Environmental education as a tool for implementing the circular economy

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ABSTRACT

As a way to change the economic paradigm of a society rooted in an economy that excessively exploits natural resources and stimulates consumption and production without considering the environmental problems posed by the linear model of production, Environmental Education (EE) emerges, establishing the necessary bases for the transition from the Linear economic model (take-make-dispose) for a Circular economic model, which is based on the principle of closing the life cycle of products, aiming to minimize the consumption of resources, the generation of waste and environmental degradation. EA is recognized as an effective instrument to contain the advance of the Linear Economy. The research question that arises is: How can Environmental Education practices be used as a tool in the implementation of the Circular Economy? This work aims to investigate the role of Environmental Education as an effective tool in the implementation of the circular economy, analyzing theoretical foundations, identifying strategies and discussing impacts of these actions and highlighting the importance of Environmental Education in the process of migration to a Circular Economy. To answer this question, fifteen publications were analyzed, including scientific articles and books, 09 tools/actions applied to different audiences were identified with a focus on the dissemination of knowledge about the Circular Economy and its implementation. It is concluded with this work that Environmental Education initiatives combined with the concepts of Circular Economy exert influence on environmental awareness, generating a more accurate view of the benefits of sustainable production for humanity and the planet.

Keywords: Environmental Education, Circular Economy, Circular practices.

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INTRODUCTION

Technological advances and the increase in population demand in recent decades have brought with them new configurations in the modern world, consumption, according to the new needs arising from this new modern era, is one of them, which makes the current economic model as the great villain of sustainability for not committing to the environmental impacts caused as a result of the excessive exploitation of natural resources and the unplanned disposal of waste in the environment. "The problem with the linear model is that it doesn't hold producers accountable for the product's life cycle, leaving the task of disposal solely to the consumer." (SAINTS; ARAÚJO; DA CUNHA, 2021).

The linear economic model, also known as *the take-make-dispose* economy , "[...] It's a system where resources are extracted to make products that eventually become waste and are wasted." (ELLEN MACARTHUR FOUNDATION, 2023). For a long time, this economic model was considered ideal and promising. However, nature had already demonstrated the consequences of the unbridled extraction of natural resources: [...] "You can see this effect in increasingly degraded soils, polluted oceans, biodiversity loss, freshwater scarcity, and deforested forests." (ELLEN MACARTHUR FOUNDATION, 2023).

With the advent of the Industrial Revolution and the improvement of production technologies, as well as the philosophies of progressive economics, there was significant economic growth for the income and quality of life of the human population, but production actions based on free competition began to produce more waste and spoils that affected the environment in often harmful ways. In addition, the exploitation of natural resources for the production of raw materials has resulted in significant environmental impacts over the last two centuries (REICH, 2009). And the production model in place since the beginning of the Industrial Revolution harms the environment and populations, whose current and future generations may be affected by the impacts caused by the actions of a model that, in the long term, is unsustainable (DOWBOR, 2017).

As a solution to the environmental dilemma generated by the linear system, "[...] An innovative new product cycle model is proposed." (ATALANIUM; IBIAPINE; MACHADO, 2022). Thus, the concept of Circular Economy (CE) emerges as an alternative economic model to the linear model; A movement that strives for the restructuring of economic systems in a sustainable way, based on the replacement of waste by restoration and the move away from the "*take, make, and dispose*" system. This new system "[...] proposes a behavioral change in the way we consume and use natural resources and waste." (COSENZ; OF ANDRADE; ASUNCIÓN, 2020). Their migration is urgent and essential for new paradigms to be implemented. For this to occur, it is essential that initiatives developed through environmental education (EE) are carried out to assist in this gradual process. "To achieve this goal, we start from the hypothesis that EE is an important instrument to

promote CE actions and, consequently, sustainable development." (SAINTS; ARAÚJO; DA CUNHA, 2021).

In this context, there is a need for effectively sustainable actions that promote the development of the circular economy. Environmental Education practices form the basis for this transition to take place, making it possible to balance the relationship between economic development and sustainability. According to Lynette (2022, p. 157): "It has long been recognized that education is an effective instrument for building and implementing environmentally sustainable attitudes." In this sense, this work aims to investigate the role of environmental education as an effective tool in the implementation of the circular economy, analyzing theoretical foundations, identifying strategies of Environmental Education for the Circular Economy, discussing impacts of these actions and highlighting the importance of Environmental Education in the process of migration to a Circular Economy.

The study is structured in five sections. In the first section is the introduction, with the justification and objectives of this work. In the second, the Theoretical Framework where concepts and works of environmental education related to the circular economy are addressed. The third section describes the methodology used in the research and the research instrument used. In the fourth section, there are *the Results and Discussion, describing the environmental education strategies/actions that stand out as circular. In the fifth section, the final considerations* of the study and, finally, the references used.

LITERATURE REVIEW

ENVIRONMENTAL EDUCATION

Environmental education, the predecessor of education for sustainability, highlights the environmental pillar of sustainable development. The rise of environmental education has resulted in a field of academic study on sustainability education, called "education for sustainable development," which examines these efforts with the intention of improving education for sustainability (WU; SHEN, 2016).

Currently, the environment is affected by the irregular exploitation of natural resources, large amounts of waste and human waste, which leads to problems such as climate change, destruction of ecosystems and loss of biodiversity (SEABRA, 2020). As human practices caused serious environmental changes, some authors (BETTATI, 2012; realized that a dialogue aimed at a behavioral change was necessary in order to preserve the environment and, consequently, the existence of a planet where the human species could survive (BETTATI, 2012).

In this sense, Environmental Education is about the applicability of socio-educational, economic, and cultural actions that seek to solve environmental issues, achieving sustainability and

testing alternative methods to the current ones that minimize the impacts caused by human action (PEIXOTO, 2021). Even so, some authors agree that the current globalized world has characteristics that are too complex to hinder environmental dialogue with a sustainable focus in harmony with economic issues and that even sustainable economic alternatives could cause changes in ecosystems (BOSSELMANN, 2012; ECCARD, 2019).

CIRCULAR ECONOMY

The concept of Circular Economy (CE) goes back to different schools of thought (GEISENDORF; PIETRULLA, 2017) and theories that question the prevailing linear economic systems, which assume that resources are infinite (PRESTON, 2012; ALLWOOD, 2014), such as Industrial Economics (PRESTON, 2012) and General Systems Theory (VON BERTALANFFY, 1968 apud GEISENDORF, 2017), supporting the idea that an economy should be analyzed in a holistic thinking and complex systems approach (GEISENDORF, 2017).

The Circular Economy is a restorative economic model that aims to reconcile human needs so that they do not negatively affect the environment, acting in the strategic planning of stimulating entrepreneurship and seeking to keep products and raw materials at high levels of value and utility over the time in which it reuses its waste stocks in new products. thus enabling sustainable development within all spheres of consumption, so that there can be solid results in its objectives (ELLEN MACARTHUR FOUNDATION, 2017; MACARTHUR, 2019; ECCARD, 2019).

The maximization of the product's life span is the driving force of the Circular Economy and its reincorporation into the production line allows the formation of environmental awareness of producing companies and consumers (STAHEL, 2010). Cost reduction within this model, as well as industrial competitiveness, attraction of new consumer niches and job creation in this area tend to act as factors that encourage investment by companies in the Circular Economy and, according to data from the Ellen MacArthur Foundation (2015), cost reduction and long-term profit prospects tend to stimulate the adherence of enterprises to an environmental ethic built on the basis of at the heart of the business.

From this perspective, environmental education is an effective tool for business awareness and also acts on consumer awareness by stimulating the preference for products from the circular economy, and it is natural that there is a certain resistance on the part of consumers to the new model due to the convenience provided by the linear production model and the consumerist patterns of modern society are still very much linked to human daily life (KIRCHHERR *et al.* , 2018). For this reason, since the proposal for a production system aimed at the reuse of raw materials emerged, there has been an exponential growth of studies that seek to propose production techniques and training that would allow the applicability of the circular economy in a business environment (KIRCHHERR;

SANTEN, 2019), as well as studies focused on environmental education and business awareness that facilitate adherence to the model beyond the producer-consumer relationship, but also in the political field, generating prospects for long-term gains not only from a business point of view, but also from a socio-environmental point of view (PEIXOTO, 2021).

RESEARCH METHODOLOGY

This research is exploratory and began with a literature review and its analysis in order to substantiate the answer to the proposed problem. The research follows the qualitative approach with its descriptive objective, which seeks to expose the importance of Environmental Education (EE) strategies in the implementation of the Circular Economy (CE) based on its activities and actions in order to facilitate the understanding of the aforementioned subjects.

The research began in May 2023 and used the Scopus and *Scholar Google database*, with a search for terms "Environmental Education" and "Circular Economy" which are the main themes of the work, the priority of the research was to find publications that covered actions, practical activities that involved the EE and CE theme as well as their ramifications, identifying them in the abstracts and keywords as well as in the body of the article's methodology or book/e-book.

From the beginning of the project planning, it was decided to select at least 15 scientific papers published in relevant journals and books. Course completion papers, dissertations and theses were disregarded; Another requirement determined is that the selected publications were of Brazilian origin, thus focusing on which projects, tools and actions Brazilian researchers are using to address both Environmental Education and the implementation of the Circular Economy. After the selection of the works, first the results found were tabulated in a way that they were divided into Tools/Actions and References (Table 1), then, after defining each tool/action, its forms of implementation are discussed in order to achieve its objectives, accompanied by each by a table containing Tools/Actions, Themes that are used to address both EE and CE, the Title of the work and, finally, its Reference (Tables 2 to 10). The current work used the bibliographic methodological concepts developed by Nascimento-e-Silva (2021a; 2021b; 2021c) as inspiration for its implementation.

RESULTS AND DISCUSSION

TOOLS AND ACTIONS

There are several tools to approach Environmental Education in order to implement at least the knowledge about Circular Economy, such as social actions, practical or theoretical activities, publication of books and ebooks, among others, it is up to the communicator to apply them in the best way so that it reaches the target audience, which can be students of a school, residents of a

neighborhood, workers in a factory, for example. After the literature review for the selection of the 15 selected works, it was noted in many the use of several activities/tools in the same action with the same objectives, using the interaction with the target audience to achieve them, such as conversation circles, seminars, workshops, among others, in order to condense for better visualization and definition of the Tool/Action. with this purpose of bringing together all these activities in a single terminology.

By tabulating published scientific papers focused on the implementation of CE using EE knowledge, one can observe a variety of ways, tools and actions to achieve the objectives. In 15 publications, including scientific articles and books, (excluding theses and dissertations) 9 tools/actions were found applied to different audiences with a focus on disseminating knowledge about the Circular Economy and implementing it (Table 1).

Table 1. Tools/Actions applied to Environmental Education and Circular Economy

References	Tools/Actions
CIRIMARCO, Sergiane Kellen Jacobsen Will et al (2022); DOS SANTOS, Karin Luise et al (2022); MOREIRA, Ana Caroline Rego et al (2023); SANTOS, Vanusa Carla Pereira; ARAÚJO, Maria Ludetana et al (2021).	Interactive Education
SILVA, Rodrigo Cândido Passos da et al (2018); QUINTA E COSTA, Margarida et al (2019); KOHLBECK, Eloiza et al. (2021).	Textbooks & E-book
LIMA, Uedja Tatyane Guimarães Medeiros et al (2022); FERNANDES, Beatriz Silva et al (2023).	Socio-Educational Projects
VIOLIN, Fábio Luciano et al (2020).	Hands-on tutoring
MOURA, R. de C. G. et al (2021).	Educational Garden
DO CARMO GARCIA, Waldilene et al. (2022).	Training Courses
QUINTA, Margarida et al (2020).	Didactic Activities
DE BORTOLI, Alcinéia et al (2023).	Composting
KITAJIMA, Luiz Fernando Whitaker et al (2019).	Visual Exposure

Source: Authors (2023).s (2023).

By observing table 1, it is noticeable that there are more studies that are suitable for the action called Interactive Education as a tool of Environmental Education to implement the Circular Economy, followed by the publication and access of Books and E-Books as an alternative to disseminate and introduce CE.

INTERACTIVE EDUCATION

The works presented in the following table used several techniques and similar actions in order to inform, implement the Circular Economy using some themes of Environmental Education. These actions, such as lectures, educational videos, practical activities, conversation circles, among others, were called Interactive Education in this work, because all the works are approaching the target audience in a close way and using practical and/or interactive activities, and may or may not use technological resources to achieve their goals.

Table 2. Interactive Education as a tool/action

Tool(s)/ Action(s)	Theme(s)	Job Title	Reference
Interactive Education	Food life cycle and organic resource management.	Socio-environmental education based on the circular economy: integrating formal and non-formal environments as a conceptual model for valuing organic resources.	Cirimarco, Sergiane Kellen Jacobsen Will *et al* (2022).
Interactive Education	Recycling, material processing.	Recycled: sustainable ideas and attitudes to generate opportunity and profit.	Moreira, Ana Caroline Rego *et al.* (2023).
Interactive Education	Environment, sustainability, solid waste, environmental education, selective collection, Circular Economy, Environmental Economy, Solidarity Economy.	Circular economy and environmental education: the actions of GEMAS/UFPA.	Santos, Age Carla Pereira *et al.* (2021).
Interactive Education	Composting	The teaching of home composting as an instrument to promote the circular economy in urban solid waste management and management systems.	Dos Santos, Karin Luise *et al.* (2022).

Source: Authors (2023).s (2023).

The Interactive Education tool can be aimed at theoretical-practical activities where the interlocutors first pass on information about the proposed topics, thus creating a theoretical foundation, being able to approach them in the form of seminars, lectures or conversation circles so that there are then interactive practical activities with the target audience using workshops, workshops and training to apply what has been taught. It is interesting that, some time later, there is a revisit for feedback in order to find out if what was proposed is still being put into practice, as in the work of Santos et al (2021) and, if necessary, repeat the activities or change the tools used to have better absorption and implementation of the proposed themes.

BOOKS AND E-BOOK

Among the selected works, the publication of books and E-books were the most found as tools for the implementation of the Circular Economy after Interactive Education. It is a resource used to better theoretically ground the reader on the topics addressed such as environmental education, the circular economy (in a more direct way), involving subjects such as entrepreneurship, for example.

Table 3. Books and E-Books as a tool/action

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Book & E-book	Environmental Education, sustainability, energy recovery.	Solid waste: circular economy technologies and best practices.	SILVA, Rodrigo Cândido Passos da *et al*. (2018).
Textbook & E-book	Circular Economy, recycling economy.	Urjalândia a Circular: circular economy.	QUINTA E COSTA, Margarida *et al*. (2019).
Electronic book	Entrepreneurship, conscious consumption and responsible for dematerialization and innovation and organic waste management.	Approach to Sustainable Development Goals, Circular Economy and Product-Service Systems in Early Childhood Education: Proposal of an e-book.	KOHLBECK, Eloiza *et al*. (2021).

Source: Authors (2023).

When analyzing the tool of publishing books and e-books, different ways of using this same tool can be observed. The book published by Silva et al (2018) is focused on bringing published articles focused on environmental education, sustainability, energy recovery, all focused on the application of the Circular Economy. Fifth et. al (2019) uses this tool in a language that serves children, focusing on the basis where students can learn about E.C from an early age, in the same way Kohlbeck (2021) proposes an e-book for early childhood education with practices where teachers can apply it with their students.

SOCIO-EDUCATIONAL PROJECTS

Socio-Educational Projects is a tool aimed at implementing the Circular Economy in communities, allying with residents or social movements to reach the largest number of people in the area and include them for sustainable, circular development as a whole.

Table 4. Socio-Educational Projects as a tool/action

Tool(s)/ Action(s)	Theme(s)	Job Title	Reference
Socio-Educational Project	Circular education and sustainable development.	Circular economy, education and sustainable development: training young people and adults from socially vulnerable communities.	LIMA, Uedja Tatyane Guimarães Medeiros *et al*. (2022).
Socio-Educational Project	Environmental Education, solid waste management.	The zero waste youth movement: environmental education actions as contributions to solid waste management in Guarulhos (SP).	FERNANDES, Beatriz Silva *et al*. (2023).

Source: Authors (2023).

This tool seeks greater proportions in terms of social activities, as well as closer monitoring. Lima et al (2022) focus this tool on young people and adults who live in communities considered

socially vulnerable, applying it mainly in their education, turning the topics covered into a complementary education to facilitate its applicability in their daily lives. Fernandes et al (2023) present a social movement called Zero Waste Youth that works with social activities and conversation circles focused on solid waste management in Guarulhos. It can be observed that one tool can be combined with another for better applicability of the Circular Economy, where Socio-educational Projects can use Interactive Education to facilitate the reach and information to the public.

HANDS-ON TUTORIALS

By using the practical tutoring tool such as the work mentioned, where it is aimed at the public of students where they may already have knowledge about the subject, mainly about the environment and other subjects involving Environmental Education, using these to address the theme of Circular Education, whose recycling and entrepreneurship can be related.

In practical tutoring, practical activities can be used with the help of one or more tutors to direct the proposed activities by forming small groups of students and thus facilitate communication and the dynamics of the project.

Table 5. Practical Tutorials as a tool/action.

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Hands-on tutorials	Recycling and entrepreneurship	The performance of Pet Tourism in schools in Rosana-SP: benefits of the interaction between School and University within the scope of the Circular Economy.	VIOLIN, Fábio Luciano *et al.* (2020).

Source: Authors (2023).

ECOLOGICAL GARDEN

A practical tool that can make a difference and create a kind of appreciation of local biodiversity is the Ecological Garden, where the author Moura et al (2021) highlights the importance of Environmental Education for the implementation of the Circular Economy. By building the garden together with the participants, planting native species, valuing the local botany, a space is created that can be used in different ways, as the same author cites as an example the development of interdisciplinary classes and making the school community responsible for the environment.

Table 6. Ecological Garden as a tool/action

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Ecological Garden	Circular economy linked to local biodiversity	Environmental education: Circulating knowledge in the caatingueiro garden of the evangelical school in Petrolina – PE.	MOURA, R. de C. G. *et al.* (2021).

Source: Authors (2023).

TRAINING COURSES

Training Courses as a tool for implementing the Circular Economy have the differential of focusing on specific subjects, in the case of the study proposed by Garcia (2022) brings the theme of waste recycling, where entrepreneurship, economic activities, among others, can also be involved and encouraged, based on the concepts of CE. This same work results in economic activities based on the commercialization of recycled products (homemade soap, biofertilizers) and solid waste collectors, there is a record of the organization of local cooperatives, thus the cycle of the Circular Economy is being initiated.

Table 7. Training Courses as a tool/action

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Training Courses	Waste recycling	Environmental education: A path to circular economy in the metropolitan region of Belém-PA.	GARCIA, Waldilene do Carmo *et al.* (2022).

Source: Authors (2023).

DIDACTIC ACTIVITIES

Bringing Didactic Activities as an Environmental Education tool for the implementation of the Circular Economy can be considered one of the most important along with the others already mentioned when the focus is on applying them in teacher training and in the teaching-learning of students. Quinta (2020) shows in her work that didactic activities focused on CE, its ramifications, can bring interest to the theme and thus facilitate the approach and implementation from the base.

Table 8. Didactic Activities as a tool/action

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Didactic Activities	Circular economy, recycling and biodiversity preservation	Educating for the Circular Economy – an innovative experiment in teacher training Educating for the Circular Economy.	QUINTA, Margarida *et al.* (2020).

Source: Authors (2023).

COMPOSTING

Previously, composting can be seen as a topic to be addressed in the middle of an action, in this case Bortoli (2023) brings it as a tool. Composting can bring several themes to the fore, but the author emphasizes organic recycling as its main one. In a place that has a green area, it facilitates the production of organic materials, which can raise inputs for the production of compost and its application (Bortoli, 2023).

Table 9. Composting as a tool/action.

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Composting	Organic recycling.	Feasibility study for the use of compost to recycle plant waste in an educational institution	Bortoli, Alcinéia de *et al.* (2023).

Source: Authors (2023).

By using composting as a tool or action before the population, it is also possible to make combined use of other tools, such as Training Courses dedicated to implementation, Interactive Education aiming to explore and explain the proposed content, for example.

VISUAL EXHIBITIONS

Bringing Visual Exhibitions as a tool can arouse the interest of those who see. Kitajima (2019), in his work, shows how everyday devices can go unnoticed when exhibiting in the form of an exhibition of photographs, bringing examples in exhibitors electronic waste and objects coming from them, showing how problematic it can be if the necessary importance is not given. During the action, topics such as recycling, reuse and reverse logistics, for example, can be addressed.

Table 10. Visual Exposure as a tool/action

Tool(s)/Action(s)	Theme(s)	Job Title	Reference
Visual Exposure	Recycling, Reuse and Reverse Logistics.	Environmental education as an instrument in the management of electronic waste problems: a proposal	KITAJIMA, Luiz Fernando Whitaker et al (2019).

Source: Authors (2023).

FINAL CONSIDERATIONS

This study showed that Environmental Education (EE) practices can contribute to the implementation of the Circular Economy (CE). This was confirmed through the various tools and actions that were identified in the literature review. Tools such as Training Courses that address the topic of waste recycling, with a focus on transforming waste into new products so that they can generate income through their commercialization, such as the work developed by Garcia et al (2022). This is configured as a practice in favor of the Circular Economy, as well as didactic and interactive initiatives that seek to work on concepts and themes related to Environmental Education and Circular Economy, as in the study by Kirchherr and Psiscicelli (2019) who held courses and workshops for teaching CE with undergraduate students.

The works identified and classified into categories in this study helped to broaden the view on how EE and CE concepts are being approached and how they contribute to the implementation of the Circular Economy today. It is notorious that in order to change an economic paradigm such as the Linear one, it is necessary to change the posture and for this to happen, it is necessary to raise awareness and more Environmental Education actions, such as those described in this work, which

generate knowledge about the importance of adhering to an economy that promotes sustainable development that guarantees the preservation of natural resources.

Knowledge awakens awareness of belonging, drives new actions, modifies attitudes, creates new business possibilities, preserving and contributing to healthy life on the planet (LYNETTE, 2022). It is also important to emphasize that Environmental Education is not restricted only to the school environment, but also to all spheres of society, having the same importance. This is stated in article 2 of Law No. 9,795, of April 27, 1999 of the National Policy on Environmental Education on Environmental Education: "Environmental education is an essential and permanent component of national education, and must be present, in an articulated way, at all levels and modalities of the educational process, in formal and non-formal character".

In this sense, it is concluded that environmental education initiatives combined with the concepts of circular economy promote the necessary bases for the transition from a Linear Economic Model to a Circular Economic Model. This transition is not established instantaneously, it is a gradual process, but for it to happen, it needs the support of everyone: government, entrepreneurs, producers, consumers and citizens committed and responsible for our common good. It is suggested, therefore, that more studies address these topics, in order to integrate theory and practice as a methodology, in order to further disseminate the future benefits of adhering to the Circular Economy, providing improvements for human life and the planet.

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