

**THE IMPORTANCE OF
INTERDISCIPLINARY ASPECTS
OF
UNIVERSITY PROGRAMS:
COLLABORATION BETWEEN
STEM AND NON-STEM
DISCIPLINES**

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Background

- The impact on knowledge economy in the globalized world has become larger
- 75 % of growing occupations requires technology and skills in STEM fields (Chief Scientist, 2014, p.7).

- Expectation for innovation and demand is bigger



- Acceptance as well as citation rate becomes an important indicator on the world ranking of universities. Thus, it is self-evident that government STEM-oriented policies are closely related to the world ranking competition



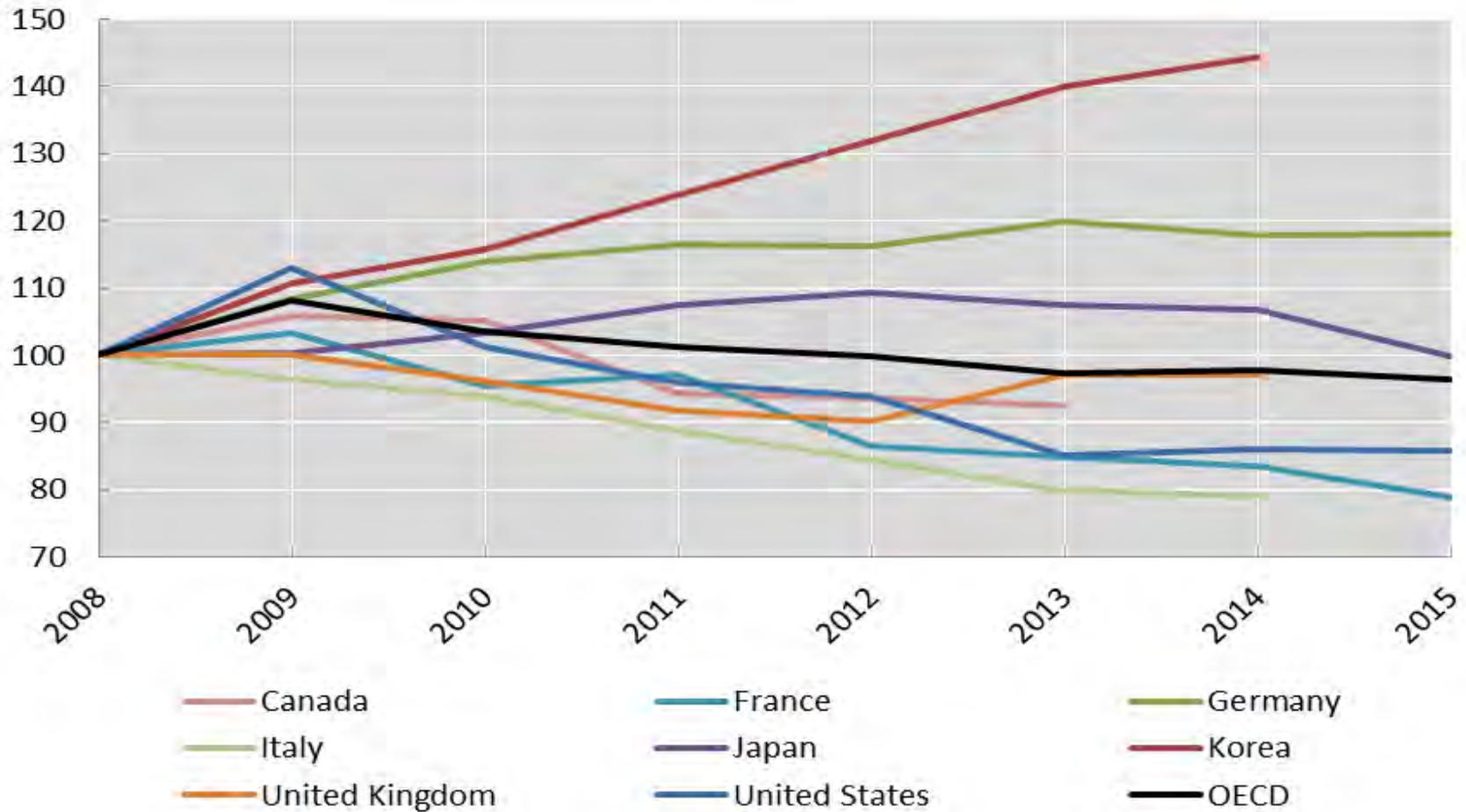
The role of STEM becomes important

Science and Technology Policies in the World and the Reports

- United States
PCAST(The President's Council of
Advisors on Science and Technology)
2010, 2012
- Australia , Chief Scientist, 2014
- England, House of Lords, 2012
- Singapore STEP 2015 (A*STAR)
- Japan
The Strategy of developing Human
Resource in Science and Technology 2015,
MEXT
The 5th Science and Technology Basic
Plan, 2015 Cabinet Office

R&D budgets

Total GBAORD (million 2010 dollars, constant prices and PPP)
2008=100



Problem Statement

- There is a concern that a too STEM-oriented policy ignores the importance of other disciplines such as humanities and social sciences.
- At the same time, interdisciplinary collaborations based on STEM and other disciplines are expected to develop in many universities worldwide. It is now considered that students of STEM disciplines should acquire both special knowledge based on their disciplines and other competences such as communication skills, intercultural knowledge and skills, and understanding of global issues acquired through other disciplines in order to promote innovation and new design

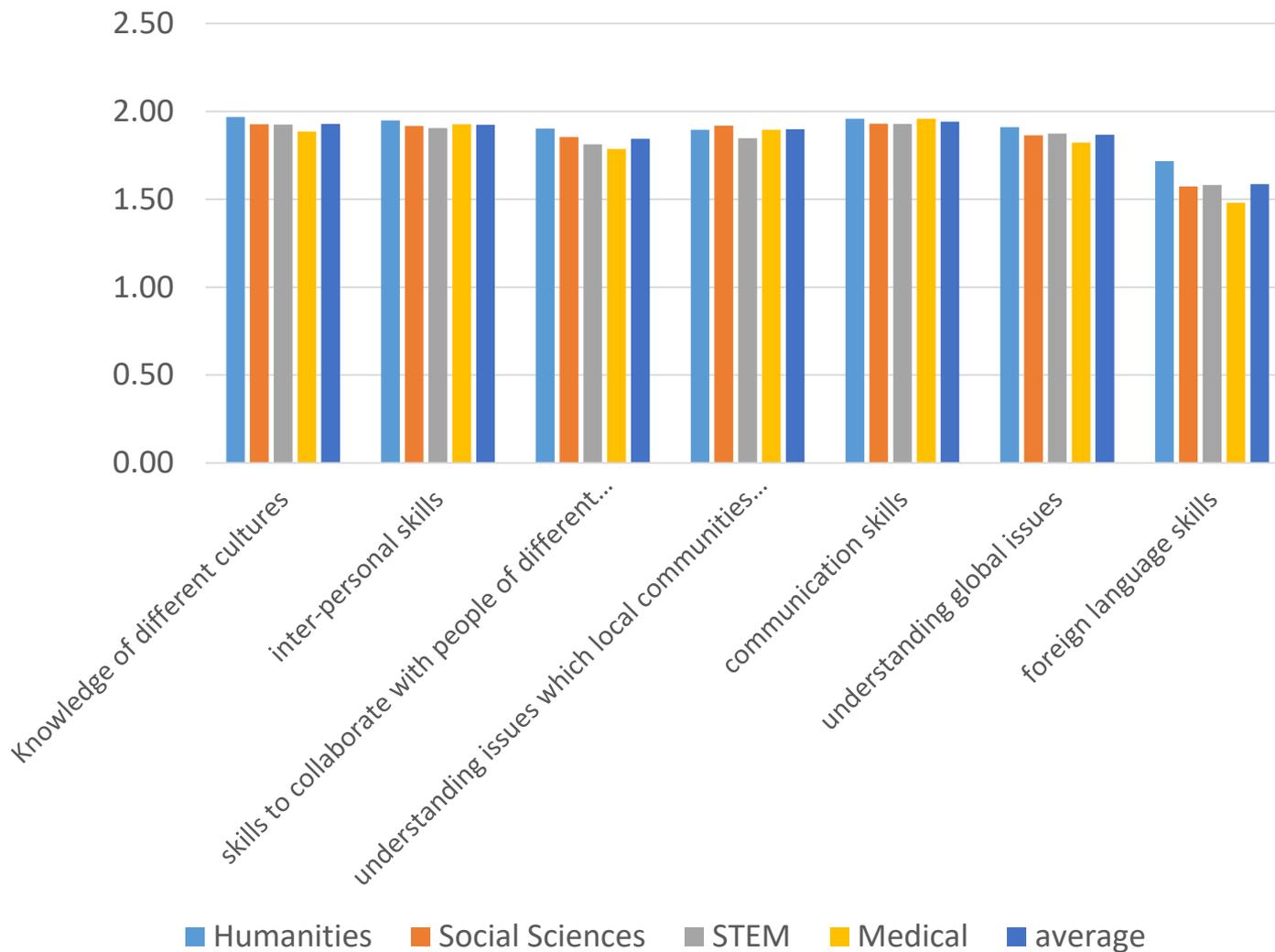
Previous Studies of the Importance of Interdisciplinary Programs

- The curriculum in higher education has proven to be an essential yet relatively unchanging part of the dominant educational paradigm and people are familiar with a disciplinary narrowness, a silo-like separation of knowledge that has changed little despite the rise of interdisciplinary studies in recent years (Hawkins, 2007; Jacob, 2015)
- Interdisciplinary studies are valued for the development of critical thinking, a broader perspective from other fields of study and the ability to translate ways of thought between different fields (Yamada, 2018)
- A method to assess the cognition and responses of STEM students to the global society, and suggested that such skills could be acquired through interdisciplinary program (Chipperfield et al. 2015)
- In order to realize a sustainable society, not only expertise in STEM, but also social, ethical and environmental awareness is essential, and these are learned through interdisciplinary liberal arts education (Murray and Horn, 2012)

The Direction of STEM Education Reform Guided by AAC&U

- 21st-century STEM challenges need more than mere knowledge acquisition; they also need the capacity to apply disciplinary-specific knowledge to solving the world's most complicated problems in culturally nuanced contexts and the ability to effectively communicate the importance of these problems and solutions. This is the challenge of STEM undergraduate education in the 21st-century
- [As defined in the Liberal Education and America's Promise \(LEAP\) initiative of the AAC&U](#), big questions directly connect to sustainability, how we live our lives, the choices we make, and our obligations to other people and to the natural world.
- Undergraduate STEM courses will: 1) provide more knowledge about real-world issues (e.g. energy, water, air quality, climate change); 2) connect these real-world issues to the concepts of sustainability; 3) offer students opportunities to analyze and implement choices that can help solve societal problems so they are better able to act on their choices both immediately and as future citizens and professionals

Self-reported evaluation on Learning Outcomes of Japanese Students



- 2010 JCSS survey
- 3.0 is maximum
- Acquired abilities and skills after entrance
- STEM students struggle to acquire 21st century learning

p<.0001

PRACTICES OF JAPANESE STEM PROGRAMS AND INTERDISCIPLINARY PROGRAMS

Program for Leading Graduate School

- The purpose :to foster leaders who can play global roles across the spectrum of the industrial, academic and governmental sectors
- Developing four kinds of talented people:
 - (1) those who will be leaders in fields other than research, including industry, public organizations and NPOs, both domestically and internationally
 - (2) those who, having extensive international and interdisciplinary perspectives, can from a wide overview and take the lead in challenging and solving societal issues
 - (3) those who, having a solid background of proven research capability, can manage projects that drive innovation
 - (4) those who can proactively set goals and achieve them by coordinating and uniting various stakeholders both domestically and internationally

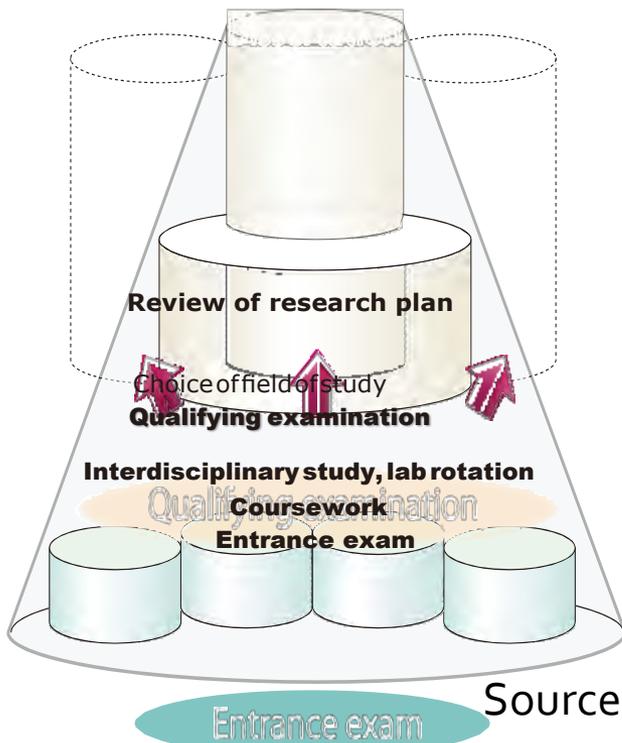
Leading Graduate Schools



Industry, academia and government participate from the program's planning stage



Assure quality of leaders (dissertation)



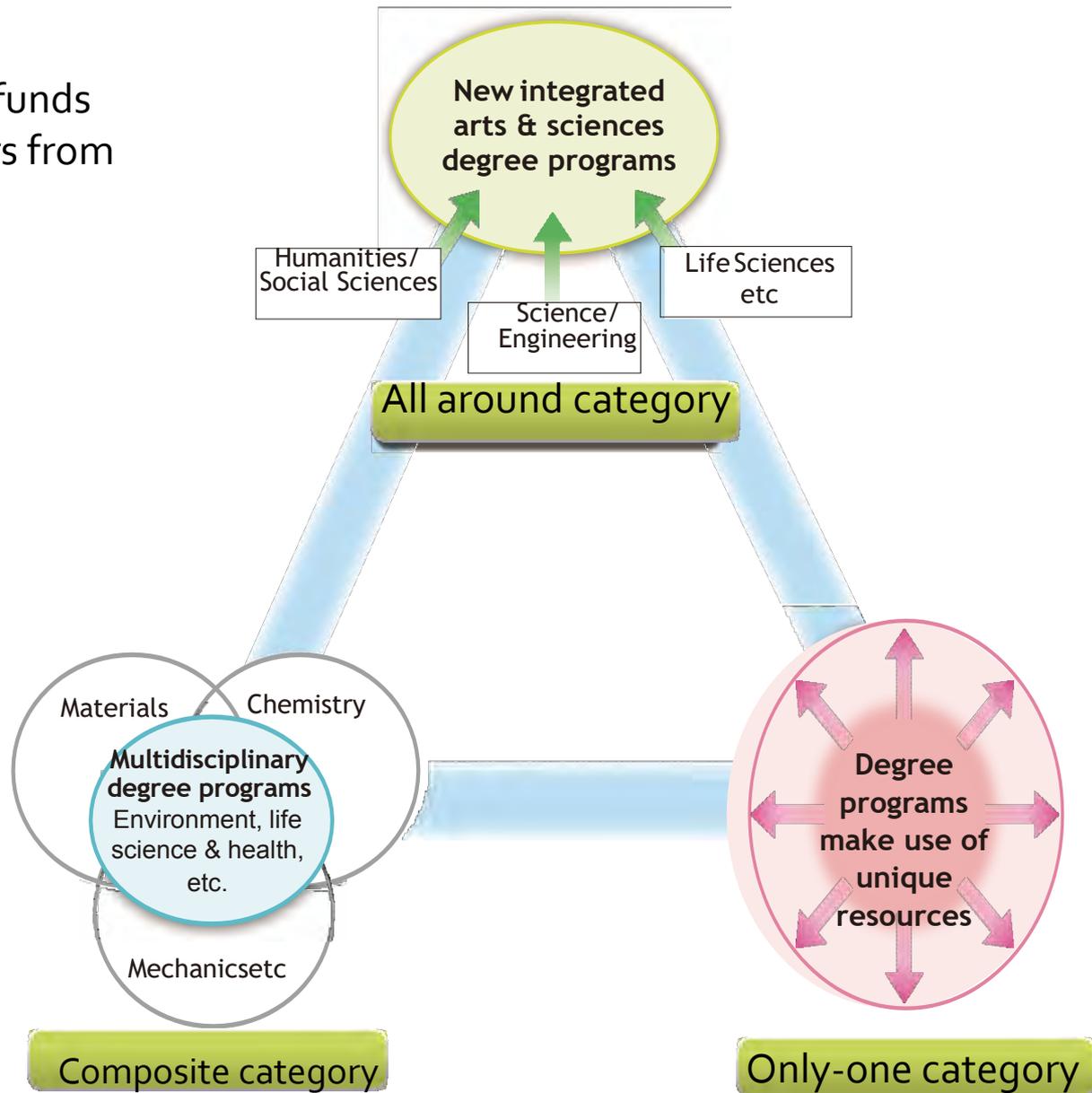
Planning of industrial, academic and governmental sectors enables research training in an international and practical environment

A closely interconnected system of guidance, assembling top-flight faculty of various sectors from Japan and abroad

While cooperating with each other, exceptional students can excel in their own creative research endeavors

A systematic program of education built upon a foundation of knowledge that transcends individual fields and that comprehensively evaluates student capacities

62 programs
Supported by the funds
of MEXT for 7 years from
2014



Referred Source: JSPS: Program for Leading Graduate
Schools p.6 Author revised the figure

Category / Theme	FY2011	FY2012	FY2013	Total
1. All-around Category	3	2	2	7
2. Composite Category				
Environment	4	2		6
Life Science & Health	4	2		6
Materials		3	3	6
Information		3	4	7
Pluralistic Society		3	3	6
Safety & Security	1	2		3
Cross-cutting Themes	2	2	2	6
3. "Only-one" Category	6	5	4	15
Total	20	24	18	62

Number of Selections

D SCHOOL AND BOSP OF STANFORD UNIVERSITY



- D school makes possible to realize the fusion in other fields
- provides the place of discussion with diverse background of people
- provides opportunity to make design thinking
- provides place for manufacturing where people can start over even if they fail (place of trial and error)



BING OVERSEAS
STUDIES PROGRAM
STANFORD UNIVERSITY

Bing Overseas Studies Program(BOSP)

Program : students study one or more quarters at most overseas locations

Internship (HIP)

For upper division students

Purpose : School of Engineering program of Stanford university employs study abroad program in order for engineering students to acquire skills to act globally

To obtain certain level performance of foreign language in overseas centers

Overseas centers : Australia, Beijing, Berlin, Cape Town, Florence, Istanbul, Kyoto, Madrid, Oxford, Paris, and Santiago

Background and Purpose of Stanford BOSP

- Engineer as occupation is recognized as Internationally compatible one
- Many graduate of school of Engineering have working experiences in overseas, experiences of consulting with other countries, of management in overseas companies



- What kind of elements are necessary and important for globalized engineer?
- Cultural Literacy and Intercultural Literacy are the foundation and should be acquired through undergraduate education

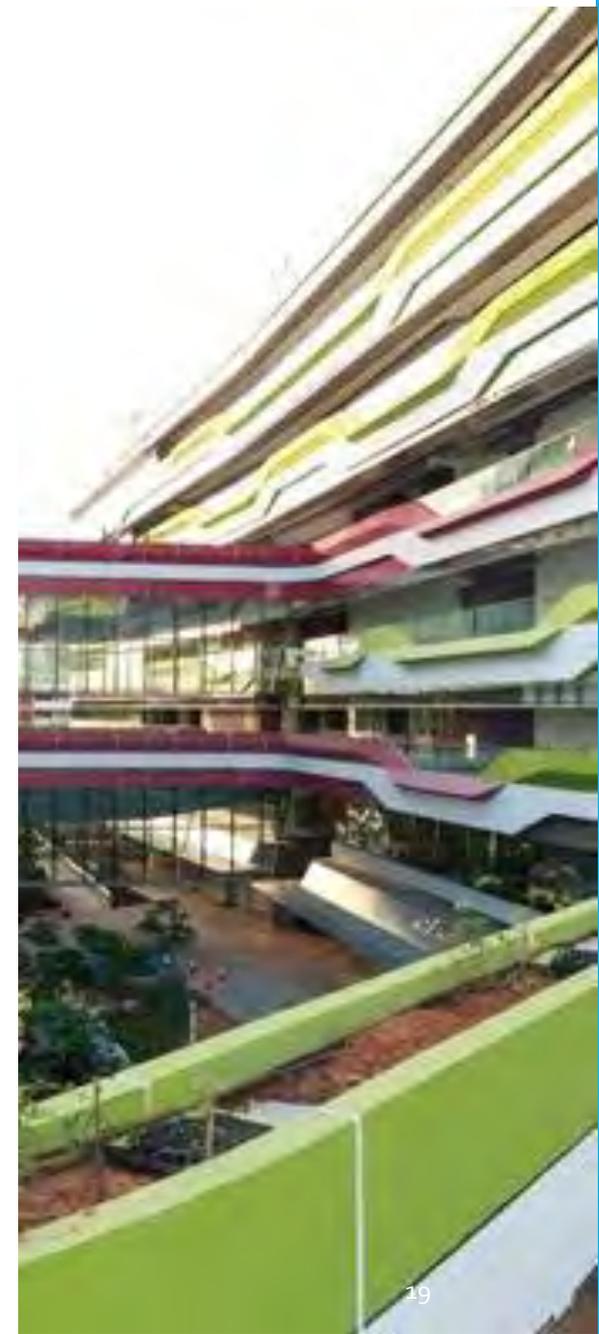


Study abroad experience is indispensable for future globalized engineers

PROGRAM OF SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Program of SUTD

- SUTD is a new national university of science and technology established in 2009 with the cooperation of MIT in the United States and Zhejiang University in China
- The number of students was about 1300 as of 2016
- Being design-oriented is the basis of education
- The characteristics of being design-based :
 - (1) an integrative, interdisciplinary approach
 - (2) having real-world experiences in the curriculum





The curriculum is based on humanities and social sciences as well as engineering and science

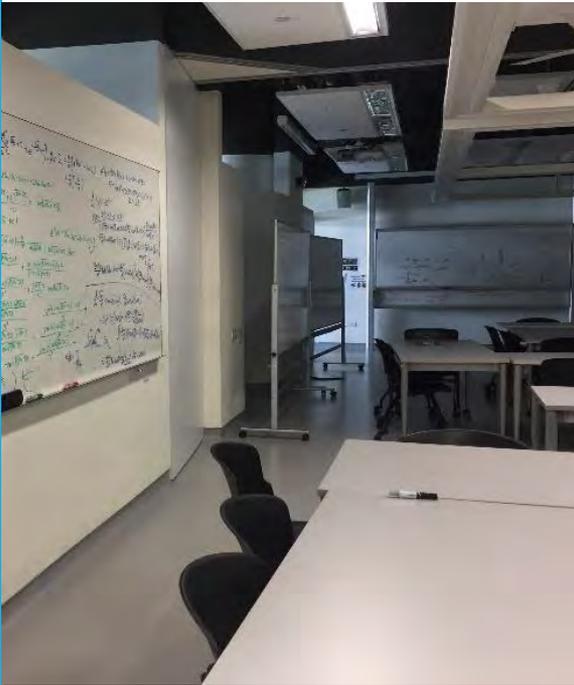


It is designed for students to take these subjects in the first semester of the first year and the second year. It is possible to foster design-based thinking by taking subjects based on the approach of culture and science in the first and second years



Students are required to experience three Independent Activities Periods (IAPs) and summer vacations require study internships abroad at overseas partner schools or internships at companies in Singapore and abroad

Three Features of Curriculum and Program



The Teaching Methods

- (1) cohort learning and active learning
- (2) use of cohort classrooms and fabrication labs
- (3) design projects: The design project is one of the basic ideas when the university was established and it is used for all design-related projects related to engineering such as architecture, industrial products, software, systems, etc
- Faculty: many foreign faculty members from Asian and Western countries

Conclusion and Further Challenges

- Development of interdisciplinary programs between STEM, arts, humanity and social sciences is essential as the cases of three countries indicate
- There are many issues to be overcome for promoting collaboration between STEM and Non-STEM Disciplines programs
 1. how to integrate research evaluations of each field
 2. how the laboratory culture specific to the field will be merged
 3. how to connect the performance of inter- and cross-disciplinary educational programs to the profession.



- New Directions of STEM Research and Learning in the World Ranking Movement : A Comparative Perspective
- Editors: **Hawkins, J.N., Yamada, A., Yamada, R., Jacob, W.J.** (Eds.)
- Palgrave Macmillan, 2018
- <https://www.palgrave.com/us/book/9783319986654>

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- Thank you very much

Please feel free to ask

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