

Editorial

The third issue of *Science Education International* for 2020 brings together a range of papers from six continents. This issue presents papers from the Philippines, the United States of America, Thailand, Turkey, Mexico, Japan, Australia, Greece, Ghana, and the final article from Brazil and Germany. The first article by the Philippines' Joje Mar P. Sanchez and the United States of America's Michael A. Ponce aimed to determine the extent of associations of Physics, Mathematics, and between Physics and Mathematics. The second article by Thailand's Akarat Tanak described pre-service science teachers' instructional practices to teach higher-order thinking skills (HOTS) related to key aspects of the inquiry. Meryem Görecek Baybars' Turkish study investigated secondary school students' images of a scientist with regard to gender as the variable in the third article. In the fourth article, Fatma Aggul Yalcin and Mehmet Yalcin sought to determine Turkish primary teacher candidates' conceptual understandings of gases. In the fifth article, Mexico's Rufino Trinidad-Velasco and Flor Reyes-Cárdenas investigated three chemistry professors general pedagogical knowledge through teachers' self-reflection. Uswatun Hasanah from Japan examined the impact of Science, Technology, Engineering, and Mathematics (STEM) instruction on strengthening the reasoning skills of Indonesian high school students in the sixth article. The seventh article is Wan Ng and Jennifer Fergusson investigating the impact of the STEAM punk Girls Program, funded by the Australian Government, on high school girls' learning and their teachers' teaching experiences. The eighth article comes from Turkey's Sündüs Yerdelen and Semra Sungur, which aimed to determine the extent of pre-service science teachers' process and materialistic understanding of the sound concept and the role of their task value beliefs in their scientific conception of sound. The ninth article by Greece's Michael Skoumios and Constantina Balia aimed to study the effect of a teaching intervention for electric circuits on the structure of the primary school students' written arguments. The final article by Brazil and Germany's Luciane Fernandes Goes, Xiaoge Chen, Keysy Solange Costa Nogueira, Carmen Fernandez, and Ingo Eilks analyzed the visual representations of redox reactions and related content in four Brazilian secondary school chemistry textbooks to identify, in which representations were used and how these representations were linked to one another and the main text.

The first article by the Philippines' Joje Mar P. Sanchez and the United States of America's Michael A. Ponce aimed to determine the extent of associations of physics, mathematics, and between physics and mathematics based on the results of 2007, 2011, and 2015 Trends in Mathematics and Science Survey achievement tests. Sanchez and Ponce highlight how

physics education has become a vital component of science education in the 21st century. To investigate the associations of physics and mathematics, their study used educational data mining (EDM). Through EDM Sanchez and Ponce reported that Elementary Physics and Mathematics and Secondary Physics and Mathematics are significantly associated with one another, respectively, indicating that knowledge in Grade 4 contributed to the achievement of students in high school. However, they noted Grade 8 Physics and Mathematics and achievement in Advanced Physics and Mathematics had a positive yet insignificant correlation, indicating that there was no significant association between Secondary and Advanced study. Sanchez and Ponce end their paper with recommendation for Filipino students based on the associations of Physics and Mathematics.

The second article by Thailand's Akarat Tanak described pre-service science teachers' instructional practices to teach HOTS related to key aspects of the inquiry. Tanak argues that the development of HOTS is imperative to becoming a scientifically literate person who is able to make wise decisions and solve complicated problems. Tanak goes on to highlight how inquiry-based learning can be effectively implemented to stimulate students' thinking skills. This study used a concurrent mixed methods design, including the Science Teacher Inquiry Rubric, analysis of pre- and end-course lesson plans, 15 pre-service teachers' microteaching, and self-reflections on their microteaching practices. Before entering the course, the two features of evidence and explain were significantly more prominent in the learning activities designed. After completing the methods course, however, the analysis of teacher lesson plans showed that pre-service teachers were able to design and implement learning activities promoting all five features of inquiry. The paper concludes with the significance of this research on promoting the nature of science inquiry.

Meryem Görecek Baybars' Turkish study investigated secondary school students' images of a scientist with regard to gender as the variable. Baybars study focussed on gender to explore how an individual's gender directly influences an individual's image of scientists. Baybars' study utilized the modified Draw-A-Scientist Test and four open-ended questions on 240 Turkish students aged between 10 and 13 years old. This study concurred with most of the research that female students mostly drew woman scientists and the male students mostly illustrated male scientists. Similarly, Baybars reported that most students' illustrations included traditional settings of laboratories for their scientist. Baybars noted in the paper's conclusions the significance of early imagery on perceptions and that this image is influenced by gender.

In the fourth article, Fatma Aggul Yalcin and Mehmet Yalcin sought to determine Turkish primary teacher candidates' conceptual understandings of gases. They argue how the difficulties encountered in linking gas concepts with daily life, results in gases as one of those chemistry concepts, in which students have both misconceptions and difficulty developing a conceptual understanding at the molecular level. Yalcin and Yalcin surveyed 240 primary teacher candidates (aged between 19 and 25 years old) enrolled in a Faculty of Education in a state university. The findings of their study highlighted that these primary teacher candidates had a weak conceptual understanding and various alternative concepts in terms of gases. Yalcin and Yalcin end their paper by highlighting the importance of addressing misconception or incorrect conceptual understanding of student teachers.

In the fifth article, Mexico's Rufino Trinidad-Velasco and Flor Reyes-Cárdenas investigated three chemistry professors general pedagogical knowledge through teachers' self-reflection. Trinidad-Velasco and Reyes-Cárdenas argue high-quality teaching allows teachers to offer highly efficient learning opportunities that will help improve student performance. However, General Pedagogical Knowledge (GPK) has often been overlooked as research tends to focus on Content Knowledge of Pedagogical Content Knowledge. A video stimulated recall technique was used to identify and examine the participating teachers' thoughts and decisions, as well as the reasons behind their behavior. Trinidad-Velasco and Reyes-Cárdenas concluded that teachers possess GPK that they use in teaching, regardless of their years of experience. They noted that while each teacher will express a different profile of GPK that it is related to their institutional context. Therefore, teachers from the same institutional context have a set of common categories. Trinidad-Velasco and Reyes-Cárdenas end their article noting the significance of their research in highlighting new categories.

Uswatun Hasanah from Japan examined the impact of STEM instruction on strengthening the reasoning skills of Indonesian high school students in the sixth article. Hasanah argues how reasoning skills emerge as a mental process that includes operating and applying knowledge to solve problems, make decisions, achieve goals, and as a complex construct that have been regarded as critical points in science education. Hasanah's study used quasi-experimental design with a control and experimental group. Sixty-three secondary school students in Grade 10 in Pangkep, South Sulawesi, and Indonesia participated. The STEM group received STEM instruction with inquiry-based learning and the connection between the science learning process and technology, engineering, and mathematics, while the traditional group received conventional instruction through reading, listening, and discussion. Based on the result of his study, STEM instruction emerged as effective instruction in strengthening students' reasoning skills. Hasanah notes the significance of his research in the challenges that arose in strengthening reasoning skills.

The seventh article is Wan Ng and Jennifer Fergusson investigating the impact of the STEAMPunk Girls Program, funded by the Australian Government, on high school girls' learning and their teachers' teaching experiences. Ng and Fergusson highlight that girls are less likely to engage with STEM education. To address, this imbalance a national strategy has set out to support gender equity across the STEM sector. STEAM education merges the arts with STEM subjects for the purpose of improving student engagement, creativity, innovation, and problem-solving skills. The Australian STEAMPunk Girls program was developed to help strengthen the pipeline of Australian women in STEM by highlighting STEM study and career pathways for young women and to equip them with relevant skills and mindsets to prepare them to select and pursue these pathways. Ng and Fergusson used a mixed-methods approach to investigate the impact of this program on the learning and teaching experiences of 352 high school students and 89 teachers. Ng and Fergusson reported that after participation in the project, student understanding of the kind of work involved in all the occupations had increased substantially. Similarly, the impact of the program on teachers and school capacity in PBL, Design Thinking, and STEAM was very positive. Ng and Fergusson end their paper with noting the implications of this research.

The eight article comes from Turkey's Sündüs Yerdelen and Semra Sungur, which aimed to determine the extent of pre-service science teachers' process and materialistic understanding of the sound concept and the role of their task value beliefs in their scientific conception of sound. Yerdelen and Sungur reported that as students' conceptions are deeply rooted and the conceptions inconsistent with the scientifically acceptable ones interfere with meaningful learning, teachers should be aware of students' misconceptions. However, research literature points to teachers being one of the possible reasons for the development of inadequate conceptions. While there are several misconceptions about scientific concepts, there is a relatively low number of studies on the conceptual understanding of sound. Yerdelen and Sungur's study was a cross-sectional quantitative study using the Sound Concept Inventory Instrument and the Task Value Questionnaire for Learning Sound on 320 pre-service teachers. They reported that these participating pre-service teachers held both process and materialistic views about sound. Yerdelen and Sungur conclude their paper discussing the difficulty in altering conceptions.

The ninth article by Greece's Michael Skoumios and Constantina Balia aimed to study the effect of a teaching intervention for electric circuits on the structure of primary school students' written arguments. Skoumios and Balia begin their paper arguing how and why there is a need for students to construct and evaluate arguments as this a particularly important science practice. Their argument is based around the notion that students construct new knowledge of natural phenomena through an interactive process between their prior conceptions and the conceptions they receive from their learning environment. Their study was a single group pre-

test and post-test quasi-experimental design carried out with 34 11-year-old Greek primary students. Data collection used written questionnaires. Skoumios and Baila noted that in the pre-test the participating students produced mainly insufficient arguments. After the intervention, the students developed sufficient claims, presented sufficient evidence supporting the claims, and developed sufficient reasoning. While their research reported that the structure these students' written arguments were improved through a teaching intervention, Skoumios and Balia noted the areas of potential further research based on their study.

The final article by Brazil and Germany's Luciane Fernandes Goes, Xiaoge Chen, Keysy Solange Costa Nogueira, Carmen Fernandez, and Ingo Eilks analyzed the visual representations of redox reactions and related content in four Brazilian secondary school chemistry textbooks to identify, in which representations were used and how these representations were linked to one another and the main text. Redox reactions were

chosen as it is essential for teachers to know how to them, how to connect the different representations of corresponding phenomena, and how to use different representations of the content. Visual representations are important as they help reduce student difficulties when moving between the different representational levels when they know how to interpret them. Four textbooks were chosen as each addresses redox reactions as required by the National Curricular Parameters for High School. Goes et al. reported that the same levels of representation appeared throughout the four chemistry textbooks. Goes et al. explore the strengths and weaknesses of the textbooks as a means to inform both teacher practice and future publications.

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