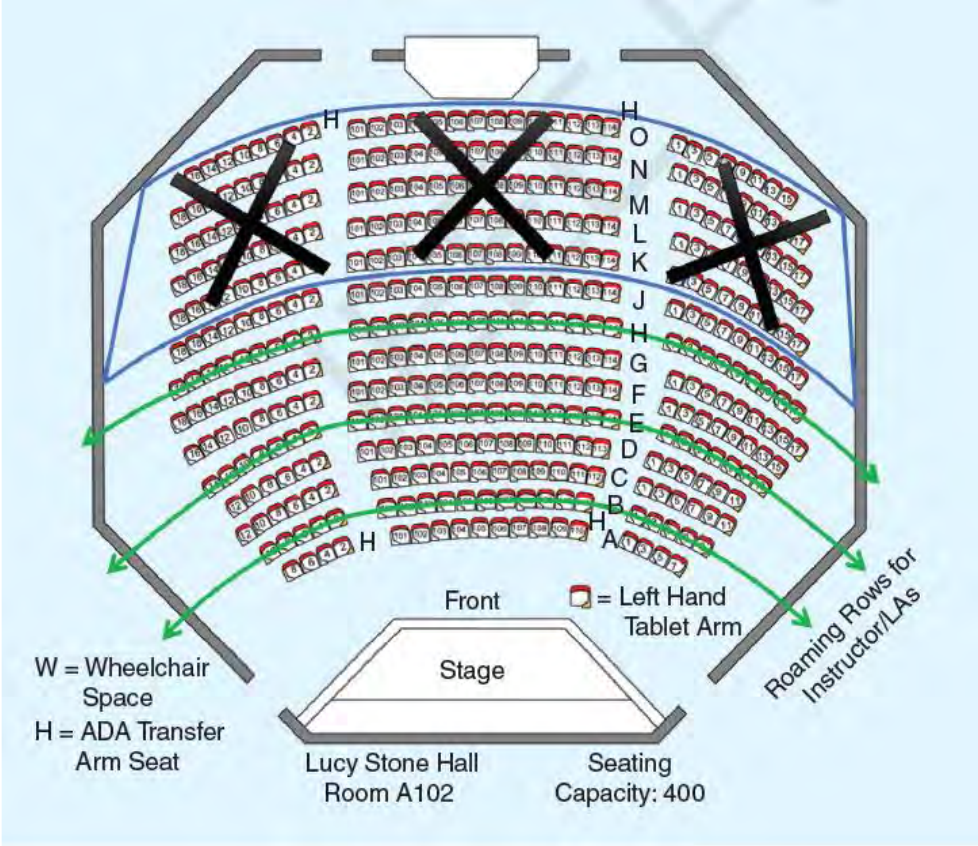


Figure 2. A possible seating arrangement in a lecture hall for students in a large flipped classroom. This arrangement, which I am using in my spring 2017 flipped offering at Rutgers, prohibits students from sitting at the very back of the hall (black crosses) and in three rows (green arrows), and enables instructor(s)/LA(s) to reach individual students by moving within the (green) restricted rows. This particular seating arrangement can accommodate up to 161 students, while it is scalable up to 257 students.

"On Flipping a large Signal Processing Class," IEEE Signal Processing Magazine, SP Education column, July 2017.

Lecture Format – Mode of Instruction

An example of the main activities that comprised a flipped offering

Step Number	Activity Category	Activity Details
1-1	Home Activity	Home Activity Viewing of assigned YouTube video lessons (~30–70 minutes per class)
1-2	Home Activity	Home Activity Completion of assigned textbook reading (if applicable)
1-3	Home Activity	Home Activity Completion of online assessment
2-1	In-Class Activity	In-Class Activity Review of key concepts by the instructor (~10–15 minutes per class)
2-2	In-Class Activity	In-Class Activity Short polling questions
2-3	In-Class Activity	In-Class Activity Paper-and-pencil problems
3-1	Home Activity	Home Activity Paper-and-pencil problems
4-1	Recitation Activity	Recitation Activity Problem solving by the **TA**
4-2	Recitation Activity	Recitation Activity Paper-and-pencil problems

Capstone Project / Design project

- **Internationalization**
  - International project teams
    - Overseas + local undergraduates
    - A theme for the project, with a number of individual projects
    - Team work + communication
    - Visit each other

Capstone Project / Design project

- For example:

  Development of a Video Surveillance System

  People and face detection / People and face tracking / Gait recognition / Face recognition

  – In addition to individual projects, each student must work with other team members to integrate their works to develop a complete system

Capstone Project / Design project

- Competitions for Undergraduates
  - Projects students are encouraged to form teams to participate in open competitions
  - For example: The Signal Processing Cup (**SP Cup**) competition
    - Created by IEEE SPS
    - Students form teams and work together to solve a challenging and interesting problem using signal processing techniques and methods
    - Final competition takes place at ICASSP

"Undergraduate Students Compete in the IEEE SP Cup: Part 1," IEEE Signal Processing Magazine, Education column, July 2015.

Trends in Engineering Education

- Open source educational materials
  - The web is a powerful medium for sharing
- Video tutorials
  - Allow professors to produce videos quickly
- Interactive simulations
  - Technology has improved dramatically for this
- Question and answer databases
  - Drill questions with known answers to help automate the process of assessing students

"Trends in Signal Processing Education," IEEE Signal Processing Magazine, In-the-Spotlight column, January 2012.

Trends in Engineering Education

- Peer evaluation / quality control
  - Establish a process for evaluating online materials
- Education network
  - Build a community of web-based educational resource users
- The way forward
  - Rapid advance of information technology
  - Different alternatives may be used
  - Teaching and learning is no longer limited within campus