

ESD in Environmental Engineering

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Contributor: Pedro Mauricio Acosta Castellanos , Araceli Queiruga-Dios

Education for sustainable development (ESD) has been especially promoted by the United Nations. ESD is an indirect measurement instrument for the inclusion of SD in higher education curricula. Environmental engineering is one of the areas of most recent creation and expansion of engineering, this undergraduate program seeks to solve the environmental problems generated by the economic development of human beings, applying the theory, techniques, and technologies of engineering.

education for sustainable development

educational strategies

environmental engineering

university education

1. Introduction

Today's world has an environment of globalization, made up mainly of capital and technological innovation ^[1]. In this context, environmental problems are increasingly recurrent and have been generated as a consequence of changes in life cycles, loss of biodiversity, overexploitation, and imbalance in the irrational use of natural resources. In the same way, the predominant global development model is based mainly on excessive economic production standards, achieving unlimited development ^[2]. Therefore, the protection and conservation of natural resources have not been the priority.

The current environmental crisis is largely caused by anthropogenic factors ^[3], which makes us set our sights on science and technology since these could be the adequate response to the depletion of natural resources and environmental pollution ^[4]. The lack of economic resources in some societies pressures the depletion of natural resources. In the same way, some developed societies generate high rates of consumption and environmental depredation ^[5]. It has been recognized that these crises are not only problems of innovative development, but are also the product of a lack of environmental knowledge and behavior ^[6]. The only viable solution to face and overcome difficulties is governed by a challenge of optimization and adjustment of a better quality of education in environmental terms ^[6].

Facing environmental, economic, technological, and social challenges is not easy since it is necessary to promote the acquisition of values, behaviors, and collective environmental awareness, where natural resources are assured and protected in the best way ^[7]. Environmental education (EE) deals with solving anthropogenic environmental problems, depending on the emergence of activities and behaviors of a responsible nature with the environment ^[3].

From another point of view, SD implies a high level of personal and humanistic training. In this way, ESD proposes an educational transformation and a moral change, achieving social and political action for environmental sustainability. The institutional commitment establishes a strategic vision of sustainability that must be embraced in higher education institutions. In other words, formal environmental teaching reinforces the inclusion of sustainability. Not only at the student level, but also at the teacher level, where research encourages the development of active knowledge in favor of SD [8].

ESD refers to a restructuring approach to teaching in higher education institutions, providing answers to current problems in society [9]. The said approach is based on the complementation of the engineering curricula, to provide ponderable knowledge, values, and behavior. Today, these models form an environmentally sustainable society. Therefore, a proper understanding of ESD is essential, focused on the incorporation of a teaching process based on active learning and critical or systemic thinking, through dynamic methods that motivate students to acquire knowledge, skills, strategies, and methodologies to forge a sustainable future [10].

The main task of universities is to train students and the next generations of professionals in all fields of research and in innovative technological designs that are friendly to the environment, to increase the levels of SD and quality education. Environmental engineers deal with structures, equipment, and systems. They are responsible for protecting, improving the quality of the environment, health, and public welfare [11].

In the specific case of Environmental Engineering, the incorporation of ESD into the curricular plans allows a methodological reorganization, as a fundamental support tool for both teachers and students, spreading a disciplinary verticality committed to SD [12]. Cultural, social, economic, and biological diversity motivate a change in the conception of social and professional responsibility. Where the learning and capacity of the competencies or skills that are required increases, that is, not only an individual change but also Social [8].

In the SDG, universities are the fundamental axes since they promote a change in social behavior through technological and economic development with environmental responsibility. An effective way to achieve and consolidate this is the application and understanding of ESD. For universities, it is not unknown to involve transversal human competencies, being common to see them involved in the study plans of the different disciplines. Engineering is not alien to these processes, since what is sought is comprehensive student development [13]. In this sense, for that ESD to be viable in engineering and especially in environmental engineering, different approaches must be taken to evaluate teaching strategies, methods, and guidelines. That they are based not only on cognitive learning but also on the social-emotional and behavioral aspects [14].

According to the results obtained. The transition that ESD has undergone has been evidenced since 1996, showing a significant increase since 1998. The Johannesburg (South Africa) summit in 2002 called the period from 2005 to 2014 "United Nations Decade for ESD". It is in this period that most publications are related to ESD and environmental engineering. [15].

ESD requires integrating into discourses and practices education for all, whose main goal is human well-being. The common objective of all proposals and projects must be directed towards SD. This is an instrument of social transformation, to advance towards a balanced, fair, and sustainable society [16].

However, in 2020 and 2021 we find that education is being oriented towards sustainability, promoting responsible, ethical, and supportive participation in caring for the environment. To achieve this, responsible academic planning and social, economic, and environmental purposes must be carried out. The above must be supported by multiculturalism, allowing respect for diversity and cultural identity. In this sense, young people participate effectively when making decisions that are focused on the common good, such as public policies, plans, and related programs [17].

2. Inclusion of Education for Sustainable Development in Environmental Engineering.

The environmental and social challenges of the 21st century show the need for a lifestyle change in society. This is why education plays an important role in achieving the formation of balanced societies, based on the pillars of SD, the economy, technology, and the environment [16]. However, the first efforts to incorporate education on environmental issues in formal and informal educational settings under these precepts were not the best, due to the lack of will and institutional support [18].

The result of the SLR indicates that the university curricula of environmental engineering require greater incorporation of ESD. Implementation must go hand in hand with participatory teaching and learning methods [16]. ESD promotes the adoption of competencies such as critical thinking, the elaboration of hypotheses for the future, and the collective adoption of decisions, these promote the change of formal education where quality education is the objective [19].

The United Nations, especially in the period between 2005 and 2014, has promoted the formal inclusion of ESD in higher education so that universities are promoters of SD. Curricula must adopt a reflective character around sustainability as a field or concept, through the competencies of an interdisciplinary, diverse, and multimodal learning pedagogy [20]. Universities must also understand the importance of implementing evaluations or management plans that help determine the degree of incidence or understanding of the competencies, methods, and strategies that contribute to the implementation of sustainable projects [21].

From the point of view of other SLR, students must know the sustainability of each of the socially implemented projects [10]. The awareness of environmental engineering students about sustainability in the short, medium, and long term must be constant and with a lot of effort. In this sense, students must demonstrate their sustainability analysis skills before graduating [22].

Higher education standards around the world take SD into account. These are measured and certified by entities, such as ABET. These carry out accreditation processes in engineering, which include the importance of

environmental sustainability [23]. This means that universities are constantly in educational innovation processes and always keeping in mind the demands of the planet that are disclosed from the UN [24].

On the other hand, today it is possible to think that the young teacher's program could be carried out, which allows the exchange of knowledge between different higher education institutions at the national and international level. This generates a strengthening of multiculturalism by creating common standards based on the inclusion and implementation of ESD. One of the strategies is to achieve this through projects that integrate sustainability and academic outings. To achieve this, there must be a restructuring and innovation of the study plans. With this research, it is possible to identify the competencies, strategies, and methodologies that can be applied in the curricula to advance in the achievement of SD with quality education [25].

Regarding the SLR carried out in this study, it has been found that a large part of the articles found has a descriptive approach; therefore, it is difficult to show a broad panorama of the problems that concern ESD in higher education institutions. This is one of the differentiating points of this research. Since the focus on competencies, strategies, and methodologies that must be handled within the study plans for environmental engineering predominate. This is in comparison to other studies because in this one we also focus on promoting the inclusion of critical thinking and pedagogy with environmental activism [26]. In this way, the emergence of quality education, social education, or education for equality within the framework of ESD is guaranteed [27].

Among the most relevant results of the research, it is noted that the production of works on ESD in higher education institutions has multiplied exponentially; which allows the advancement of the scientific community around major current events such as the 2030 agenda [17].

Within the concept of environmental activism, ESD is also involved as an influencing factor in the commitment to the environment and the possible actions that are carried out from science and the techniques learned. These generate solutions to economic, environmental, and social problems. These are the aspects of the context in which the dynamics of knowledge are carried out [20].

Strategic planning, in turn, generates innovation in SD, defining the values that enhance the economic, social, and environmental models. This strategy promotes the application of a multidisciplinary and comprehensive approach to education within the framework of SD, including modes of action based on responsibility, commitment, humanism, and justice. Implementing in this way environmental activism as a result of the commitment to the environment [20]. This ideology, in addition to having a comprehensive interdisciplinary approach, involves critical thinking as indispensable competency in the educational work of universities [28].

It is important to mention that the pedagogical approach continues to be a problem since it depends on the degree of inclusion of ESD in the curriculum. One possible effective response is green or green engineering research or projects, which should build on society and foster relevant activities with transformative goals [25]. In addition to taking into account a pedagogy with a critical approach as mentioned above. This theme, when implemented, encourages a permanent questioning about the conflicts in the environment. Finally, to implement a route towards

sustainability, it is necessary to integrate and in some cases create a sustainable methodology that denotes an eco-social educational curriculum [29]. In this sense, the curriculum must be capable of assertively transmitting knowledge and social realities, allowing ESD in higher education institutions to generate a clear focus on sustainability and multidisciplinary [17].

3. Conclusions

The ESD is an important tool for the cognitive, ethical, and socio-affective formation of society and students [26]. It indicates that green programs and innovative tools are part of environmental pedagogy with a multidisciplinary approach based on systemic thinking [19].

ESD pedagogical tools, methodologies, and models highlight the innovation and implementation of green or ecological engineering, as well as the use of ecological plans and collaborative research projects. These together with the use of basic science and engineering allow solving social problems [21]. The execution of the study plan allows carrying out the systematic evaluation of each of the curricular contents, which provides an opportunity to improve it [5].

It is important to highlight the complexity of the current situation since the standards of economic and global understanding that have been achieved in recent years do not allow us to see the true social and environmental context that has been generated long ago [30]. This is why environmental engineering requires actively guiding personal transformation, through a curricular change that fosters experiences, practices, methods, research workshops, green engineering projects, and young teacher programs (YMP).

The determination of ESD is an emergent and dynamic approach, which implies a new vision of education, to generate responsible actions and attitudes in society in favor of the construction of the context of SD [21]. That is why universities have a constant ethical and collective commitment not only to research, technological innovation, and the generation of knowledge, but also to propose sustainable solutions that persevere in the short, medium, and long term [31]. However, economic development and administrative entrepreneurship, in many cases prevent the transformation of actions, tasks, and operations to viable projects that confirm a social and environmental effectiveness worldwide [23].

This is why it is recommended that society and the current young generations be committed to a greater degree with SD through quality and inclusive education, sustained under current standards and principles of innovative globalization [31]. That said, the research carried out using the SLR was effective, since it was possible to express and guide the competencies, strategies and methodologies that are subject to the pedagogical training of environmental engineering. However, it is necessary to develop more research and literature publications at the national and universal level that propose ideas and projects that seek the implementation of a balanced vision in favor of the environment, technology and the economy within engineering careers.

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