A New Strategy for STEM Learning in a Changing Society: Focusing on the Undergraduate Program

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Discussant: M. Ogasawara (Hokkaido Univ.)
Development and Educational practice of STEM as a Contemporary Liberal Arts Subject

- Action Assignment (2017~2018 academic year) by the Japan Association for College and University Education (JACUE)
- Representative: T. Hosokawa
Activity Policy

1. Text Publishing (e-Publishing)
2. Survey of overseas activities
3. Publication of class examples (on the JACUE website)
4. Study of the philosophy and introduction method of STEM education adapted to Japan
Background of this activity

At present, as a global movement, in higher education, strengthening of science and technology education from a new perspective is being started. In particular, in the United States, ladders for STEM (Science, Technology, Engineering, and Mathematics) movement are being conducted on a national scale. Education and learning technology is developing and spreading to acquire not only specialized knowledge but also the ability to apply it to problem discovery, analysis and solution.

Focusing on this trend, the JACUE will partner with AAC & U to introduce new teaching and learning methods from FY2015. In addition, I would like to focus on developing a course in a bachelor's degree course where science and technology related fields and humanities and social fields cooperated, taking advantage of the characteristics of this society of having members in various specialized fields. Furthermore, it may be considered that the field of practical science, which is a feature of Japanese universities, will be liberal arts, for example, in the form of integrated engineering, and it will be one of the pillars of future undergraduate courses. (2016, 38th Annual Meeting Lunchtime Session)
Background of this activity

U.S.A.

- In the 2012 Programme for International Student Assessment (PISA), the rankings of "mathematical applied powers" in the United States were from 25th to 31st, and "scientific applied powers" from 20th to 24th in 2009, "Reading ability" dropped from 11th to 21st.
- President Obama submitted the STEM 5-Year Plan for Education in 2013 (Committee on STEM Education, 2013). As a result, $3.1 billion was recorded for STEM education in FY2016.
- The objects are, 1. Increase in the number of STEM students, 2. Elimination of racial disparities, 3. Elimination of gender disparities, 4. Elimination of disparities with foreign students, 5. Increase in learning achievement, 6. Improvement of education system.
- Association of American Colleges and Universities (AAC&U) and American Association for the Advancement of Science (AAAS) came to take STEM as an issue at the annual conference.
- AAC & U promotes the development of human networks such as the "Kaleidoscope Project", supporting minority students and teachers, improving curricula, developing cross-disciplinary and interdisciplinary subjects, developing related guidelines and tools, etc. More than 10 STEM related projects are implemented.
Background of this activity

Eu and England
• STEM education is focused, and four recommendations and reports have been made in the last 20 years.

Japan
• Japan enacted the Science and Technology Basic Act in 1995, and a 5-year basic plan in science and technology, which starts in 1996, has been submitted for five periods.
• The purpose of the basic plan of fifth period (2016~2020) is (1) creation of future industry and social change, (2) response to economic and social issues, (3) strengthening of fundamental power, (4) construction of a virtuous circulation system of human resources, knowledge and funds
Goal of this activity

- Based on the situation in the world, we will consider how to incorporate STEM education into modern Japan's higher education and support it if possible.
- In order to introduce STEM education at each university in Japan, it is desirable to have an opportunity to refer to the preceding concrete examples.

We,
- introduced "Teaching tips (TT) construction as a concrete introduction example of new STEM education".
- received materials (text, syllabus, lesson method, problems, evaluation method) from the university that has already conducted STEM education, and published it on the website of JACUE along with its significance.
- We investigated the reality of STEM education in North America and EU countries.

Unlike in previous researches, we reported them using Web of JACUE.
Results of this activity

• We developed and published the text.

• We recruited class examples and made them public.

• We reported the cases of STEM education in foreign countries.

• We introduced the results at conferences, research meetings and symposia of JACUE.
Integrated science–Science training course to live in the present age—

Author: Hisao Suzuki, Toshiyuki Hosokawa
Supervised Masaaki Kurasaki, Shin Tohcinai, Masahiro Nakamura, Masaaki Ogasawara
(2018.10 Amazon Electronic Publishing, 380yen)
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.)
(2018.10 Palgrave Macmillan, e-Book 89$)

Educational Policy Across the World: How STEM Disciplines Deal with Twenty-First Century Learning Outcomes and Challenges. Yamada, Reiko

STEM and the History of the University Ranking Movement: Contextualizing Trends in Methodologies and Criteria. Stevenson, William R., III

STEM and Underrepresented Populations: What’s at Stake. Ivory, Tristan

Developing Global Competencies Through Interdisciplinary Studies: Why Collaboration Is Important Between STEM and Non-STEM Students. Yamada, Aki

STEM Education in a Changing Society: Japanese Experience and Urgent Problems to Be Solved. Ogasawara, Masaaki
Release in Web

- Hisao Suzuki
- Mitsuru Kawazoe
- Joji Goto
- Hosokawa Toshiyuki
- Jun Saito
Reports in JACUE meeting

2016 spring (Round table)
・Tetsusuke Hayashi: "Joint general education" started by three universities with different fields of science, humanities and medicine
・Reiko Yamada: Stanford University's Bing Overseas Studies Program (BOSP) with the aim of studying one to two semesters abroad and experiencing internship.
・Tetsuya Takahashi : "Basic mathematics" which is required for students with humanities background

2016 Autumn (Action Assignment Meeting)
・Mitsuru Kawazoe: Teaching Tips for Mathematics Literacy Subjects Required for Modern People
・Takashi Hata: STEM Education and Liberal Arts-What is Required for Contemporary Liberal Arts Education?
・Reiko Yamada : How should 21st Century Liberal Arts be incorporated into STEM Higher Education? : Global Competency and Challenges of STEM Higher Education

2016 Autumn（International symposium）
・Hisao Suzuki : International Comparison of STEM Education between Japan and the United States and Attempt of Integrated Science Class
・Mitsuru Kawazoe: Teaching Tips for Mathematics Literacy Subjects Required for Modern People
・Discussion: A perspective on STEM education research by international collaboration

Translated by T.H.
Reports in JACUE meeting

2017 Feb. (Symposium)
Jun Saito: Improvement of systematic STEM education by AAU STEM Initiative and report of University of Colorado Boulder
Wakeman Kevin and Zhou Bo : Report of AAC&U STEM Education Meeting 2016
Osamu Seto: Liberal Arts Education at QUEST University of Canada
Keiichiro Yoshinaga : Educational Innovation at Orin University of Technology

2017 spring (Round table)
Hisao Suzuki : Trial of Integrated Science Course "Science Training Course Starting from Zero"
Saito Jun: The practice of improving universal STEM education at the University of Colorado Boulder
Yoshiko Saito: STS (Science, Technology and Society) Education
Kiyoshi Yoshinaga: Department of Physics, University of Cambridge and Zurich Institute of Technology (ETH)

2017 Autumn (Action Assignment Meeting)
Joji Goto: Development and Practice of Mathematics Literacy Subjects-Efforts as Common Education-
Reiko Yamada : A New STEM Program for Humanitarian Fusion: Focusing on Cases in Singapore, the United States and Japan
Hisao Suzuki : Report on AAC & U STEM Meeting
Reports in JACUE meeting

2018 Feb. (Symposium) Transforming Undergraduate STEM Education in Japan
Jun Saito: Active Learning in Asia
Masako Hosaka : Implications for STEM Education from Research on the Learning Experience of Female Students
Fujio Omori : Discipline Based Education Research
Keiichiro Yoshinaga: International Comparison of STEM Education Reform
Sachiko Tosa: A Lesson Study for Active Learning in University Physics in Japan and the United States
Hisao Suzuki : Report on AAC & U STEM Education Meeting 2017

2018 Mar. The 23rd FD Forum (Kyoto Sangyo University / Organizer / University Consortium Kyoto Consortium Kyoto) 4th Subcommittee
· Design and operation of a cross-cutting program to support science literacy-statistical education, integrated science experiment, and practice exchange site model-
  Coordinator: Yoshio Ueno, Reporter: Jun Saito, Norihiro Nakamura, Hiroshi Yadohisa

2018 spring (Round table)
Keiichiro Yoshinaga : Report on the 2018 AAAS Annual Conference
Jun Saito: Active Learning in STEM Education in Asia
Masami Isoda: Problems on connection to university STEM education from the viewpoint of mathematics education
Noriko Noguchi : Science communicator training education program
Reports in JACUE meeting

2018 Autumn (Action Assignment Meeting)
Reiko Yamada : Meaning and Problem of Fusion of Humanities and Sciences in STEM Education
Yoichiro Miyamoto : English and America in the STEM Education Period
Yuki Nakamura: Science Curriculum at UC Berkeley ~ Based on the real experience of the Department of Chemistry ~
Hisao Suzuki: Report on AAC & U STEM Meeting 2018

2019 Feb. (Symposium) 2019 Transforming Undergraduate STEM Education in Japan
Jun Saito: Physics Education at a Major University in East Asia: a Survey of China, Taiwan, and Korea
Satoru Takagi: Integral and Integral Materials of Multivariate Functions for Science and Engineering Students
Reiko Yamada : Trends in STEM Higher Education Policy and Humanitarian Programs: From a Comparative Perspective
Norihiro Nakamura: Society and Natural Science Spinning on Big History: As an Example of Integrated Science
Atsushi Haruna: STEM education from the viewpoint of university management
Masaaki Ogasawara: STEM Education Reform as a Science Renaissance
Status of STEM Education in the United States

Goals of STEM education under the Obama administration ($3.1 billion in 2016)
(1) Increase in the number of STEM students, (2) Elimination of racial disparities, (3) Elimination of gender disparities, (4) Elimination of disparities with foreign students, (5) Increase in learning achievement, (6) Improvement of education system

Those who received a master's degree in the US STEM field in 2015 were up 6% from the previous year. In addition, while the number of master's degree doctoral degrees in science and engineering majors decreased in the United States during the period of 2008 ~ 14, foreign students increased by 35%. (2) and (3) of the five-year goals have not been resolved. That is, it is difficult to achieve goals other than (1) and (6).

In September 2017, President Trump signed a presidential decree instructing that STEM and computer science be given $200 million annually for K-12 programs and universities with emphasis on education items (Washington Post, 2018). It seems that STEM education is considered important even in the new administration.

In Japan, the Science and Technology Basic Plan has entered its fifth term, and it is expected that, particularly in higher education, the training of talented scientists and engineers and the training of the basic skills necessary for STEM related fields are expected.

In connection with this, programming will be incorporated into primary and secondary education from FY2020.
Today’s presentation

- Characteristics of Rikei Students (Science & Technology Majors) in Japanese Universities Indicated by Statistical Analysis
  M. Ogasawara, T. Hosokawa, A. Miyamoto (Hokkaido University)
- Mathematics Education Using Real-World Problems
  M. Kawazoe (Osaka Prefecture University)
- Role of Integrated Science Approach in Higher Education in Japan: An attempt in Hokkaido University
  H. Suzuki (Hokkaido University)
- The Importance of Interdisciplinary Aspects of University Programs: Collaboration between STEM and Non-STEM Disciplines
  R. Yamada (Doshisha University)

Thank you