





Editorial

Competencies in Education for Sustainable Development: Emerging Teaching and Research Developments

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Abstract: The 2030 Agenda for Sustainable Development clearly reflects the urgency to embed the principles of education for sustainable development (ESD) into all levels of education. ESD, understood as an integral part of quality education and all educational institutions, from preschool to higher education and in nonformal and informal education, can and should foster the development of sustainability competencies. This Special Issue entitled “Competencies in Education for Sustainable Development” responds to this urgency and the papers presented deliver recent developments in the field of ESD competencies. They focus on various perspectives: systematic literature reviews; curriculum developments; meta-analysis of the interrelation between sustainability content, competencies developed and pedagogical approaches used; testing and validation of evaluation tools and processes for sustainability competencies; and the development of conceptual models focused on different subject areas and educational levels (higher education, primary education, rural schools, external support services to schools, and extracurricular activities). The contributions indicate how the field of ESD competencies in the area of sustainability has become a major focus in recent years. Further research efforts need to be put into operationalizing sustainability competencies and developing tools to measure and evaluate students’ and educators’ competencies development.

Keywords: competencies; education for sustainable development; evaluation; pedagogical approach; curriculum

1. Introduction

The new 2030 Agenda for Sustainable Development, adopted by world leaders at the United Nations Sustainable Development Summit in 2015 [1], clearly reflects the urgency to embed the principles of Education for Sustainable Development (ESD) into all levels of education. Through the concretion of the 17 Sustainable Development Goals (SDGs), education is reaffirmed as a crucial goal to contribute to more sustainable, socially just and equitable societies. Besides, numerous education-related targets and indicators are also contained within SDGs [2].

ESD aims at developing competencies that empower individuals to reflect on their own actions, taking into account their current and future social, cultural, economic, and environmental impacts, from a local and a global perspective [3]. Individuals as part of society should also be empowered to act in complex situations in a sustainable manner, which may require them to strike out in new directions; and to participate in sociopolitical processes, moving their societies towards sustainable development [4]. ESD has to be understood as an integral part of quality education, inherent in

the concept of lifelong learning: all educational institutions—from preschool to higher education and in nonformal and informal education—can and should foster the development of sustainability competencies. ESD is a holistic and transformational education that addresses learning content and outcomes, pedagogy, and the learning environment [5]. It should create interactive, learner-centred teaching and learning settings; therefore, it asks for an action-oriented, transformative pedagogy, which supports self-directed learning, participation and collaboration, problem-orientation, inter- and transdisciplinarity and the linking of formal and informal learning to the development of key sustainability competencies [6,7].

Over the last decades, an emerging body of literature regarding ESD and sustainability competencies has emerged. We understand the term sustainability competency as the combination of cognitive skills, practical abilities, and ethical values and attitudes mobilised in a real situation or context related to sustainability [3]. The difference between ESD and sustainability competencies is that ESD competencies focus on the competencies that teachers and educators need to put in place in educational settings in order to promote sustainability competencies amongst their students. In this Special Issue, we accepted papers focusing on both ESD or sustainability competencies.

To date, most of the existing research has explored the learning outcomes and competencies that educational programmes need to seek to develop in students for them to become change agents towards sustainability [3,8–13]. This mirrors the lack of common definitions and frameworks, and the importance of defining common frameworks of sustainability competencies. This is a previous necessary step to create innovative teaching and learning, and transformative institutional approaches that can lead to sustainability competencies [14].

Despite the divergence in the usage of different concepts such as abilities, learning outcomes, and competencies, and the existence of some criticisms around the usage of these terms, there is a need to define competencies in sustainability in order to foster curriculum developments and innovations. Developing sustainability competencies amongst all levels of education is particularly critical to the development of sustainability literacy and individuals becoming positive change agents in their workplace and personal lives [7]. However, little evidence exists on the development, outcomes, and impact that courses introducing students to these competencies have [10,14,15].

Over the last years, there has been a rapid increase in the number of publications regarding the evaluation of sustainability competencies [16]. Also, it is plausible that an emergent diversification of the assessment tools was used. Questionnaires have been commonly used to assess or explore students' knowledge, attitudes, and behaviours towards sustainability [17]. Other qualitative tools have also been identified as suitable to assess sustainability competencies such as reflexive diaries, interviews, conceptual maps, rubrics, and scenario/vignette visioning [18,19]. However, still a lot of the articles focus on summative evaluation rather than formative or self-evaluation. Thus, developing formative and self-evaluation tools is needed in order to get a more comprehensive overview of students' learning process and sustainability competencies.

The research efforts in the next years need to be put into operationalizing sustainability competencies and developing tools to measure and evaluate students' competencies development. This Special Issue "Competencies in Education for Sustainable Development" responds to this need, covering ESD and sustainability competencies' conceptualisation and innovative pedagogical approaches to develop ESD competencies in different educational settings, such as Project-Oriented Learning (POL), Self-Inquiry-Based Learning (SIBL), and Agile Methodologies, amongst others.

Furthermore, it deals with the need to design and test ESD competencies evaluation tools. During our working period, we received many submissions, which had significant contributions for the main topics of interest of our special issue. However, only 17 high-quality papers were accepted after three rounds of strict and rigorous review (Contribution 1–Contribution 17). All accepted articles delivered recent developments in ESD competencies. In particular, these accepted papers mainly focused on various perspectives: systematic literature reviews; development of conceptual models focused on different educational levels (higher education, primary education, rural schools, external support

services to schools, and extracurricular activities) and subject areas such as engineering, bamboo craft, business and management, and teacher education; curriculum developments—the sustainability competencies' development through innovative pedagogical approaches to ESD competencies such as POL, reflective practitioner approach, service learning, problem-based learning (PBL), simulation games and case studies, and self-experience-based learning (SEBL); meta-analysis of the interrelation between sustainability content, competencies developed and pedagogical approaches used; and the testing and validation of evaluation tools and processes for sustainability competencies.

2. Conceptual Contributions

Four papers in this special issue focus on the development of conceptual models. In Contribution 1, Valdés, Correa, and Mellado presented a conceptual model to design and evaluate engineering training programs in Sustainable Construction (SC). The methodology used by the authors to establish the skills and the proposed training model consists of three stages: Theoretical Phase, Methodological Phase, and Validation Phase (surveys and interviews). A total of 113 professionals who performed activities related to SC answered the survey, and the interviews were conducted with five experts in training in different SC aspects. This article provides guidelines to be followed by any higher-education institution that trains engineers in sustainable construction. The engineering study programs should develop advanced skills for SC such as: teamwork in a collaborative way, ethics, creativity and innovation, communication and negotiation skills, and empathy with stakeholders. Moreover, Lozano, Barreiro-Gen, Lozano, and Sammalisto's paper investigates the connections between sustainability teaching, sustainability competencies, and pedagogical approaches used (Contribution 2). A survey was distributed to over 4000 contacts in Europe that was responded to by 390 participants. The survey included questions about the respondents' background, self-assessment of sustainability criteria taught, pedagogical approaches used, competencies covered, learning approaches, and open-ended questions about the embedding of sustainability in courses. The results demonstrate that, in order to achieve sustainability in higher education, there is a need to cover competencies through a combination of pedagogical approaches. Traditional approaches such as lecturing need to be rethought to be able to successfully develop students' sustainability competencies.

In Contribution 3, Tejedor and colleagues' focus was on the didactic strategies considered most relevant for training in sustainability competencies in college students, according to the guidelines commonly accepted by the international academic community. Through collaborative work among experts from six Spanish universities taking part in the EDINSOST project (Education and Social Innovation for Sustainability), the role of five active learning strategies (service learning, problem-based learning, project-oriented learning, simulation games and case studies) in ESD were reviewed. Through a systematic approach of their implementation, the authors provide a synthesis of their aims, foundations, and stages of application (planning, implementation, and learning assessment), which can be used as valuable guidelines for university lecturers. Besides Eizaguirre, García-Feijoo and Laka conducted research to determine which are the sustainability core competencies, considering three different geographical regions (Europe, Latin America, and Central Asia), and the perspective of four different stakeholders (graduates, employers, students, and academics) (Contribution 4). An exploratory factor analysis (EFA) was applied jointly with large-scale consultations to the different stakeholders. The main results of the study are: (i) the identified sustainability factor, in each of the regions, presents elements related to both ecological and social aspects; (ii) proposal of a set of interconnected competencies that are at the heart of the sustainability concept according to the consulted stakeholders. The authors highlight the importance of investigating real performance of these competencies, and to analyse the most effective methodologies, course design and development, assessment, teacher training, and university management considerations, amongst others.

3. Systematic Literature Reviews

Two contributions in this special issue outline systematic literature reviews on ESD. In Contribution 5, Garrecht, Bruckerman, and Harms analysed existing empirical studies that explore students' decision-making in ESD-related extracurricular activities. The review shows evidence in the literature regarding studies that display the consideration of decision-making within ESD-related extended education activities. However, most of the papers predominantly object to model decision-making as a quantitatively measurable competency and, therefore, focus on decision-making as a competency itself, where sustainable development is a thematic circumstance. Despite the theoretical relationship, hardly any empirical enquiry is found examining the trinomial interrelation with an equal consideration of all three components. The authors emphasise the need to explore equal distribution between all three foci and consider the integration of sustainability-related issues in extracurricular activities as a promising learning opportunity to optimally foster students' decision-making.

In addition, López-Alcarria and colleagues presented a systematic review to analyse how Agile Methodologies are being used to foster key sustainability competencies in the field of education (Contribution 6). Agile methodologies praise adaptive development by means of short continuous cycles of planning, action, correction, and adjustment to produce valuable increments in outcomes. The systematic review follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) selection rules to determine the existing studies, which possess a minimum scientific soundness and quality to be considered. The selected studies have shown how the application of a series of basic actions, such as forcing periodic group meetings, gathering feedback, working in cycles, equitably distributing tasks, and developing a closer relationship between faculty and students, allow the development of important competencies. These are critical thinking, coping with uncertainty, adaptability, creativity, dialog, respect, self-confidence, emotional intelligence, responsibility, and systemic thinking, which conform the pillars of sustainability-oriented citizens.

4. Pedagogical Approaches and Curriculum Developments

The exploration, implementation, and evaluation of pedagogical innovative approaches and curriculum developments to foster ESD competencies within different education contexts have a growing interest within the research field of ESD. This is evidenced by the number of papers devoted to this matter in our Special Issue, a total of 8 papers out of 17.

In Contribution 7, Albareda-Tiana and colleagues explored which teaching methodologies are suitable for the development of competencies in sustainability and research in Higher Education (HE). The participants taking part in their study are students in pre-service teacher training. The experimental educational model used for the development of competencies in sustainability and research consists of a methodological sequence of Project-Oriented Learning (POL) and a Cross-disciplinary Workshop on Sustainable Food. This study provides evidence that POL is an excellent methodology for developing competencies in sustainability and facilitates the relationship between sustainability and research competencies. Similarly, Fuertes-Camacho et al. presented a proposal for the integration of sustainability into the curriculum in the third year of the degree in Early Childhood Education at the Universitat Internacional de Catalunya (UIC) (Contribution 8). Projects on sustainable food are planned and elaborated to this aim. This study applies a global and systemic approach to solving socioenvironmental problems. The authors conducted quantitative research using a pre-test/post-test quasi-experimental design, separated by a period of didactic training in the project method. The results show how students' sustainability competencies improve after working on didactic proposals in a global manner. The authors conclude that elaborating competencies in ESD enables an integrated approach of knowledge, procedures, attitudes, and values in teaching through promoting the project method in multidisciplinary and transdisciplinary teams, which enhances future teachers' sustainability competencies.

Moreover, Wilhelm, Förster, and Zimmermann's paper addresses the need for contextualizing and operationalizing ESD competencies in tertiary education (Contribution 9). The authors claim that, although helpful competency models for ESD exist, little is available on how to put them into practice.

Using a reflective practitioner approach, the paper describes a heuristic procedure and a didactic tool that enable lecturers to establish quality ESD teaching and learning: the tree of science and constructive alignment. After a critical analysis and comparison of various competency models, the authors used the tree of science and constructive alignment to shift attention from what ESD competencies are needed to how to foster them. Two examples from their own teaching practice have been chosen as case studies to illustrate the application of these procedures. The article concludes by outlining three key factors that support the integration of competency orientation in ESD: pedagogical–didactic tools, ESD professional development for university educators, and institutional change.

In Contribution 10, Carrascal, Magro, Anguita, and Espada focused on the development of Visual Arts in Education (VAE) as an innovative educational methodology in cooperation with institutions, public entities, and universities of the city of Mixco in Guatemala. VAE is a research and participative action project with the main objective of influencing the teaching and learning process through an innovative methodology based on visual literacy and visual thinking, using contemporary graphic images of the impact caused by humankind on the environment. The context of this research is primary rural schools. The participant observation is the core methodological tool used by the authors to study four key competencies, namely, critical analysis, systemic analysis, collaborative work or work through projects, and commitment to society. The team participating in the work focused its research on the use and implementation, in different schools at an international level, of the E.CO Kit, a teaching kit regarding human influence on the environment. The results show how the E.CO Kit and visual thinking contribute to the visual literacy of children, to their cognitive, social, and emotional development, irrespective of their culture or territory, addressing competencies in sustainability in the teaching–learning process from a critical, holistic, transformative, and contextual perspective.

Dai and Hwang research (Contribution 11) explored the teaching practice and promotion methods of bamboo craft courses in universities as related to the concept of ESD, including the value of disseminating techniques and knowledge, learning effectiveness of students, and the role of craft courses. This study used participatory observation and in-depth interviews to collect information on bamboo craft courses in four departments of three universities and used qualitative coding analysis to explore the sustainable teaching methods of craftsmanship teachers, sustainable development learning effects on students, and different ways of promoting ESD with bamboo craft courses in different universities. The research results show the following: (1) there are differences in bamboo craft courses—teachers' craftsmanship and curricula are different, resulting in differences in technical depth and creativity; (2) with respect to the ESD evaluation criteria of the four bamboo craft courses, skills learning itself is not complete, but students are provided with a path to self-reliance in the craft and in responding to cultural sustainability challenges; and (3) regarding the relationship between ESD and bamboo craft education, this promotes the concept of sustainability and is important for the creation of crafts; universities offer opportunities for testing students' technical talents and knowledge, but ESD is limited and blurry. The knowledge and skills learned in the bamboo craftsmanship course can be better brought into play in social practice to make their learning effective and build students' cultural self-confidence in bamboo craftsmanship.

In Contribution 12, Frank and Stanzuz proposed the use of self-inquiry-based (SIBL) and self-experience-based learning (SEBL) in order to promote personal competencies for ESD, and for education for sustainable consumption in particular, in higher education. These pedagogical approaches were developed at the Leuphana University of Lüneburg, Germany, and applied within the framework of two seminars called Personal Approaches to Sustainable Consumption. The authors investigated the potential of both pedagogies for cultivating personal competencies for sustainable consumption. The research concluded that SIBL and SEBL are promising approaches for this purpose as they have been proven to increase students' self-reflexivity/self-awareness, emotional resilience, self-care and self-acceptance, psychological resources, intrinsic motivation to consume in a more sustainable way and engage in problem-oriented action.

Furthermore, the Poza-Vilches, López-Alcarria, and Mazuecos-Ciarra (Contribution 13) study aimed to characterize the professional practice of an Educational Guidance Service (EGS) (external support service to the school) in the Metropolitan Area of Granada (Spain) linked to the development of professional competencies in ESD, in order to identify and analyse any weaknesses and recommended improvements with regard to advice and teacher training, but also from the teaching practice of teachers, as recipients of these actions. They conducted an exploratory and descriptive case study with a mixed methodology (quantitative and qualitative), through interviews (6 EGS members) and a questionnaire distributed to 43 primary school teachers. The results show that counselling on participatory, innovative, and cooperative methodologies, working on values, competencies, and curricular sustainability, as well as the cross-curricular nature of the content that is imparted, are the most effective ways from which these teacher guidance services can promote the development of professional competencies linked to sustainability in schools. This study concludes with the need to create ESD training opportunities for teaching staff and the guidance team.

Finally, Vare, and colleagues described the implementation of the Erasmus+ project “Rounder Sense of Purpose (RSP)” that initially sought to develop a practical accreditation model for educators working on ESD (Contribution 14). Project partners developed a framework of 12 competencies (systems, futures, participation, attentiveness, empathy, engagement, transdisciplinarity, innovation, action, criticality, responsibility, decisiveness) that was validated by consulting with more than 500 experts and users, using a Delphi approach. The project also piloted a range of assessment techniques, although authors state that this remains an area for further enquiry. Finally, project partners realised that designing a pan-European qualification was unattainable due to the complexity that this would involve if the different cultural and educational contexts were to be taken into account.

5. Design and Implementation of Evaluation Tools

An emerging research area within the field of ESD is the operationalization of sustainability competencies through the design, implementation, and validation of evaluation tools of sustainability or ESD competencies as a means to contribute to monitoring the effects of ESD initiatives. Three papers in this Special Issue refer to this topic. In Contribution 15, Waltner, Rieß, and Mischo, taking concepts of empirical educational and other relevant research findings (for example, psychology for sustainability) into account, developed a reliable and valid approach to measuring sustainability competencies. They presented novel data of a first school evaluation, where one thousand six hundred and twenty-two students (aged from 9 to 16) participated in the survey. The paper-pencil questionnaire covers general (sociodemographic) as well as cognitive, affective, behavioural, application- and curriculum-orientated aspects of sustainability competencies. The gathered insights show a path towards the operationalization of sustainability competencies to clarify the needs and achievements of ESD implementation in schools.

Also, Giangrande and colleagues (Contribution 16) sought to develop a meaningful evaluation process focusing on two questions: What competencies should education, in particular ESD, achieve to address SDG 4.7 and wider visions of sustainability?; how do we begin to activate these competencies? The method used is based on dialogical intervention across complementary expertise and piloted concepts in a trainer workshop (six meetings). The authors offer innovations to the concept of competencies to assess ESD, including additional emphasis on intrapersonal competencies, the particular focus on community (nonformal) learning and on the SDGs, the nature of the evaluation questions as part of an active learning cycle, and the proposal for multiple intelligences to enact the competencies gained through ESD.

The last contribution made by Dlouhá et al. stressed that, in order to achieve transformative action for sustainability at the individual and society levels, there is a need to promote competencies that address the cognitive, socioemotional and behavioural domains of learning in a balanced way (Contribution 17). The authors differentiated between a personal dimension (addressing the individual's values, attitudes, and lived experiences) and a systemic dimension (learning objectives emphasizing

cognitive processes) of competencies. Their contribution is the development of an analytical tool to assess the equilibrium of both dimensions, which has been tested to compare two existing international competency frameworks and reflect on practical ESD initiatives. The authors concluded that the personal dimension of sustainability competencies must be reinforced in higher education and, to this end, relevant pedagogical strategies and evaluation tools must be promoted to ensure progress in the development of values, skills, and behaviour associated with sustainability.

The contributions in this Special Issue indicate that the conceptualisation, innovative pedagogical approaches, curriculum developments, and the design and implementation of evaluation tools for ESD competencies in the area of sustainability have become a major focus in recent years. These contributions can inspire and reinforce other studies in this field of knowledge. However, still further research is needed to operationalize sustainability competencies and design and implement evaluation tools for determining students' and educators' competencies development. This Special Issue shows that we are on the right journey to advance in the embedding of ESD within all educational contexts.

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