Smarter Use of Information Technology for Transforming Teaching and Learning

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KAIST
KAIST

- **Korea Advanced Institute of Science and Technology**
  - Fully sponsored by government, established in 1972
- **4,000 undergraduate, 6,000 graduate students**
  - Full Scholarship, All in Dormitory
- **650 tenure-track professors**

- **Science, Engineering, Business**
- **THE Times World University Ranking: Engineering 25th**

- **Highly research-oriented**

- **No significant educational innovation effort**
- **No expert on educational studies & teaching and learning**

Before 3 years ago
Challenges in Education
Quality of Education

Massive Education, Volume Expansion

Quality
Knowledge-Based Industry & Society
Need New Talents

Creative  Synthesizing
Communication, Teamwork, Leadership

How to Teach?
Genuine Equality and Balance

Educational opportunities are still limited
- Space, Time, and Money
- Admission & Qualification

Imbalances of opportunities and capabilities
- Regions, Universities, Countries, People
What are the most important inventions in education?
Blackboard

11th Century in India
18th Century in Europe
1801 in USA

Lecturing

PowerPoint

Overhead Projector

Standardization

50 min class, 10 min break, weekly schedule, semesters, elementary/middle/high, …
IT

Internet, Computer, PowerPoint, Video, Projector, Video, Display, Tablet PC, Smart Phone, Smart Blackboard, e-Learning, MOOC, ...

Overcome Space & Time Limits
Increase ‘Efficiency’

Lecturing
Lecturing was very effective for Mass Education:

- Educate the nation
- Initiated by Prussia, 19th

cf. Mass Production
Failed Mission of Education?

Harvard Conference on Teaching & Learning, Feb. 2012

Failed mission of understanding genuine meaning of the learned, making questions, deriving knowledge, and applying it and creating new ones in a new context

Harvard Univ.: Donation of $40 million for teaching and learning innovation by Gustave M. and Rita E. Hauser
- Teaching & learning innovation methods
- Classroom Renovation
‘LectureFail’ Project

Chronicle of Higher Education

- http://chronicle.com/article/Lecture-Fail/130085/

- Debate on College Teaching at YouTube

- Students
- Professors

PowerPoint Abuse
Wasting Class Hours for Lecturing

• “Lectures are often the least educational aspect of college: after four years of instruction, research shows that many students haven’t mastered basic reasoning or communication skills. Students forget most of what they hear in lecture and then only recall 40% of the tested material two years later. Lectures do little for students actually enrolled in the school, ...”

• Why would anyone waste precious class time on a lecture?

Move Over Harvard and MIT, Stanford Has The Real “Revolution In Education”
Posted May 9, 2012 by Gregory Ferenstein (@ferenstein)
What are the most helpful for your study?

- A survey for students in a “tutoring” class for a basic compulsory course (lecturing)
  - Nov. 9, 2012, KAIST

![Bar chart showing the most helpful study methods.](chart.png)
Lecturing
One-Way Information Transfer
Limited Interaction
Passive
Lecturer-Centric
Vertical
Teaching

Learning

Lecturing
How/What to do?

Interaction

Student Participation

Student-Centric

Self-Study & THINK
Communication

Interaction

Q&A, Discussion

Self-Learning

孔子
Confucius

Socrates

All Lost, Lecturing for Mass Education
Educational Studies: Student-Centric Learning

Interaction/Student-Participation

Active Learning

Peer-Assisted Learning/Peer Instruction

Collaborative Learning

Cooperative Learning

Problem-Based Learning

Peer Tutoring

Bishop and Verleger, 2013
Why not so successful for replacing or improving lecturing?

Because most class hours are consumed for lecturing.

Lecturing is the most convenient for professors.

PowerPoint is too Powerful! ...
Simple, Effective
Education 3.0
Interactive & Student-Participative Teaching and Learning by using e-Learning
Don’t Lecture in a “classroom” Send lecturing to Internet!
What in a classroom?

Anything but lecturing!
Education 3.0 Class Model

Interactive Class

Online Self-Learning

No Lecturing

Flipped

Problem-Based, Collaborative, Active

Interaction in Class

Q&A  Discussion  Team Learning/Task  Interactive Exercise  Evaluation  Presentation  Labs

Team Learning + TA Support

Online Interaction

Quiz & HW  Q&A, Information Sharing, Social Network Services

MOOC or e-Learning

Lecture Video

Lecture Slides

Virtual Lab

Textbook
A kind of ...

Flipped Learning

Interactive/Student Participative Class (≈ Active Learning)

Q&A, Team Learning, Discussion, Problem Solving, Cases, Labs, …

But, more emphasis on interaction, teamwork, …

e-Learning (Out-class Activities)

Lecturing, Exercises, Short Discussion
Interactive Teaching & Learning in Class

• Quizzes

• Q&A

• Review & Summary

• Interactive Problem Solving

• Discussion

• Group Learning/Discussion/Project

• Labs
Changes for Interaction

- Enforce self-study of lecture videos, quizzes, & problem sets before coming to the class
- Max 48 Students/Class – 2 Sessions for 100 Students
- ½ Class Hours: One Class/Week
- 6 Students/Group
- 1 TA for each 15 students: 2~4 TAs/Class
- More TA roles in classrooms
- Individual professor consulting
- New Interactive Classrooms
Education 3.0 Classroom

Roundtable + Glassboard + Screen/Beam Projectors + Internet + Interior Design + …

7 + 10 (Fall 2014)
More than 60 in 2018

Hybrid: Movable for Edu 3.0 or Lecturing

Also possible in conventional one-directional classrooms
- Move desks + whiteboard
- 3 students/team
Online Self-Learning System: KLMS (KAIST Learning Management System)

MOODLE-based, CAMTASIA,
Segmented into 10 min, Q&A, Quizzes, SNS,

Smartphone Camera-based Q&A, Concept Tree, ...

e-Learning Technologies – available, evolving

Personalized, Interactive, Intelligent, Collaborative
Case 1: Introduction to Biology

- Required to submit 1-page hand-written summary of lecture videos each week to promote self-study
  - Easier than summarizing by reading a thick textbook
  - Better understanding & reflection by summarizing in his language

- Maximize TA help
  - 1 TA for each group
  - TAs: graduate students, + 3rd & 4th year undergraduates ➔ better networking, learning by teaching

- Maximize group discussion for concept learning & problem solving

- Each group makes a video of “biological dances” ➔ fun and motivation

- Absolute evaluation ➔ Motivation. Higher achievement
Case 2: Calculus I & II

• Lecture videos pre-study
• Extensive online exercises
  – Use Pearson’s problem DB/contents

• Group problem solving and discussion in class
• TA roles in class

• High achievement and satisfaction
CASE 3: Introduction to Programming

• Programming assignments in class for a group (2 or more)

• Important
  – self-study of lecture videos before class
  – Culture of participation and interaction

• Class activities should be closely associated with lecture videos.

• Group management is important. – no free riding!
  – Grouping, Periodic regrouping, Peer Reviews

• Should motivate students to participate
Case 4: Bioinformatics

- **15 min Quizzes only for one of three class hours**
- **Need a TA for each group**
- **Q&A and group discussion in class**
- **Productive lecture recording in a self-studio**

- **Significantly higher level/difficult questions**
  - Past: questions on simple concepts
  - Now: More advanced questions
Case 5: English & Scientific Writing

- May use many good e-Learning resources
- Or make new e-learning lectures

- TAs

- Team Assignment, Discussion & Practices
  - Grammars – Problem Solving & Discussion
  - Phonetics, Speaking, Dialogues, ...
  - Composing Sentences
  - Writing – Discussion & Peer Review
**Students Feedback**

- **Better Understanding:** 88%
- **Learning Habit Change:** 65~71%

### More Interactive vs. Less Interactive

<table>
<thead>
<tr>
<th>Semester</th>
<th>Spring 2012</th>
<th>Fall 2012</th>
<th>Spring 2013</th>
<th>Fall 2013</th>
<th>Spring 2014</th>
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<td>#Classes</td>
<td>3</td>
<td>10</td>
<td>18</td>
<td>42</td>
<td>46</td>
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<tr>
<td>Satisfaction</td>
<td>4.3</td>
<td>4.1</td>
<td>3.9</td>
<td>3.9</td>
<td>3.9</td>
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<tr>
<td>Prefer Edu 3.0</td>
<td>4.1</td>
<td>65%</td>
<td>69%</td>
<td>65%</td>
<td>67%</td>
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<tr>
<td>Retention</td>
<td>4.4</td>
<td>75%</td>
<td>69%</td>
<td>65%</td>
<td>62%</td>
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<tr>
<td>Class Eval.</td>
<td>4.4</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>4.15</td>
</tr>
</tbody>
</table>

### Even Higher Exam Scores

- **Introduction to Computer Programming**
  - Mid & Final Exams: $3^{rd}$ of 12 classes (fall 2012)
  - $1^{st}$ of 11 classes (fall 2013)

- **Calculus II**
  - Mid Term Exam: **10 points higher** than average of other 9 classes (fall 2012)
Professor Feedback

Better Understanding: 75~88%

Retention: 88~95%

3.0 수업방식의 활성화를 위한 필요요건

- 교실 인프라 관리 및 개선
- 동영상 저작도구 (camtasia 등)
- 동영상 강의 제작환경 (studio)
- KLMS 시스템 업그레이드
- 교수법의 혁신 노력
- 교수의 역할/인식 변화
- 학과의 지원
- Edu 3.0에 대한 이해
Keynotes & Invited Talks
- More than 30
- SNU, POSTECH, ...
- Auburn, Nanjing, ...
- GEDC, AEDS, AOTULE, ...
- Forbes, ...

SNU, POSTECH, ... also have begun.
Do you need more Scientific Evidences?


Obama's science education chief

Wieman Science Education Initiative at UBC, Canada

Basic Physics – Large Class ( > 300 students), Conventional Lecture Hall, For 11th week, divide the class into two groups. Take the same exams of 12 problems.
“Flipped School”

Clintondale High School
CHANGING EDUCATION, ONE CLASS, ONE STUDENT AT A TIME

HOME | ENGLISH | MATH | SCIENCE | SOCIAL STUDIES | ABOUT US

"At home, we go on Google Groups and work together as a class to answer questions, it helps so much."
- Ashley

Flipped School Model of Instruction
Our students receive their teacher’s lectures at home and do their homework in class. Our students work side-by-side with our expert staff. One-on-one time with students is up four times over years past, test scores are up and our students are more engaged. We are “flipped out” over our fabulous results and are extremely committed to ensure that all of our students and their families get the very best we have to offer. More details

Clintondale High School
35100 Little Mack Avenue
Clinton Township, MI 48035
Phone: 586-791-6300
Greg Green, Principal

Watch our story
Sustainable!

Even Better!

Just Begun!
Future Plan

30% (800 classes)
Most classrooms (> 60)
MOOC for Teaching & Learning Innovation
History of MOOC

MIT OCW
- Open Courseware
  - 34 majors, 2000 courses

MITx
- New Lecture Video/Exercises+
  - Class Management
  - Tests/Certification
  - Open, Charge Certificates

Harvardx
- MITx+Harvardx
  - 35 Univ., 200+ courses
  - SNU

edX
- MITx+Harvardx
  - 35 Univ., 200+ courses
  - SNU

Coursera
- Stanford + Princeton + ...
  - 119 Univ., 719 courses, 6 million students
  - KAIST

Udacity
- Commercial MOOC
  - CS 28 courses

FutureLearn
- UK, Open Univ. + ...
  - Yonsei Univ.

Cyber Universities
(Fees, Credit/Degree)

e-Learning

MOOC-based Degree Program
- GIT, MS in Computer Science with Udacity, ...

Credit Earning, MOOC-based Degree Program

First MOOC?

2003

President Charles Vest’s Decision to OPEN
- Hard to make a business. Pursue Reputation/Contribution and Donation
MOOC (Massive Open Online Course)?

Lecture Video, Exercises, ...

- e-Learning Contents
- Class Management
- Test & Evaluation
- Free, Open, Massive Automation
- Social Learning (Peer-to-Peer)

Quality, Best
# KAIST at Coursera

<table>
<thead>
<tr>
<th>Course</th>
<th>Session</th>
<th>Instructor</th>
<th>Enrollment</th>
<th>Passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Acoustics</td>
<td>5/12~6/15 (5 weeks)</td>
<td>Y.H. Kim (ME)</td>
<td>10,921</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>145 countries (emerging countries 34%)</td>
<td></td>
</tr>
<tr>
<td>Introduction to Light, Color &amp; Life</td>
<td>5/26~7/13 (6 weeks)</td>
<td>Y.G. Park (Physics), C.H. Choi (Bio &amp; Brain Eng.), H.J. Seok (Industrial Design)</td>
<td>7,835</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>141 countries (emerging countries 39%)</td>
<td></td>
</tr>
<tr>
<td>Supply Chain Management: A Learning Perspective</td>
<td>6/16~8/11 (8 weeks)</td>
<td>B.W. Kim (Business School)</td>
<td>20,352</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>175 countries (emerging countries 47%)</td>
<td></td>
</tr>
</tbody>
</table>

Joined in Oct. 2013, First in Korea

First learned of KAIST through the course
KOOC
KAIST Open Online Course

1st Quarter 2015

Industry & Research Inst.

30~40 Courses in 2015

Other Universities

High School Students

Entrepreneur/Ventures

KAIST Alumni

KAIST Faculty & Staff

KAIST Students
Why MOOC by Universities & Professors

Reputation/Leadership

Quality

Social Contribution
  - Equal opportunities

Teaching & Learning Improvement!!! – How?

Revenue/Incentives???
MOOC for Offline Classes

MOOC + Offline Classes with No Lecturing → Flipped Learning
Synergy between MOOC and Edu 3.0

MOOC, KOOC

Import & Use Online Lectures

Produce & Export Online Lectures

Education 3.0 Classes
Higher Interaction in MOOC & e-Learning?

Social Learning, Peer-to-Peer Interaction, Intelligent “Tutoring”
Global Classroom Networking for Joint Classes & Team Learning
Globalization Needs of Education

• Multicultural Knowledge
  – Global Markets/Customers, Different Needs

• Global Issues
  – Global Warming, Pollution & Environment, Energy, Food, Disasters, Pandemic Diseases, ...

• Student Exchanges & Joint Programs

• Complementary Teaching Capabilities

• Need More Students, Need More Faculty

Balance of Teaching Resources & Learning Demands btwn

– Developing countries ➔ Most good students go abroad
– Developed countries ➔ Need more graduate students from abroad
Real-Time Online Joint Classes

• iPodia Consortium: Online Global Lecturing or Interactive Classes
  – Founded in 2012
  – USC+Peking Univ.+ National Taiwan Univ. + Technion + RWTH Aachen Univ. + IIT-B + KAIST

  – Stephen Lu (USC), James Morrison (KAIST), Yang Wang (PKU)
  – 20+20+20 Students for Global Student Group Learning
  – Interactive Class+Online Lecture: Flipped, “Education 3.0”

• Local Joint Class: Acoustics

Internet + Codec
INTERACTION within Classroom + INTERACTION outside/ across Classrooms
Global Classroom Networking

- Joint interactive class with other universities
- Remote team learning/teamwork

High-Speed Educational Network
Multivision, Audio, …
Global Students Teamwork

Group Discussion & Problem Solving, Team Learning, Team Projects, even Labs

MITEL
http://www.mitel.com/

BeingThere Center
http://www.cs.unc.edu/cms/research/research-groups/being-there/
KAIST’s Strategies: e-KAIST

- Contribute to Society
- Transform Education
- Connect
- Transform
- Open
- Global Collaborative e-Learning

Global MOOC
KOOC KAIST MOOC

Education 3.0
Interactive Classes

Coursera
Smarter Education?
Smarter Use of Technologies for Transforming Teaching & Learning
Interaction, Participation, Collaboration

In Classroom

Outside Classroom

Across Space/Time
超越時空的相互作用 支持信息技术
前面的任務：
創新教學與學習為互動方式
Thank you!