

Editorial

The Journal of Research in Science Education © ISSN 1850–6666, published by the Núcleo de Investigación en Educación en Ciencia y Tecnología de la Facultad de Ciencias Exactas de la Universidad Nacional del Centro de la Provincia de Buenos Aires, celebrates with this special issue twenty years of uninterrupted publication, since its first appearance in December 2006, with two semi-annual issues regularly published in July and December. Since its creation, the journal was conceived, founded, and directed by Dr. María Rita Otero, who continues to serve to this day as editor-in-chief.

Over the course of these two decades, our journal has consolidated itself as a benchmark academic space, entirely devoted to research in science and mathematics education. Its pages disseminate research that addresses problems in the teaching of science and mathematics from diverse didactic, cognitive, and epistemological theoretical frameworks related to the teaching and learning of mathematics, physics, chemistry, biology, and computer science.

Since its beginnings, the journal has been part of the Núcleo Básico de Revistas Científicas Argentinas del CAICYT-CONICET and SciELO, Dialnet, Directory of Open Access Journals (DOAJ), Latindex Catálogo, Redalyc, ERIH PLUS e IRESIE, which attests to its recognition and visibility in the national and international academic sphere. The journal also has a scientific committee made up of prominent international researchers in the various disciplinary areas it addresses. It is a fully open-access publication and accepts contributions in four languages: Spanish, English, French, and Portuguese, reaffirming its commitment to the broad and democratic circulation of scientific knowledge. The official website of the journal is <https://reiec.unicen.edu.ar/reiec/index>

In this special issue we publish nineteen invited articles, which particularly reflect the thematic, theoretical, and methodological diversity that has characterized the journal throughout its history.

In the first article, *Institutional and epistemological conditions for a transition to the paradigm of questioning the world*, Yves Chevallard and Heidi Strømskag develop a theoretical analysis, grounded in the Anthropological Theory of the Didactic, on the institutional and epistemological conditions necessary to move from the paradigm of the visit to works toward the paradigm of questioning the world in secondary and tertiary education. The work conceives paradigms as tacit social contracts that regulate educational activity and reconstructs historically the evolution from the former to the latter. Based on central notions such as didacticity, milieu, and definalization, the authors analyze the dialectic between

didactization and adidactization, the construction of the milieu, and the evolutionary topogenesis of teachers and students, illustrating these processes through activities and study and research paths. The article concludes by identifying epistemological attitudes necessary to engage in an education oriented toward questioning the world and toward redefining the aims and the assessment of learning.

In the second article, *What computer science teaching in French primary schools? Reflections on 40 years of development*, Georges-Louis Baron analyzes the historical evolution of the teaching of computer science in the French educational system, with special attention to the primary level. The author examines the different stages of the institutionalization of computer science, from its introduction as a method to its recognition as a discipline, highlighting institutional tensions, curricular decisions, and the prominent role that mathematics has acquired. The work underscores the unfinished nature of this process in primary school and emphasizes the relevance of peri-school, extracurricular initiatives and participatory research for the construction of a computer culture accessible to all students.

In the third article, *Onto-semiotic analysis of the emergence and evolution of the electric charge concept*, Juan D. Godino characterizes the various meanings of the concept of electric charge throughout its historical and scientific development using the Ontosemiotic Approach. The study identifies stages ranging from the observation of macroscopic electrical phenomena to the subatomic conceptualization of charge as a fundamental quantized property of matter. For each partial meaning, the phenomena, problems, operational and discursive practices involved are analyzed, as well as the role of symbolic and experimental tools. The article discusses relevant didactic implications and argues that understanding this plurality of meanings can help overcome misconceptions in the teaching of electrical phenomena.

In the fourth article, *The concept of Cognitive Conflict in Science Education: structural and functional aspects*, Konstantinos Ravanis develops a theoretical work that addresses cognitive conflict from a bidimensional perspective. On the one hand, it analyzes its structural components and, on the other, its functions in research in science education and in teaching practices. The author defines the concept, distinguishes it from related notions that often generate confusion, and presents a typology that includes simple, operational, and sociocognitive conflicts, providing examples that show its relevance for learning and teaching in the natural sciences.

In the fifth article, *Migration of concepts from mathematics didactics to professional didactics*, Janine Rogalski studies, in the French context, the transfer and resignification of

central concepts from mathematics education to professional didactics, drawing on theoretical contributions by Vergnaud, Brousseau, Chevallard, and Pastré. The analysis focuses on notions such as conceptual fields, didactic situations, didactic transposition, and pragmatic concepts, highlighting the centrality of the analysis of situations and work activity. The work discusses the genesis of professional didactics and its contributions to mathematics education, incorporating an instrumental dimension linked to the use of information and communication technologies.

In the sixth article, *Potentially meaningful material for teaching proportionality functions*, José Roberto da Silva and Marco Antonio Moreira present a qualitative action-research study carried out with primary and secondary education teachers in a specialization course. The study describes the development and use of a support text grounded in the Theory of Meaningful Learning, the Theory of Conceptual Fields, and Activity Theory. The analysis of activities, questionnaires, and concept maps shows relevant changes in the resignification of the participants' conceptual system regarding affine, linear, and proportionality functions, concluding that the material developed constitutes a potentially meaningful resource within the Ausubelian framework.

In the seventh article, *Guy Brousseau's contribution to the constitution of the didactics of mathematics*, Saddo Ag. Almouloud and Teodora Pinheiro Figueroa develop a theoretical analysis of the main contributions of Guy Brousseau to the field of mathematics education. Based on a review of his academic and professional trajectory, the work examines the central constructs of the Theory of Didactic Situations and highlights the coherence, explanatory power, and scientific relevance of this approach in consolidating mathematics education as a field of research.

In the eighth article, *Teaching and learning physics based on scientific investigation: between teacher guidance and student autonomy*, Jean-Marie Boilevin critically analyzes inquiry-based physics teaching through a review of the literature and a francophone theoretical approach linked to Chevallard. The work discusses the lack of consensus on the definition and effectiveness of this type of teaching and reflects on the distribution of roles between teachers and students. It argues that learning physics requires teacher guidance that enables the progressive development of student autonomy, in a process of negotiation between scientific rationality and common sense.

In the ninth article, *Uncertainty, risk, and an open future: science education and the contemporary world*, Mauricio Pietrocola develops a theoretical reflection article supported by the frameworks of the risk society and manufactured risks. The work analyzes the tensions between progress, risk, and uncertainty in the contemporary world and discusses their

implications for science education, emphasizing the need to educate citizens capable of evaluating risks, deliberating in scenarios of uncertainty, and understanding the limits of expert knowledge.

In the tenth article, *A virtual experience in pre-service teacher education for the understanding of complex numbers*, Valeria Randolph, Marcela Parraguez, and Sebastián Herrero describe a qualitative interpretive case study developed in a virtual learning environment. From the Theory of Modes of Thinking, the work analyzes how prospective mathematics teachers articulate different ways of thinking about complex numbers. The results show the predominance of the analytical-arithmetic mode and difficulties in consolidating dynamic geometric and structural meanings, although conceptual articulators that favour a more integrated understanding are identified.

In the eleventh article, *Analysis of the solutions to exercises and problems about integrals by first year university students*, Myriam Núñez, Cecilia Crespo Crespo, and Paula Zambianchi present an empirical study with a qualitative and quantitative approach focused on the analysis of assessments of incoming students. The study identifies frequent errors and skills involved in solving exercises on integrals, based on the comparison of results obtained in different semesters, providing relevant elements for the teaching of integral calculus at the beginning of university studies.

In the twelfth article, *Gamified interactive narrative: Mel's Journey and the learning of financial mathematics*, Juliana Evaristo Costa, José Aires de Castro Filho, and José Gilvan Rodrigues Maia present an empirical study on the use of a gamified interactive narrative for teaching financial mathematics content. The study, conducted with secondary school students, analyzes data from a pre-test, problem situations, and a usability instrument. The results show an improvement in problem-solving performance and good acceptance of the resource, highlighting the potential of gamification and narrative contextualization to promote learning.

In the thirteenth article, *Mathematical modeling in the rural multigrade classroom, when mathematics goes to the countryside*, Miguel Ángel Rodríguez Mejía and Avenilde Romo Vázquez present an empirical study conducted in a rural multigrade school in Colombia. Within the framework of the Anthropological Theory of the Didactic and the paradigm of questioning the world, the study analyzes the design, implementation, and effects of a Study and Research Path. The results allow the description of the evolution of modeling activity from an ecological perspective and reflection on the conditions, possibilities, and challenges of teaching mathematics in rural contexts.

In the fourteenth article, *The impact of a groupware lesson planning system on teachers' well-being*, Leandro Marques Queiros, Aluisio José Pereira, Rosane Maria Alencar da Silva, and Alex Sandro Gomes present an empirical study with a mixed methodological approach. The study analyzes how a groupware system aimed at collaborative lesson planning impacts the perceived well-being of basic education teachers, considering affective, community, and work-related dimensions. The results show a predominance of positive emotions, the strengthening of a sense of belonging to the teaching community, and an increase in the perception of productivity and job satisfaction.

In the fifteenth article, *Support for hybrid pedagogical practices as a space for in-service continuing education of mathematics teachers in elementary education*, Gustavo Adalberto de França Silva, José Roberto da Silva, and Alex Sandro Gomes develop an action-research study focused on supporting hybrid pedagogical practices. The results show that the use of virtual environments fosters professional development, critical reflection, autonomy, and pedagogical innovation, configuring ecosystems of continuous in-service education.

In the sixteenth article, *A conceptual framework for steam education: a proposal from and for the Global South*, Dennys Leite Maia and Raíza de Araújo Domingos Soares propose a conceptual framework for STEAM education developed from document analysis, literature review, and empirical research. The work conceives STEAM education as an interdisciplinary pedagogical approach based on inquiry and problem solving, contextualized in the Global South, and offers guidance for teachers, teacher educators, and educational policy makers.

In the seventeenth article, *Principles of financial education contributed by mathematical modeling from the perspective of meaningful learning*, Maria Aparecida da Silva Rufino, Jozeildo José da Silva, and Cleiton de Santana Ferreira present an exploratory qualitative study developed in two phases. The study analyzes a pedagogical proposal that articulates mathematical modeling with financial education, showing that both can be meaningfully integrated for learning financial mathematics and the principles of financial education.

In the eighteenth article, *Contributions of implicative statistical analysis in the treatment and analysis of issues in the field of evaluation*, Saddo Ag. Almouloud presents an in-depth study based on a qualitative metasynthesis of research applying Implicative Statistical Analysis in educational assessment. The work shows that this tool makes it possible to identify cognitive hierarchies, dependencies among items, and knowledge structures, complementing traditional methods and contributing to more meaningful and contextualized assessments.

In the nineteenth article, *A strategic framework for the ethical and didactic integration of generative artificial intelligence in teaching with a STEAM approach*, Mario Di Blasi Regner critically analyzes the Technological Pedagogical Content Knowledge framework for the integration of generative artificial intelligence in education. The article proposes an extension of the model that incorporates ethical, contextual, and institutional dimensions, integrating critical literacy, prompt engineering, and ethical governance, in order to guide a responsible implementation of artificial intelligence in STEAM educational contexts.

The editors of REIEC thank the contributions to this 20th anniversary issue made by international researchers of recognized trajectory, leading figures in the field of science education, mathematics education, and computer science education. We especially thank Dr. Yves Chevallard, Dr. Heidi Strømskag, Dr. Georges-Louis Baron, Dr. Juan D. Godino, Dr. Konstantinos Ravanis, Dr. Janine Rogalski, Dr. Marco Antonio Moreira, Dr. José Roberto da Silva, Dr. Saddo Ag. Almouloud, Dr. Jean-Marie Boilevin, Dr. José Aires de Castro Filho, Dr. Alex Sandro Gomes, Dr. Marcela Parraguez, Dr. Cecilia Crespo Crespo, Dr. Mauricio Pietrocola, Dr. Avenilde Romo Vázquez, Dr. Leandro Marques Queiros, Dr. Dennys Leite Maia, Dr. Maria Aparecida da Silva Rufino, and Dr. Mario Di Blasi Regner, who, in some cases, invited thesis students and collaborators to participate in the preparation of the works published here.

María Rita Otero. Editora responsable de REIEC.

Viviana Carolina Llanos. Editora asociada de REIEC.

María Paz Gazzola. Editora asociada de REIEC.