

Editorial

As we welcome the winter season, we are thrilled to present to you the December issue of Science Education International. In December issue, you will find a collection of thought-provoking articles, insightful research, and innovative pedagogical approaches that highlight the diverse and dynamic landscape of science education. This issue encapsulates the spirit of exploration and discovery that defines the world of science education. Our contributors, hailing from various corners of the globe, have brought forth their expertise to enrich our understanding of how we teach and learn science in today's ever-evolving educational landscape. From research findings to practical classroom strategies, each article in this issue contributes to the broader conversation on enhancing science education. We extend our sincere gratitude to all the authors, reviewers, and readers who continue to make Science Education International a thriving hub of knowledge and collaboration. Your commitment to advancing science education is truly commendable, and we are honored to be part of this collective journey.

The first article is from Türkiye by Feride Ercan Yalman. The research aimed to assess the quality of arguments and informal reasoning abilities of pre-service science teachers concerning various socioscientific issues, utilizing dilemma cards. The case study method, a qualitative research approach, was employed, involving 12 pre-service science teachers. Participants completed the dilemma cards over a 12-week period. The analytical procedure for these cards incorporated content analysis. Findings from the study indicated that participants were often unable to construct a comprehensive argument that considered all argumentative components, such as claim, evidence, support, and rebuttal.

The second article was written by Sittichai Wichaidit and Manabu Sumida from Japan. The research aim was to examine the effectiveness of game-based learning (GBL). The GBL was utilized to teach 101 middle school students concerning bioaccumulation and biomagnification concepts. Concept cartoons were used for pre- and post-test to assess the extent of conceptual change. Students' reflections were employed to understand the emotional and social aspects analyzed by content analysis. The result indicated that before engaging in the GBL activity, most students had limited concepts of bioaccumulation (50%) and held partially accurate concepts of bioaccumulation without biomagnification (49%). After learning with the game activity, the students changed their concepts range from limited concepts to accurate concepts of bioaccumulation and biomagnification.

The third article entitled, Reconciling Teachers' Views and Practices with Early Graders' Ability to Engage in Scientific Inquiry, was done by Mjege Kinyota from Tanzania. This

study used a three-phase design to explore how teachers' views and practices of scientific inquiry can be reconciled with early graders' ability to engage in scientific inquiry. First, 19 early years teachers were interviewed to explore their views and practices of scientific inquiry. Second, six standard two students were exposed to a problem-solving situation so that their ability to engage in scientific inquiry could be assessed. Finally, six standard two teachers who involved in designing the problem and who also observed students solving the problem were interviewed to explore any changes in their views, and the findings indicated that, under specific conditions, early graders are able to engage in some inquiry activities such as framing questions, designing, and conducting investigations. Furthermore, changes in teachers' beliefs and understanding of scientific inquiry were noted.

The fourth article is done by Feride Sahin, Semra Sungur, and Salih Ates from Türkiye. The purpose of this study is to test the relationship between seventh-grade students' personal epistemology for science, subjective task value, and science self-efficacy, with prior achievement serving as a moderator. The mediating role of subjective task value is proposed in the prediction of the relationship between personal epistemology for science and science self-efficacy. To achieve this aim, a model that explains the relationships among the specified variables is proposed, and then, this model is tested using moderated mediation techniques, controlling for the effects of gender and parental educational background variables. The analyses confirm the mediating effect of subjective task value and reveal the moderator effect of prior achievement on the prediction of personal epistemology for science and science self-efficacy.

The fifth article's title is How a Digital Educational Game can Promote Learning about Sustainability and written by Thomas S. Muenz, Steffen Schaal, Jorge Groß, and Jürgen Paul from Germany. It investigated the learning potential of game elements within a digital educational game for ESD. The final game aims to convey specific aspects of ESD ranging from sustainable land use to personal power consumption. Seven groups of 2–3 secondary school students (9th and 10th grade, n = 18) played the educational game in an early prototype phase. Following the DBR approach, students were shown screenshots of specific game situations in subsequent group interviews to reveal their conceptions and conceptual developments regarding sustainability. To analyze the causes of possible learning processes, retrospective query on the learning process and qualitative content analysis was used. The results indicate that the observed learning processes can be primarily traced back to feedback mechanisms and the visualization of processes that would be too complex and long termed to be

experienced by students in real life. This is how a simulation game, which makes complex interrelations tangible, can contribute to ESD.

The sixth article is written by Jennifer A. Endiape, Jamaica Fayette V. Lopez, Zenerica T. Lastimoso, Charie Ann V. Gecain, Nheljay Mae C. Herbierto, Joje Mar P. Sanchez, and Marchee T. Picardal from the Philippines. This quasi-experimental study determined Graphic Organizer Integrated Online Instruction's effectiveness in understanding astronomy concepts. Three groups of Secondary Science Education students from a state university in Central Visayas, Philippines, were exposed to text, both text and graphic organizers, and the latter only. Study findings revealed that students across the three groups obtained above-average performances and improved performance; these groups also showed no significant difference in the improved performance. Using graphic organizers yielded high retention and satisfaction among the students, as they were immersed in visual-verbal instruction, a valuable learning scaffold, and a fun experience. In conclusion, the use of Graphic Organizer Integrated Online Instruction was effective in improving student performance, retention, and learning experiences. Integrating these visual tools in online instruction is highly recommended for use at the undergraduate level in the new normal.

The seventh article is From Professional Knowledge to Practice: The Effect of Academic Counseling Model (ACM) Based on Academic-Teacher Collaboration on Pedagogical Content Knowledge (PCK). The article was written by Nesli Kala and Selcan Sungur-Alhan from Türkiye. The aim of the study was to investigate the effect of the ACM based on academic teacher collaboration on the PCK of in-service teachers. The seven volunteer science teachers in different seniority levels participated in the research from three secondary schools (urban, suburban, and private schools). A total of six academics, four of whom were in the counseling team and two in the support team, took part in the academic team. Statistical differences were found in all stages of ACM, except for gradually decreasing and evaluation, according to the classroom practices of the participant teachers. Consequently, it was determined that ACM significantly improved science teachers' professional skills on PCK.

The eighth article was done by Ahmet Taşdere and Mehmet Fatih Kaya from Türkiye. The aim of the study was to investigate the effect of the Common Knowledge Construction Model on 10th-grade students' conceptual understanding of the buoyancy and density of liquids topic. Students' conceptual understanding of the states of objects in different positions (swimming, sinking, and suspending) in the liquid was determined by means of the SG. Through the WAT, the cognitive structure of the students for the stimulus words of mass, volume, density, buoyancy, and Archimedes was determined. According to the post-tests for the SG questions, it was determined that there was a significant increase in the

number of correct boxes selected and a significant decrease in the number of incorrect boxes selected. In addition, it was determined that the mind map obtained from the post-WAT, which revealed the cognitive structures of the students, had a much more interrelated and complex network.

The ninth article was written by Hayat Hokayem, Ihsan Ghazal, and Savannah R. Graham from the USA. This study explored elementary students' reasoning about the life cycles of various organisms, including insects and amphibians. The study took place in a private school in Lebanon with 24 fifth-grade students. Students participated in a life cycle unit with pre and post-written assessments about what they learned and interviews to help determine their reasoning about life cycles. Findings suggest a learning progression (LP) approach to guide students over time in their learning about life cycles and their importance for species persistence within an ecosystem. Two LPs were developed from this study: Reasoning about the cyclic nature of life and comparison of life cycle stages. Overall, students improved their understanding of the cyclical nature of life, but comparing organisms' structures, stages, and life cycles proved to be more challenging. These LPs have direct implications for elementary instruction about life cycles, organisms, and species.

The tenth article is Introduction and Testing about Development the Technology-Based EIGEC Models to Enhance Student Learning Outcomes and written by Suritno Fayanto, Dedi Kuswandi, Monamorn Precharattana, La Tahang, Erniwati, and Hunaidah from Indonesia. The purpose of this study was to introduce technology-based EIGEC models and implement these models into the learning process in the classroom. This research was quasi-experimental, using a pre-test and post-test control group design. The research sample consisted of two classes with different treatments. Each course was selected randomly, with the number of students who were the object of the trial being as many as 36 in each class. The data collection technique used an instrument test and was analyzed descriptively and inferentially. The T-test was used in inferential analysis to determine how the model's implementation and impact on learning outcomes were affected. The analysis found that the technology-based EIGEC model contributed 0.59 to improving learning outcomes compared to conventional models (0.39), based on the results of the N-gain value. The five stages of the technology-based EIGEC were (1) engagement, (2) introduction, (3) guidance, (4) execution, and (5) conclusion. From the analysis results, the technology-based EIGEC model can be an example of a model used to support learning in the classroom.

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