

Mathematics Teacher Education for Sustainability (MTEfS): an emerging research agenda

Formación de Profesores de Matemáticas para la Sostenibilidad (FPMpS): una agenda de investigación emergente

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Abstract ∞ The papers contained in this Special Issue on Mathematics Teacher Education for Sustainability (MTEfS) provide much-needed evidence to make progress with regard to the triple social, environmental and economic transformation associated with sustainable development, showing how this emerging mathematics education research agenda is beginning to contribute to the emergence of relevant data for the creation of positive social solutions.

Keywords ∞ Mathematics teacher education; Education for Sustainable Development; Mathematics Teacher Education for Sustainability; Mathematics teacher professional development

Resumen ∞ Los artículos contenidos en este Número Especial sobre la Formación del Profesorado de Matemáticas para la Sostenibilidad (FPMpS) aportan evidencias imprescindibles para avanzar en la triple transformación social, medioambiental y económica asociada al desarrollo sostenible, mostrando cómo esta agenda emergente de investigación en educación matemática está empezando a contribuir a la aparición de datos relevantes para la creación de soluciones sociales positivas.

Palabras clave ∞ Formación del profesorado de Matemáticas; Educación para el Desarrollo Sostenible; Formación del profesorado de Matemáticas para la Sostenibilidad; Desarrollo profesional del profesorado de Matemáticas

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1. INTRODUCTION

Sustainability can be considered to be a philosophy and a way of life which leads to transformations of different kinds (Geli et al., 2019): social (consumption, business practices, culture and lifestyle); environmental (use of natural resources, pollution control, ecological footprint, environmental management); and economic (business ethics, fair trade, improvements in the management of human, financial and natural resources).

From this perspective, recent decades have borne witness to significant efforts to incorporate Education for Sustainable Development (ESD) into higher education, taking into consideration the fact that it is one of the main tools at the disposal of governments as far as ensuring their countries' development is concerned. In this regard, different guidelines and declarations have been published, such as *Education for sustainable development: a roadmap* (UNESCO, 2020), *Rio+20 Treaty on Higher Education*, an initiative of the COPERNICUS Alliance in collaboration with all its international counterparts (COPERNICUS Alliance, 2015), the *Aichi-Nagoya Declaration on Higher Education for Sustainable Development* (UNESCO, 2014) and the *Berlin Declaration on ESD* (UNESCO, 2021), which does not only make reference to higher education.

In these guidelines and declarations, it is stressed that both the meaning and values of ESD should be developed in an interconnected way via the contributions of different disciplines and fields: science and technology, humanism, sociology, etc. For this reason, concerning the field of teacher training, Alsina & Mulà (2019) have stated that “teacher education cannot be rethought based on mere intuition and experience. Progress will only occur if university lecturers, responsible for training pre-service teachers, explicitly incorporate key knowledge and lessons learned provided by research in various fields linked to teacher education” (p. 2). Furthermore, in reference to the role of mathematics in solutions associated to the great crises of our days, Alsina (2022, p. 10) states that “these crises cannot be solved with mathematics alone, but rather via the sum of different disciplines. In other words, knowledge of different kinds must be integrated in order to confront and resolve these challenges”.

This is the main reason the Special Issue “Mathematics Teacher Education for Sustainability: an emerging research agenda” focuses on current advances in research on this agenda. It currently seems that there is not much sense in training teachers to teach mathematics if its teaching does not have any effect on the great challenges and transformations of our day. Thus, in both initial and on-going teacher training in mathematics the necessary knowledge and tools should be provided for teachers to be able to play an effective role as agents of social change (Alsina, 2022).

With this purpose, the introductory article of the Special Issue is a special invitation to two female experts in ESD to describe the contemporary landscape of this topic from an international perspective. In this regard, I. Mulà (Universitat de Girona, Spain) and D. Tilbury (Universitat de Girona, Spain), both recognised for their contributions to Sustainability internationally and as advisors to

governments in various countries, provide an understanding of the need for, and challenge of, mainstreaming ESD and describe the critical role of teacher education in advancing sustainable development. Drawing on findings of a literature review and case study collection commissioned by the European Commission, the authors identify key challenges and lessons learned to enhance teachers' professional learning in ESD.

The other contributions in the Special Issue provide evidence of current research advances in MTEfS. In the first article, A. Coles (University of Bristol, UK) responds to UNESCO's call for a new social contract for education, in relation to mathematics teacher education. With this purpose, the author sets out four principles behind "socio-ecological" practices in mathematics education: not taking nature as a fixed background for our concerns; avoiding the epistemological error of taking the individual as the unit of learning; questioning what is centred in our work; and moving towards a dialogic ethics.

The following two empirical studies in the Special Issue investigate the development of sustainability competences mobilised by pre-service mathematics teachers. F.M. Moreno-Pino, R. Jiménez-Fontana (Universidad de Cádiz, España) and D. Romero-Portillo (Universidad Pablo de Olavide, España) analyse the development of sustainability competencies of 105 Spanish pre-service mathematics teachers of three different university degrees. Findings show that the development of sustainability in pre-service mathematics teachers of the last pre-university degrees (secondary and higher) is significantly lower compared to pre-service teachers of the other degrees (early childhood and primary education) in all competences. I. García-Alonso, D. Sosa-Martín and R. Trujillo-González (University of La Laguna, Spain) analyse the impact of a training programme for pre-service secondary mathematics teachers that promotes the design of mathematical and ESD tasks. Overall, the results show that after the training, the 15 participants improve the level of achievement of all competences.

The last three studies focus on in-service mathematics teachers. T. Helliwell, L. Hennessy (University of Bristol, UK) and K. Bushnell (The Castle School, South Gloucestershire, UK) show the complexity involved in navigating issues of climate justice as a mathematics teacher. They show the way in which one secondary mathematics teacher embraces contradictions and draws upon multiple forms of knowing during his process of becoming in relation to teaching mathematics and climate justice in the context of a small-scale professional development programme. Á. Alsina (Universitat de Girona, Spain) and M. Silva-Hormázabal (Universidad Austral de Chile), analyse the effect of a previously validated training program, designed from a STEAM approach and called Pro-STEAM, involved 23 in-service Chilean childhood and primary education teachers. The results show that after the training programme, over half of the participants reach an advanced level in the Sustainable Development Goals (SDGs) covered in the program (SDG 5 on Gender Equality and 13 on Climate Action). Additionally, in the practical phase of the program, in-service teachers design and implement a statistical task in connection with sustainability, which shows that they develop competences linked to teacher learning objectives to promote ESD. Finally, C. Vásquez (Pontificia Universidad

Católica de Chile), M^a J. Seckel (Universidad Católica de la Santísima Concepción, Chile) and Francisco Rojas (Universitat Autònoma de Barcelona, Spain) investigate the belief system of 11 Chilean primary education teachers who are active in statistics education and its links with sustainability. The results show that teachers acknowledge the integration of statistics education and sustainability as a challenge, identifying as the most recurring topics their mastery of content and the development of skills.

In summary, the papers contained in this Special Issue on MTEfS provide much-needed evidence to make progress with regard to the triple social, environmental and economic transformation associated with sustainable development, showing how this emerging mathematics education research agenda is beginning to contribute to the emergence of relevant data for the creation of positive social solutions.

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