

Editorial

The first issue of *Science Education International* for 2020 brings together 12 articles. These articles come from Ghana, Turkey, Greece, Israel, and Japan covering topics ranging from chemistry, astronomy, physics, nuclear energy, Lego robotics, and nature of science (NOS). In the first article, Uswatun Hasanah reports on the effectiveness of science, technology, engineering, and mathematics (STEM) education for overcoming students' misconceptions in high school physics. Turkey's Necla Dönmez Usta, Eser Ültay, and Neslihan Ültay used concept maps to investigate physics teacher candidates' understanding of light for the second article. Ghana's Ruby Hanson in the third article reports on a baseline study for E-content for teaching basic analytical chemistry in higher education. The fourth article on pre-service chemistry teachers' collective PCK regarding solubility concepts being enhanced after participating in a microteaching is by Turkey's Yezdan Boz and Hatice Belge-Can. The fifth article from Salih Gülen determined the ability of 5th-grade students in expressing their knowledge about the Sun, Earth, and Moon on different assessment tools. The sixth article comes from Greece's Georgios Tsaparlis, Sotirios Hartzavalos, Vasiliki Vlacha, Constantina Malamou, Ioanna Neila, and Christina Pantoula. Their study reports on the affective and cognitive outcomes of project-based teamwork in 14–15-year-old students around the topic of nuclear energy. Meltem Irmak investigates the socioscientific reasoning competencies and NOS conceptions of undergraduate students in a Turkish University. The eight articles by Ceyhan Cigdemoglu employed flipping the use of science-technology and society (STS) issues as triggers to Turkish students' motivation and chemical literacy. Cohen Hagit and Zion Michal examined the contribution of metacognitive guidance to the development of drinking-related nutritional literacy (DNL) in Israel. In the tenth article, Bülent Çavaş, L. Özge Güney, Emre Karagöz, and Pınar Çavaş investigated how Lego Mindstorms EV3 based Robotics Education changed the concept of what is a scientist in the minds of 5th, 6th, and 7th-grade Turkish students. Esra Açıkgül Fırat determined science teachers' perceptions of and beliefs about integrated STEM Education in the science curriculum. This issue's final article by Gülfem Muşlu Kaygısız, Neşe Uygun, and F. Melike Uçar examined the relationship between the level of pre-service primary school teachers' self-efficacy beliefs in science teaching and their level of determining taxonomy, strategy, and teaching methods-techniques for the curriculum's objectives in primary science education.

In the first article, Japan's Uswatun Hasanah reports on the effectiveness of STEM education for overcoming students' misconceptions of Indonesian high school physics students. In his study, he used a STEM system as a tool and the materials for the physics learning process from the engineering viewpoint to

reduce the participating Indonesian secondary school student's misconceptions in the alternating current (AC) circuit topics. This study was a multi-method research study. The STEM system involved a stereo capture device and cable connections, probes, a voltage divider, a circuit plate, RLC components, multimeter, and a laptop computer as a soundcard oscilloscope with a signal generator. Hasanah reported that these students' concepts and understanding of physical phenomena and mathematical formulation significantly affected the students' achievement and their final conceptions. Students in his control group had misconceptions for all indicators. Meanwhile, students in the experimental group, in which the STEM system was applied, were predominantly showed improvement in some areas. As a result of this study, it is recommended that more researchers should find, create, develop, and implement more teaching materials that support the understanding of students in AC circuits as well as the other parts of physics.

Turkey's Necla Dönmez Usta, Eser Ültay, and Neslihan Ültay used concept maps to investigate physics teacher candidates' understanding of light for the second article. The aim of this study was to determine the ability of physics teacher candidates' to read a concept map about a light topic and then convert the concept map into the appropriate text. Thirty-two physics teacher candidates were asked to convert a concept map into meaningful text. Dönmez Usta, Ültay, and Ültay reported six physics teacher candidates had difficulty in establishing relationships between concepts and that their alternative concepts were resistant to change. They went on to note that 25 of these physics teacher candidates were able to read the concept map at a medium level. Only one teacher candidate had a high level of understanding. As a result of this research, it is recommended that the concepts related to the subject of light should be increased using different teaching methods and techniques in learning environments.

Ghana's Ruby Hanson in the third article reports on a baseline study for E-content for teaching basic analytical chemistry in higher education. Hanson's study developed an e-resource for six topics and six activities for chemistry that could be implemented through the hybrid learning approach. Hanson highlights that E-studies have become popular in recent times to allow adult learners, workers, mothers, and people who are geographically separated from desired places of learning to access education. This was a baseline study intended to develop a design to embed e-content into an already existing traditional non-e-content to generate a blended approach to teaching and learning. Hanson reported that for these participants, there appeared to be poor understanding or interpretation of simple English worded problems; they were unable to express their own ideas articulately on paper; there

were some inadequate conceptual understanding of basic analytical procedures; and the majority of the students gave partial responses about sampling and sampling techniques. Hanson reported that pictures, videos on titration, virtual activities on titration, and threaded conversations about observations made would strengthen students' visualization capacities on desired concepts. Based on her research Hanson recommends that employing information and communication technology in teaching and learning activities would facilitate the implementation of the blended learning approach not only in the study of chemistry but also other courses.

The fourth article on pre-service chemistry teachers' collective PCK regarding solubility concepts being enhanced after participating in a microteaching is by Turkey's Yezdan Boz and Hatice Belge-Can. The aim of their study was to help students better understand the teaching profession, class, and school environment. In this study, the pre-service chemistry teachers performed microteaching about chemistry topics. This research employed a lesson study. The participants decided their own topics, conducted a lesson, and then reflected on its effectiveness before repeating this lesson. Boz and Belge-Can reported that for these teachers their understanding of the unsaturated, saturated, supersaturated solutions, diluted, and concentrated solutions collective PCK did not change. Their collective PCK regarding curriculum was enhanced; however, in terms of assessment, only the time of assessment changed while methods used to assess students' understanding did not show any changes. Boz and Belge-Can's study has several implications for teacher educators. They highlighted how microteaching lesson study enhanced pre-service teachers' collective PCK and suggest the use of microteaching lesson study as a fruitful way of enhancing the pre-service teachers' professional growth in teacher education programs and pre-service teachers should be given the opportunity to apply their collective PCK in different class contexts.

The fifth article from Salih Gülen determined the ability of 5th-grade students in expressing their knowledge about the Sun, Earth, and Moon on different assessment tools. Gülen highlighted how drawing has a long history of being a way of expressing the emotions of people and as a means of communication especially for the imaginary, inaccessible or distant concepts or objects. Previous research notes that students' information about the Sun, the Earth, and the Moon is generally at the level of basic fact knowledge. This study used a mixed method. A 3-point Likert-type questionnaire and true-false test were used to collect quantitative data. Qualitative data were collected through a fully structured interview form and a drawing. It was determined that these students could also transfer the knowledge of the survey and the true-false test. It was determined that these students were able to transfer their knowledge from a fully structured interview to a drawing. To increase this ratio, models, images, computer simulations or virtual materials should be used in the training of spatial concepts.

The sixth article comes from Greece's Georgios Tsaparlis, Sotirios Hartzavalos, Vasiliki Vlacha, Constantina Malamou, Ioanna Neila, and Christina Pantoula. Their study reports on the affective and cognitive outcomes of project-based teamwork in 14–15-year-old students around the topic of nuclear energy. Tsaparlis *et al.* noted that formal education often neglects a range of science topics relevant to health and medicine, nutrition, environment, energy, new materials, and astronomy and space, such as nuclear energy. In this paper, they report on the implementation of a project-based group learning activity about nuclear energy with 14 ninth-grade students. This study was conducted using two written questionnaires, administered to the students after the completion of the overall project. The first questionnaire elicited students' opinions about the project, while the second questionnaire examined students' acquired relevant knowledge. Tsaparlis *et al.* reported that the majority of the students declared that they benefited from their familiarity with searching and evaluating information, expressed a favorable opinion with regard to their acquaintance with radioactivity in the university laboratory, were enthusiastic about their contact with scientists, and developed a more positive image of science. In addition, almost all students were positive about teamwork and expressed a favorable opinion about their acquaintance with radioactivity in the university laboratory and the talks by the three scientists at the seminar. The results of the present study highlight the importance of context-based, teamwork and the role of the connection and interaction of a modern school with scientific and research institutions.

Meltem Irmak investigates the socioscientific reasoning competencies and NOS conceptions of undergraduate students in a Turkish University. Socioscientific issues provide a fruitful context for including moral and ethical issues in science teaching and learning, because socioscientific decision-making requires scientific knowledge acquisition, NOS understanding as well as an awareness of moral and ethical issues. Therefore, in this study, security sector reform (SSR) competencies and NOS conceptions of 169 undergraduate students from five different faculties were investigated through survey research methodology. The survey research methodology was utilized in this study to gather data about undergraduate students' SSR competencies and conceptions of NOS. Irmak reported that students from the science department had the lowest score in both constructs. On the other hand, the Health Science students had higher scores on SSR. Irmak highlighted that although science students are more engaged in scientific inquiry in laboratories, they are less competent in comprehending the NOS. Irmak recommends offering courses in which NOS is explicitly taught for all of the departments aiming to develop a sophisticated NOS view and scientific literacy.

The eight articles by Ceyhan Cigdemoglu employed flipping the use of STS issues as triggers to Turkish students' motivation and chemical literacy. The aim of this paper was to investigate the effect of the use of STS issues through flipped and traditional learning environments on students' motivation

to learn chemistry as well as their chemical literacy. From a constructivist perspective, cooperative learning is a strong active learning method, and the method favors students' achievement. Cigdemoglu noted that active learning techniques are the most likely source of learning gain in flipped classroom implementations. The flipped learning model provides opportunities for instructors to advocate more time to student-led discussions since students are directed to already available course videos before the class hour. This study used a quasi-experimental design. The instructor used the same STS issue for both the intervention and comparison group; therefore, each group covered the same STS discussion. This study revealed that flip-STS intervention supported students' motivation to learn chemistry more than conventional-STS instruction. Cigdemoglu recommends that based on this study, the gain in intrinsic motivation to learn chemistry and make chemistry more relevant is evidence that flipping-STS designs should be incorporated into teaching-learning environments for making chemistry more relevant and motivating.

Cohen Hagit and Zion Michal examined the contribution of metacognitive guidance to the development of DNL in Israeli children aged 9–11 years old. Hagit and Michal highlight how research has shown that children and adolescents have limited understanding of how food and drink affect health; their knowledge and understanding require improvement to support health-promoting dietary habits. They examined the contribution of metacognitive guidance in developing children's DNL. Hagit and Michal argue that metacognitive guidance can stimulate students to cognitive control and critical thinking. Their study used two questionnaires: The first was a nutritional literacy questionnaire that examined knowledge, attitudes about the importance of drinking water and reducing sugar-sweetened beverage (SSB) consumption, and self-efficacy; and the second examined healthy drinking habits. During three science lessons, the students studied a "Nutritional Literacy about Drinking" learning unit, which emphasized the importance of sufficient water drinking and the hazards of SSB consumption. Hagit and Michal reported that this research shows that metacognitive guidance can generate changes in drinking-related behavior. This study highlights the great potential of the relation between metacognition and nutritional literacy to be subjects of future investigation.

In the tenth article, Bülent Çavaş, L. Özge Güney, Emre Karagöz, and Pınar Çavaş investigated how Lego Mindstorms EV3 based Robotics Education changed the concept of what is a scientist in the minds of 5th, 6th, and 7th-grade Turkish students. Çavaş *et al.* noted that there is a dramatic decrease in students' attitudes and interest in science and technology as they progress through schooling. They go onto report that one reason for this decrease is that activities in science classes are often teacher centred and another is that the students' perceptions of scientists are often based on stereotypes. As a result, Çavaş *et al.* highlight that students' perceptions of scientists have been one of the important research fields in science education. In their study, a modified version of the Draw-A-Scientist-Test

was used to assess students' stereotypes of scientists before and after robotic education. Twenty-one 11–13-year-old male and female students participated in this research. Some of the notable results included while the students drew more male scientists in the pre-test, there was a significant decrease in the post-test. Another result obtained from the study was related to the physical properties of scientists. In the first drawings of the students had more crazy hair, bald/no hair, and beards, but these masculine physical properties decreased. This study exposed the students to education through Lego Mindstorms EV3 kits. These kits were used as a supportive educational tool to provide students with opportunities to learn how to use robotic technologies to solve socio-scientific problems after learning robot building, programming, and coding. Çavaş *et al.* argued that robotics education caused an increase in students' perception of technological concepts. In the pre-test pictures, the number of students who visualized the concepts of a dream world such as nuclear waste car, drone flying car, and hologram computer in their paintings was two, while the number of students using these concepts in post-test pictures was 11. Çavaş *et al.* conclude the robotic education contributed to the perceptions of these students.

Esra Açıkgül Fırat determined science teachers' perceptions of and beliefs about integrated STEM Education in the science curriculum. Fırat notes that science deals in some complex events and in science teaching, students need to deal with complex problems and natural phenomena that cannot be easily understood or solved from a single discipline framework. Therefore, there is increasing importance attached to STEM education based on interdisciplinary approaches, which focus on real-world problems and projects within which concepts and skills are learned separately in each discipline. Fırat highlights that in the literature shows that teachers can explain the interdisciplinary nature of STEM but teachers lack of STEM training. Farit's study used the case study research method to determine teachers' perceptions of and beliefs regarding integrated STEM education. Interviews were conducted in which the questions were semi-structured and open-ended about the participating teachers' STEM concept knowledge, curriculum knowledge, and STEM implementation knowledge. Farit reported when teachers' beliefs regarding the problems that might be encountered during an integrated STEM education process were examined, it was found out that the emphasis was especially on teacher based problems. Farit recommends that teachers as the implementors of the curriculum, to enable an efficient integrated STEM education, should receive training and student-based STEM laboratories should be designed.

This issue's final article by Gülfem Muşlu Kaygısız, Neşe Uygun, and F. Melike Uçar examined the relationship between the level of 101 Turkish pre-service primary school teachers' self-efficacy beliefs in science teaching and their level of determining taxonomy, strategy, and teaching methods-techniques for the curriculum's objectives in primary science education. In the revamps, Turkish curriculum teachers are

now expected among other things to encourage students to undertake research and guide them through this process. Kaygısız, Uygun, and Uçar argue that for students to acquire the knowledge and skills emphasized in the science curriculum, their primary school teachers not only need to be equipped in this field but also hold self-efficacy in their abilities. Therefore, this study aimed to examine the relationship between the level of pre-service primary school teachers' self-efficacy beliefs in science teaching and their level of determining taxonomy, strategy, and teaching methods-techniques suitable for the curriculum's objective in primary science education. Their study used a correlational research method. Two surveys were used to gather quantitative data in addition to open-ended questions for qualitative data. Kaygısız, Uygun, and Uçar reported that for pre-service teachers' their self-efficacy beliefs toward science teaching were relatively high. Similarly, when their level of determining appropriate objective-oriented

taxonomy, strategy, and teaching methods-techniques was examined, it was also relatively high. In fact, these pre-service teachers perceived themselves as sufficient in the teaching process. Finally, there was a positive correlation found in this study between pre-service teachers' self-efficacy beliefs toward science teaching and the level of determining appropriate objective-oriented taxonomy, strategy, and teaching methods-techniques. Kaygısız, Uygun, and Uçar conclude that conducting theoretical and practical courses are effective in increasing the self-efficacy of the preservice teachers in science teaching.

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