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Technological foundations of environmental education for the discipline Project, Construction and Conservation of Civil Works

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ABSTRACT

The use of technologies does not always benefit the environment, however, their valuation contributes to minimize and/or solve the environmental impacts caused by civil works before, during and after they are built. The purpose is to define the technological foundations that support environmental education in the discipline of Project, Construction and Conservation of Civil Works. Theoretical methods such as the historical-logical, analytical-synthetic and systemic approach were used. Empirical methods such as document review, observation and interviews were used to obtain experiences and criteria. As a result, a theoretical contribution was obtained in the contextualization and integration of environmental education to the profession.

Keywords: Environmental education; Technological foundations; Environmental impact; Civil works; Life cycle.

Introduction

The existence of new technologies, together with the high level of development and standard of living achieved by human beings and the so-called industrial civilization, creates problems of an ecological and environmental nature.

The United Nations Organization (UN) in its General Assembly of (2015), from the document Agenda 2030 in the Sustainable Development Goals SDGs, describes goals 4, 6, 9, 11, 12, 13 and 15. These allow valuing quality education; contents on the availability and management of clean water and sanitation; the construction of resilient infrastructure and foster innovation; the reduction of negative environmental impacts in cities; responsible production and consumption; actions to combat climate change and its effects; promote the sustainable use of terrestrial ecosystems and halt the loss of biodiversity, and in turn constitute actions that originate technologies for the mitigation and/or solution of environmental problems in the life cycle of civil works.

In consideration, the introduction and updating of the environmental theme, based on the model of the professional and Law 150 SRNMA (2022), requires the contextualization and integration of the contents in the Professional Pedagogical Process (PPP) of the discipline Project, Construction and Conservation of Civil Works. For this purpose, it was necessary to review documents that show the use of technologies in the life cycle of civil works, in machinery and those that facilitate the use by human beings, showing to a great extent that the world is moving towards new ways of development. With machinery that reuses fuel or uses biodegradable energy, the use of ICT, the reuse of materials that do not pollute the environment, among other aspects.

Although technology provides benefits, "the knowledge of the conception of the world towards the environment has an enormous practical importance, since the attitude of the human being towards the reality that surrounds him depends on it and serves as a guide for action" (Rosental & Iudin, 1981, p. 376). In this sense, it is emphasized that knowledge constitutes a basis for each area of professional knowledge and its essential elements must be considered foundations for proceeding in and for the world from its complexity. In the realm of ideas, the foundation of an approach is based on solid primary ideas, contrasted data or a reliable source of information.

The research that triggers the present article has the need to contribute to the improvement of environmental education in the discipline Project, Construction and Conservation of Civil Works. For this purpose, the contents of the discipline were taken into account, which correspond to the SDGs mentioned above. Where environmental education is key to understand the existing relationships between theory and practice of educational processes, constitute an instrument of environmental management and enhance

responsibility from information, communication, interpretation, sensitization, awareness, training and learning Massa and Zuñiga (2021).

Thus, the program of a discipline as a "guiding document, organizes in the form of a system and logically and pedagogically ordered knowledge, skills and values related to the professional's activity or object of work" (McPherson, 2004, p. 38). Furthermore, it "reflects the most important characteristics of the same, and constitutes the systematic and hierarchical description of the general objectives to be achieved and the essential contents to be assimilated" (Resolution No. 2/2018, p. 30).

Both definitions complement the object of study of the discipline Project, Construction and Conservation of Civil Works. They determine the essential aspects and features for the training and education of the student, which contributes to the action in environmental education from the technological. In addition, it specifies that as a guiding document it must describe, organize and logically order the technical and pedagogical contents in its necessary updating and integration for life.

The Bachelor's Degree in Construction Education has as technical disciplines: Investigative Labor Training, Construction Project Management, Design of Structures, Project, Construction and Conservation of Buildings and Project, Construction and Conservation of Civil Works, the latter is selected due to the composition and size of the works that comprise it, Roads and Hydraulics. This course includes the following subjects: Soil Mechanics, Topography, Executive Technical Project of Highways, Executive Technical Project of Railways, Project and Construction of Hydraulic Works I, II, Hydraulics and Hydrology. As their own: Construction of Road Works, Bridges and Culverts, Management of Hydraulic Infrastructures and Management of Road Infrastructures, which contribute to the integral formation of the students. Their contents express the technical knowledge and activities that are carried out in correspondence with the life cycle.

However, in the research and theses consulted, the lack of technological foundations in the technical disciplines of construction is evident. To a great extent, others provide materials, methods and procedures for the contextualization of environmental education. Therefore, in the author's opinion, the technical contents need foundations that allow establishing the way to focus educational activities and actions, taking into account the documents that govern environmental policy in Cuba and the world.

In consideration of the above, the objective of this article is to define the technological foundations that support environmental education in the discipline of Project, Construction and Conservation of Civil Works.

Development

The human being has developed a lot of knowledge, the vertiginous advance of science and technology has placed him on the cusp of good and at the same time on the cusp of evil. The progressive transformation of nature, as a consequence of the excessive impulse in the development of society, has changed its context, as well as its natural space, which is modified to such an extent that it is progressively degraded.

From researches consulted on the interrelation between science, technology and STS society in the environment (Mayer, 1998 and Arcia, 2018), the link with the problematic of development and environmental education is evidenced. It reveals the principle of the development of the dialectical-materialist theory of knowledge, which means to let see the understanding of phenomena at their origin, the historical evolution of the thought of human beings and the content of their actions in practice, which outcrops consequences from a materialist position. In this regard Lenin formulates "never assume our knowledge to be finished and unchanging, but analyze the process by which the incomplete and inaccurate knowledge becomes more complete and more accurate" (MES, 1994, p. 16).

With this principle of development and Lenin's words, it is conceived that not only knowledge constitutes the component for the progress of the human being. It starts from the global to the concrete of the phenomenon, by analyzing its essence and in turn the solution in practice. In this sense, the study of new ways of living originates actions to build.

In education, the student must be able to value the phenomena and processes of the reality that surrounds him, as the reflection in the conscience of the significance they have for him. The environment, where it develops, expresses its social scope, the needs, interests and purposes of the subject, his affective and emotional processes, his accumulated experience that influences the knowledge he manages to reach of it. Significantly, environmental education achieves the valuation of knowledge from an awareness that allows its action in society with an open development to social phenomena.

In turn, construction as a science, through technological activity, has an impact on the deterioration of the environment. Processes such as earthmoving, extraction of raw materials and production of construction materials, clearing and use of machinery, cause negative impacts on the environment. It is a social necessity to educate in the knowledge of the impacts that this science produces on the environment. Although science and technology provide us with numerous positive benefits, they also bring with them negative impacts resulting from human action, some of which are unpredictable, but all of which reflect the values, perspectives and visions of those who are in a position to make decisions concerning scientific and technological knowledge. It is also of significant interest for the country to develop a conscience adjusted to social commitment Meneses *et al.* (2021).

In this regard, the 2030 Agenda for Sustainable Development approved by the General Assembly of the United Nations, proposes objectives that call for changing development styles respecting the environment, with a transforming vision towards economic, social and environmental sustainability of the member states, which constitutes a guiding document for educators.

Environmental education as a social necessity takes on an important significance. Educational institutions together with other agencies, organizations and community actors promote new ways of acting, thinking and feeling with respect to everything that affects our environment and degrades it. The educational work from the discipline Project, Construction and Conservation of Civil Works enhances the vision of how environmental education should be approached, which contemplates the technologies that in one way or another affect the environment and in turn what attitude or decisions should be raised with a view to a sustainable society in its development.

The new technologies that arise in construction, originate positive and negative impacts by human beings on society and nature. It is through knowledge that these impacts are reduced or minimized. Proof of this are the environmental strategies that the sector manages both in the products they manufacture, such as cement and plaster, which emit dust into the atmosphere and pollute, as well as in the construction processes.

Knowledge about construction technologies helps to minimize earth movements, the excessive use of obsolete equipment, the incidence of other construction activities in the extraction of materials from quarries, the impact on the topsoil and the impact on the urban environment. In society, human beings interact with nature and with each other;

therefore, historical development has brought as a consequence that the more human beings learn, the more they act in nature through technologies.

It is clear that the development of a society is instrumented through science and technologies. In this sense, it encompasses all human activity, the way of communicating, thinking and creating.

Environmental education represents the significant responsibility of training generations in values that allow them to have an ethical, social, scientific relationship and adequate responsibility, with respect to their natural environment, Henao & Sanchez (2019). The knowledge of the main environmental problems constitutes the basis of education in direct link with the Cuban environmental policy documents Rodriguez (2020).

The National Environmental Strategy EAN (2021-2025) presents among the macro-problems those referring to pollution, loss of biodiversity, climate change, depletion of natural resources, lack of water, soil degradation, destruction of the ozone layer, excessive use of technologies and the so-called demographic explosion. Others recently defined by Valdés and Llivina (2021) in the Education Strategy for Sustainable Development of the Ministry of Education of the Republic of Cuba EDSMERC as the increase of disaster events and temperatures, sea level rise, increase of storms and devastating hydrometeorological events, increase of droughts and increase of greenhouse gases. Their knowledge enriches the treatment of environmental education, inasmuch as it assesses how technologies do or do not affect conditions in existence.

Other documents such as: The State Plan for Confronting Climate Change. Life Task (CITMA, 2015), inspired by the thinking of the historical leader of the Cuban Revolution, Fidel Castro Ruz, constitute antecedents that reflect actions that should be worked from the subjects. The Environmental Strategy for Construction EAC (1997), identifies the main impacts that construction works and the production of materials cause to the environment during their life cycle. It proposes ways to reduce or mitigate their effects and establishes the instruments and procedures to materialize the objectives established in the environmental policy of the construction industry.

Environmental education is a process that contextualized in the contents of a discipline allows discerning between the benefits or detriments that technology manifests. Among the benefits are mentioned the improvement of the quality of life, through its advances

reduces pollution levels (creation of vehicles with natural gas as fuel, filters in industries that reduce gas emissions, vehicles powered by electric and solar energy), less human effort and the contribution of constructive and material solutions. As for damages, in solutions that bring damage to the environment with the use of large machinery that deteriorate the ecosystem, unsustainable construction projects, people who do not know how to handle scientific and technological advances, excessive use of natural resources from quarries, exposure of solid, liquid and gaseous waste, to name a few.

In order to define the technological foundations of environmental education for the discipline Project, Construction and Conservation of Civil Works, the SDGs, knowledge on construction technologies, environmental problems defined in documents governing environmental policy, the Science-Technology-Society (C-T-S) relationship, as well as the contents of the discipline under study were taken into account.

Technological foundations

The research on environmental education in the discipline Project, Construction and Conservation of Civil Works PCCOC, is based on the precepts of the philosophy of education by considering, mainly, the thought of the historical leader of the Cuban revolution Fidel Castro Ruz, and other researchers. The humanist conception by describing the human being as a mobile in the struggle to realize the aspirations of the ideal of a better world, being the center that intervenes in the process mediated by activity and communication towards higher levels of development.

Conceived in the Science-Technology-Society (C-T-S) relationship by glimpsing the scientific conception of the world, as knowledge in a framework of great generality, related to decision-making and procedures that cause environmental transformations from the technological development of construction.

The achievement of an environmental conscience by virtue of the limits of resources and waste generation, whose transgression initiates the rupture of the dynamic equilibrium of the Society-Nature relationship. It is supported by the criteria of Blanco (2003), in relation to the educational influences exerted by all members of society, institutions, universities and social groups.

The technical preparation of educators and workers that allows a reasonable technological learning capacity in the updating of knowledge. The way of assimilation and creation of

methods in the application of information and communication technologies (ICT). The application of variants that allow the observation and understanding of constructive actions in each activity and context.

Reflection from environmental education to value the reorientation of the values that guide the behavior of human beings towards nature, to the elaboration of new theories on the environmental relations of production and social reproduction, and the construction of new styles of development. This is evidenced by the assumption of guideline 80 of the Economic and Social Policy of the VIII Congress of the PCC al:

> Improve and develop the environmental system based on preventive management, information and training to ensure the rational use of natural resources, the conservation of ecosystems, the improvement of environmental quality and the reduction of the country's vulnerability to the effects of climate change (p. 67).

Consider updating university training and research programs to meet the needs of the development of new technologies in construction.

Guideline (88) by "promoting the dissemination of new concepts of technological development such as the circular economy" (p. 69). Guideline (95), which expresses "strengthening relations with science, technology and innovation entities, production and services and achieving the introduction of research results in terms of the country's development, particularly in the territories" (p. 70).

Prioritize and extend the knowledge of the National Hydraulic Plan for the expansion, rehabilitation and maintenance of aqueducts, sewerage and storm drainage for the use of new technologies in correspondence with the financial and constructive capacities, with the objective of guaranteeing the quantity and quality of water, reducing losses, increasing its recycling, reducing energy consumption and the services associated with the utilization systems.

The use of ICTs to support the continuous training processes of teachers and students through virtual spaces, where interaction, collaboration and learning are transformed into scenarios for updating and visualization of the construction reality. For example, videos on technologies in the construction and conservation of roads, railways, bridges and hydraulic works that are designed and used in countries such as France, Japan, Mexico, Colombia, Italy, among others.

The updating of information makes it possible to conceive that:

The technological changes that are taking place worldwide in terms of the renewal of methods and systems for project design (3D printing), building information modeling (BIM) in the geometric design of roads, aqueducts and sewage systems, design of models instead of plans, to cite examples, can be applied in the educational context of the PCCOC discipline. Machinery technologies, discarding archaic equipment that leads to waste of resources and materials. Advancement of railway technologies that lead to minimize noise, pollution, spillage and use of fossil fuels, with new track designs for passenger and freight transportation. Provision with the use of GPS and total station in topographic measurements with the saving of resources and personnel.

To discuss in the search of digital documents that provide knowledge about actions that other countries perform in civil works to mitigate the impacts that from the life cycle can be related such as: the preservation of tributaries, the impacts of the emission of articulated material to the atmosphere, properly separate construction and repair waste in recycling for the manufacture of construction materials, sustainable management of resources, as some exercises that should become a habit for builders with existing technology or not. Work on environmental projects, for example: "Through the measurement of waste generation and the adoption of concrete solutions to manage them, focusing on rejection, reduction, reuse, recycling and recovery" HubSpot (2021).

The knowledge of Cleaner Production, as a technology means "The continuous application of a preventive environmental strategy, integrated to processes, productions and services in order to increase efficiency and reduce risks for human beings and the environment and achieve the sustainability of economic development" (Terry & Abó, 2001, p. 1).

For the practices it includes the contextualization and application of scientific-technological knowledge, the improvement of technologies, a vision of the impacts that are originated and an adequate environmental education that makes possible changes of attitudes in the students.

It is necessary to take into account in the use of technologies, the Cuban environmental law, its prescriptions and fundamentally the civil responsibility "to the supposed environmental damages, preventive role that imposes certain conducts and the protection of the environment due to its restorative nature" (Viamontes *et al.*, 2007, p. 421).

In order with the technological foundations of environmental education in the discipline under study, the documents are part of it for its monitoring and control. In the work with the Construction Regulations (CR) indicated for the protection of the environment from the life cycle of civil works are evidenced:

- RC 8001 for temporary facilities, their location according to the construction typology (metal bars, wooden huts, block buildings and light roofs)
- RC 8002 for the sustainable use of soils in construction according to the distribution of hydraulic and sanitary facilities, waste disposal, maximum use of the physical-geographical characteristics of the site, such as slopes, natural drainage, vegetation, location of borrow and deposit areas for surplus materials.
- RC 8003 for the hydraulic concrete preparation plants, they will be located in industrial areas or in areas provided for those purposes, their adequate insertion in the environment and their screening by means of natural screens (trees) or closed fences that allow minimizing the visual impact will be foreseen. The plant's mixers will have hermetic seals during the mixing process to prevent dust emission to the outside.
- RC 8004 during the engineering-geological investigations, maintain all vehicles circulating in the work areas in good technical condition, achieve access to the desired points without creating new roads, to avoid increasing erosive processes. For the location of topographic points, GPS equipment (equipment to establish the geographic position spatially) will be used whenever possible, as this instrument allows reducing negative impacts on the vegetation. Use small drilling machines in order to reduce the width of the trails.
- RC 8005 for the production of asphalt materials, their placement and maintenance, where the systems for receiving, storing and transporting asphalt cement will be sufficiently watertight and have the necessary equipment to prevent the product from spilling. Provision of an area within the plant's boundaries for the temporary storage of solid waste from asphalt concrete.
- RC 8006 for the environmental analysis of road and hydraulic project variants, forecasting models, whether empirical or rational, are carried out to foresee the environmental impacts that the infrastructure works and their operation will have on the environment.

- RC 8007 for the design of roads in ecologically sensitive areas, without ruling out other documents such as manuals, catalogs that can be used internationally.

These are some prescriptions and ways of working on environmental protection from constructive actions that are carried out taking into account the CR in civil works still in force and that technologies have a lesser impact on the environment.

Conclusions

The technological foundations that support environmental education in the discipline of Project, Construction and Conservation of Civil Works constitute a contribution to the Professional Pedagogical Process. They confirm the contextualization and integration of environmental education in the knowledge of new technologies that are used worldwide and nationally and constitute environmentally friendly aspects.

Technological foundations are defined that contribute to the theory of pedagogical research in the discipline Project, Construction and Conservation of Civil Works such as: the humanistic conception by describing the human being a motive in the struggle to realize the aspirations of the ideal of a better world; Science-Technology-Society (C-T-S) relationship towards the Scientific Conception of the world; the achievement of an environmental awareness by virtue of the limits of resources and waste generation; the technical preparation of educators and workers; the updating of training and research programs; the contributions in the use of ICT as support to the continuous training processes of teachers and students; the search for digital documents that provide knowledge on actions that other countries carry out in civil works to mitigate environmental impacts from the life cycle; the knowledge of Cleaner Production, as technology in continuous application; the Cuban Environmental Law as a document in the follow-up and control of the environmental policy and the above mentioned Construction Regulations (CR).