



# Editorial: Past, Present, and Future of Science, Mathematics, Engineering, and Technology Education Research and Practice in South Korea

Sonya N. Martin  
*Seoul National University, Seoul, Republic of Korea*  
Sungmin Im  
*Daegu University, Gyeongsan, Republic of Korea*  
Jinwoong Song  
*Seoul National University, Seoul, Republic of Korea*

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This Special Issue of *Eruasia Journal of Mathematics, Science, and Technology Education* offers ten articles addressing issues that are currently emerging in Korea and that will be a continued focus for teacher educators and researchers in the years to come. The papers in this issue represent the efforts of 31 researchers, from four different countries and more than 18 universities and research institutes. The papers were selected to offer the international reader perspectives on a broad range of educational issues in Korea. These works highlight current trends in research in different STEM related disciplines, issues in teacher education and professional development, and they provide a socio-historical context for making sense of Korean students' achievement in math and science on international comparative exams and on national assessments. Finally, this issue includes a special focus on STEAM (*Science, Technology, Education, Arts, and Mathematics*) education. STEAM education emphasizes the convergence of different content areas with an emphasis on "Arts" integration as a means of enhancing interdisciplinary teaching and learning. Since 2011, the Korean government has supported the spread of STEAM education into K-12 classrooms via government policy and curriculum revisions, funding initiatives, and teacher education programs. As a result, STEAM

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education has rapidly emerged as an important area of research in Korea. Thus, we have provided considerable space in this issue to share some of the research on this topic. Below, we provide a brief overview of each paper in this issue.

The first four papers focus on domestic issues related to teacher education and student achievement. We open the issue with a critical review of the current state of science teacher education in Korea written by Sungmin Im, Hye-Gyoung Yoon, and Jeongho Cha. The authors offer an overview of the science teacher education system in Korea, as well as, a review of the current challenges facing science teachers educators and teachers, including curricula, recruitment, and assessment procedures. Then they interrogate how different laws, policies, and institutional programs have historically impacted on the development of science teacher education. Especially this article highlights some features of science teacher education emphasizing the academic competency of science teachers and the oversupply of qualified science teachers as an urgent issue related to the unique sociocultural background of the Korean educational system. Next, Hyun-Kyung Kim, Dong-Heon Lee, and Soojin Kim examine Korean students' achievement on the 2010-2013 National Assessment of Educational Achievement (NAEA) exams to raise some questions about the need for changes in classroom teaching and learning methods and to argue for revision of the national science achievement standards to help address discrepancies between students' academic abilities and the curriculum they experience in K-12 science classrooms in Korea. Through this study they call for establishing data-driven policy-making to support the quality of science education (both domestically and internationally). The third contribution by Jennifer Park, Hye-Eun Chu, and Sonya Martin, takes a sociohistorical perspective to understand how demographic shifts in Korean society, resulting from globalization and immigration, are impacting on teaching and learning in science classrooms where Korean teachers are tasked with using inquiry-based, student-centered activities with an increasingly culturally and linguistically diverse (CLD) student population. Specifically, this paper introduces a questionnaire designed to investigate Korean teachers' conceptions of diversity, inquiry teaching, and language education to explore how teacher attitudes and self-efficacy towards teaching inquiry and language education could shape teaching practices that limit or afford opportunities for CLD students to learn school science. The paper offers implications for science teacher education programs in Korea focused on enhancing diversity and content specific strategies for supporting language learning. The final paper in this section by Younkyeong Nam, Sun-Ju Lee, and Seoung-Hey Paik explores the impact of implementing an Engineering Integrated Science (EIS) curriculum as a new pedagogical approach for teaching science and engineering in a technical high school in Korea. This research offers readers an insightful examination of the role of technical education in Korean society and argues the need for introducing innovative teaching strategies to support an often neglected group of learners to not only improve achievement, but to also increase these students' interest and confidence in science learning.

The next group of papers contributes to an expanding body of literature focused on comparative international explorations of factors influencing student achievement in math and science in different learning contexts. The first paper was written by an international team of researchers from the United States and Korea and includes Ji-Won Son, Seongwon Han, Chungseo Kang, and Oh Nam Kwon. In this paper, researchers draw from the 2011 Trends in International Mathematics and Science Study (TIMSS) data set to compare and contrast student, teacher, and

school factors associated with mathematic achievement of students in both Korea and the United States. While the study found several factors had similar impacts on student learning in both countries, their research indicated that teachers' participation in professional development was particularly influential in student achievement and teacher efficacy in the United States, but not in Korea. This finding raises some interesting questions about what factors are most salient for Korea students' mathematics achievement and about the efficacy and impact of teacher education and professional development in Korea. The next paper offers an international comparative study exploring factors that predict differences in mathematics and science achievement by students in Turkey and Korea. Using IES International Database Analyzer, Mustafa Sami Topçu, Evrim Erbilgin, and Serkan Arikan examined data from the 2011 TIMSS study related to student aptitude, instruction, and environment. The researchers found a variety of differences and similarities between the two groups of students, which they discuss in detail.

The final four papers in the issue focus on introducing and exploring STEAM education. HyunJu Park, Soo-yong Byun, Jaeho Sim, Hye-Sook Han, and Yoon Su Baek provide a brief overview about the emergence of STEAM education in Korea and they share findings from their study examining teachers' perceptions of STEAM as a curriculum innovation and pedagogical approach. Their work highlights several challenges teachers face when trying to implement STEAM in their classrooms and they offer suggestions for revisions in the curriculum standards and national assessments that would support teachers to align their teaching efforts to better reflect the government's STEAM education policies. As STEAM education becomes a more prominent feature in Korean classrooms, more research is needed to investigate the ways in which teachers implement STEAM lessons and to understand how students learn when using this approach. Hunkoog Jho, Osku Hong, and Jinwoong Song share findings from a case study using Community of Practice (CoP) as a framework for analyzing the ways in which STEAM lessons support teachers to effectively engage students in collective learning activities that promote student reflection and consensus building. Their paper offers practical implications for teachers and raises questions about the need for more qualitative research to contextualize researchers' appreciation for how STEAM impacts student learning. Hyoungbum Kim and Dong-hyun Chae's research focuses on the development and evaluation of a STEAM program integrating aspects of Korean folk arts, history and culture in a series of lessons designed to promote students' problem solving abilities while learning about the physics of sound by playing traditional Korean instruments. This study focused on understanding the value of arts integration on students' participation in STEAM activities and the researchers found students' problem solving abilities and interest in science learning were enhanced. The final paper in the issue by Banghee Kim and Jinsoo Kim discusses the development and evaluation of a tool that can guide teachers to include various competencies necessary for designing and implementing quality STEAM education lessons. Using Behavioral Event Interviews (BEI) with experienced STEAM educators and drawing from the expanding literature in Korean research journals about STEAM, the authors identified seven core competencies that are indicators of high quality STEAM classrooms. This paper offers a useful overview of the Korean language research on this topic and provides a tool for practitioners to help improve their development and implementation of STEAM lessons.

In closing, this special issue provides understanding on unique features of STEM education in Korea with a particular focus on exploring some sociohistorical

issues that have impacted the landscape of Korean science and math education research. The articles in this issue also argue the need for more discussion about the orientation and quality of STEM education in the future, both for Korea and the international community. There are many challenges in STEM education at present and in the future each country will need to address various factors that are related to localized sociocultural issues and more globalized needs affecting STEM education and STEM education research. We hope this issue can begin a discussion about the issues facing STEM education in Korea, as well as, contribute to broadening the international researchers' thinking about how to improve STEM teaching and learning.