

INTERNATIONAL & DEVELOPMENT EDUCATION

New Directions of
STEM Research and
Learning in the World
Ranking Movement
A Comparative Perspective

Edited by
John N. Hawkins, Aki Yamada, Reiko Yamada, and W. James Jacob



International and Development Education

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John N. Hawkins · Aki Yamada
Reiko Yamada · W. James Jacob
Editors

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PREFACE: THE IMPACT OF STEM RESEARCH IN A KNOWLEDGE-BASED SOCIETY AND THE NEED OF INTEGRATED STUDY OF STEM AND OTHER DISCIPLINES

The impact on the knowledge economy in a globalized world has become larger and larger in recent years and there is a growing expectation and demand for innovation in higher education. It is generally expected that Sciences, Technology, Engineering, and Mathematics fields of study will take a leadership position in innovation. The word STEM coins the widely recognized concept of integration between science, technology, engineering, and mathematics. Many countries, such as the United States, United Kingdom, Australia, Singapore, China, Japan, and others put more emphasis on Science and Technology policies than other fields of study. Eventually, STEM education reform from K-12 to higher education has become increasingly important. Many countries devise policies to increase the number of university students as well as graduate students in STEM fields and to connect university research with industry to create a foundation for future job markets. At the K-12 level, the issue of upgrading the quality of STEM teachers is also being discussed.

Research in STEM fields has many commonalities in content, innovative aspects, and direction. Therefore, researchers worldwide submit their papers to distinguished international journals published in English. Acceptance, as well as citation rate, becomes an important indicator in the world ranking of universities. Thus, government STEM-oriented policies are closely related to the world ranking competition. Many universities in the world are therefore forced to become conscious of world ranking regimes, to secure more research funding, more foreign

students, increase their world reputation, and to get national funding. Thus, STEM disciplines have received a disproportionate amount of attention largely due to the link with global ranking systems.

On the other hand, in 2015, the issue of restructuring the social sciences and humanities (SS/HUM) in the context of the STEM emphasis at the university level became a national issue in Japan. Nobody contests STEM fields' important role in research and development, with respect to future jobs and the improvement of global ranking scores. The abundance of STEM-oriented policies obscures the importance of other disciplines such as humanities and social sciences. At the same time, there has been a call for interdisciplinary collaboration based on STEM and other disciplines. There is a growing concern that students in STEM disciplines need to acquire specialized knowledge based on other disciplines to acquire global competences, such as communication skills, intercultural knowledge and skills, and interdisciplinary contextualization and innovation. This raises the question about the future direction of STEM education in higher education. Is it important to integrate STEM fields with other fields, such as humanities, arts, and social sciences? Should STEM students be exposed to international education and exchange programs as other students do in the humanities and social sciences.

This project intends to analyze the dominance of STEM fields in various university rankings and the reason why and how many governments in the world disproportionately give value to STEM fields. STEM is an up and coming hot theme. However, most of this attention focuses on research which leads to national productivity, innovation, and world competitiveness. There is little research to discuss the relationship of recent world science and technology policies, STEM disciplines and the world university ranking movement. The world university ranking movement is also a new trend and it influences higher education policy globally. Thus, research on STEM receives large amounts of research funding, influences the mobility of foreign students, and develops industry and university collaboration.

Second, although there is a general agreement that STEM fields are important, we also examine the role of interdisciplinary and multidisciplinary approaches for a revised STEM education. What should be the direction of STEM higher education in the future? Both purposes are analyzed comparatively in examples from the United States, Canada, Japan, China, Korea, and Taiwan. The study is a comparative analysis

that will clarify the commonalities and differences between countries. There is a hypothesis that many countries covered in this study have commonalities of science- and technology-oriented policy in the knowledge-economy society, however, there are some differences of approach for STEM higher education and STEM higher education reform. We will examine what makes commonalities and differences between countries and how we might propose new directions for STEM higher education in the twenty-first century. The chapters of this book illustrate some new directions of STEM higher education from the perspective of twenty-first century types of learning outcomes and thus focuses on the need of developing an interdisciplinary approach for STEM higher education reform.

The Introductory Remarks written by John N. Hawkins illustrates the existence of a dilemma of STEM integration in the Arts, Humanities, and Social Sciences and argues that this dilemma has had profound implications for the current debate on the value and action implications of various ranking regimes.

In Chapter 1, Reiko Yamada analyzes how globalization and knowledge-based economy have impacted the promotion of STEM human resource-oriented policies worldwide in comparative perspective and then, examine the necessity of global competences for STEM college students from the interdisciplinary aspect.

In Chapter 2, William R. Stevenson III shows the relationship of university ranking and field of STEM, examined from the historical perspective. It becomes clear that for over a century, universities have been assessed and ranked according to both outcome-based approaches and student-oriented input-based criteria.

It is recognized that science and innovation will increase the productivity and bring the well-paid jobs and enhance competitiveness and result in the economic growth. Chief Scientist (2014) states that the advancement of science technology and growing occupations require technology and skills in STEM fields. Also, STEM research is recognized to contribute to increasing world university rankings. However, emphasis on STEM fields may increase inequality issues in higher education. In Chapter 3, Tristan Ivory examines inequality issues arising from emphasis on STEM fields at three general levels—the individual, institutional, and national.

Chapter 4 written by Jason Cheng-Cheng Yang demonstrates how the impact of ranking also can be found on faculty behaviors at top

universities in Asia and university's internal allocation of funds on different subjects. He chose Taiwan as a case to study the relationship between world higher education ranking and STEM research.

Chapter 5 by Grant Jun Otsuki discusses cases in which people have worked at and across this boundary in ways that defy easy categorization as “STEM” or “H&SS.” These interactions, it is suggested, are as important to the work of scientists as they are under-recognized. This will lead us to a discussion at the end of some of the consequences of the persistence of this boundary despite its porousness.

In Chapter 6, Aki Yamada shows the direction of interdisciplinary collaboration in US higher education and then analyzes similar developments in Japanese higher education, such as the Empowerment Informatics Ph.D. Program (EMP Program) at the University of Tsukuba. These institutions merge STEM majors with of artists, humanists, and social scientists in collaborative classwork, research and development, and field work.

Although there are limitations to the measurement of global poverty, it is a large enough indicator to draw the interest of global and regional development banks, bilateral and unilateral aid from governments, and research initiatives from companies, think tanks, and universities. Concerning global poverty research, there are eight development labs (at seven universities) funded by USAID. In Chapter 7, Christopher S. Collins focuses on the role of interdisciplinary work at university development labs.

In Chapter 8, Byung Shik Rhee aims to fill that gap by examining the humanities competencies of STEM students enrolled in two Korean research universities, one comprehensive university and one science and technology university by asking the following questions: (1) What are the current humanities-competency levels of STEM undergraduate students at two research universities in Korea? (2) Do the humanities competencies of STEM students change by year during college?, and (3) How are the humanities competencies of STEM students related to faculty mentoring, student engagement, institutional climate, and liberal arts courses taken?

From the 1950s, strengthening science and technology became the core policy of Chinese education and thus, China is now matching and surpassing most of the western countries. But this overemphasis on science has led to a neglect of studying the arts and there exists a tendency

to generally undervalue the arts and regard them as unimportant. Chapter 9 by Yi Yang analyzes Chinese arts education policies in a new era in relation to the perspective of “From STEM to STEAM.”

In Chapter 10, Masaaki Ogasawara demonstrates that consistent Japanese special higher education policy on STEM field after Meiji Era had contributed to produce many graduates with technical and scientific abilities to lead our industrial society. However, at present, Japanese STEM disciplines are suffering from the decline in the number of students who have interests in STEM fields. He argues that the existing traditions and customs in the Japanese system has caused the present STEM issue.

Chapters in this book illustrate some new directions of STEM higher education from the perspective of twenty-first century types of learning outcomes and thus focuses on the need of developing an interdisciplinary approach for STEM higher education reform.

Kyoto, Japan

Reiko Yamada

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