

Circular Economy and Zero Waste for Environmental Education

*Federico Venturini**

Key words: *Environmental education, circular economy, Zero Waste*

1. Introduction

Environmental Education (EE) goes beyond knowledge transmission regarding the environment and the current ecological crisis. Instead, it facilitates a new relationship with nature and promotes actions for change (Spork, 1992). EE is said to offer three forms of education: *in*, *about*, and *for* the environment (Lucas, 1979; Thomas, 2005). Education *in* the environment puts students with direct contact with the environment, while education *about* the environment provides students with knowledge about ecological processes. Education *for* the environment stimulates sustainable ways of living and aims to change behaviour. However, this last form has received less attention and is more difficult to develop for reasons summarised by Thomas (2005):

- knowledge is dangerous and leads to political controversy (education *for* the environment challenges current economic and social systems so it raises objections);
- moving from theory to action is difficult (it is hard to move students from simply absorbing information towards real action);
- effective practice calls on teachers to implement practical activities and develop first-hand experience (this is often viewed as a challenge to the school system);
- values in EE may conflict with student values and attitudes;
- challenges remain in preparing teachers for EE (teachers are often not trained and lack sufficient resources).

This article illustrates how the concept of waste can be viewed through the perspectives of circular economy and Zero Waste¹ in order to enable a more effective EE.

First, the centrality of waste is introduced. Then, the concepts of circular economy and Zero Waste are explored. Subsequently, we ask how these two concepts

* Udine, Università di, Italia.

This paper was developed within the framework of the research project «HEAd HIGHER EDUCATION AND DEVELOPMENT» Operation 3 UNIUD, funded by Friuli Venezia Giulia (POR FESR 2014-2020).

¹Zero Waste is used with capital letters as it refers to a specific approach.

can be used to develop EE, and introduce two educational experiences. Finally, some conclusions are highlighted.

2. Waste

Waste is increasingly a global problem. A recent World Bank report (Kaza *et alii*, 2018), reveals some staggering data. In 2016 an estimated 2.01 billion tonnes of municipal solid waste were generated. If business-as-usual continues, this number will increase to 3.40 billion tonnes by 2050. The problem of where and how to dispose of this material in order to minimise contamination is a major environmental issue. In 2016, the treatment and disposal of waste generated 1.6 billion tonnes of carbon dioxide – about 5 percent of global emissions. Managing waste is complex, with a number of phases, including collection, transportation, pre-treatment, processing, and abatement of residues (Demirbas, 2011), and many actors involved (Baud *et alii*, 2006). Waste is finally disposed of by either composting, recycling, incinerating, or by being physically placed in a landfill or open dump.

When a product ends up in a landfill not only the physical materials of itself are wasted but also all the resources used in the previous phases of its life – from extraction to manufacture, to sales and consumption.

Even if it seems to have magically disappeared, «waste doesn't really go away – it flows over time and through space» (Hird, 2013, p. 105). Waste management processes mean that energy and environmental costs impact on local communities, requiring local political decisions. Waste must, therefore, return to the top of the political agenda (Murray, 2002).

A crucial question is what does «waste» mean? The European Union (EU) has adopted the following definition: «Any substance or object which the holder discards or intends or is required to discard» (EU, 2008, p. 9). This seems quite plain and objective. However, it hides a much more malign picture, as illustrated by Moore (2012). Waste has been variously defined in the academic literature as a hazard, manageable object, commodity, resource, archive, out of place, disorder, risk, filth, fetish, governable object, abject, or vital «actant». Despite its abundance, waste is commonly perceived as an incidental or secondary product. Along this line, the World Bank describes municipal solid waste as «one of the most important by-products of an urban lifestyle» (Hoornweg, Bhada-Tata, 2012, p. ix). This word *by-product* is very problematic. Waste as seen as an unintended and inconvenient, but inevitable, result of our mode of production, and part of a commonly accepted narrative. However, we contend that waste is not a by-product, but an integral part of any mode of production. As stressed by Valenzuela and Böhm (2017), it is important to include the discourse on the role of the capitalist expansion.

3. From a linear mode of production to a circular economy

Taherzadeh and Richards (2016) remind us that each new world inhabitant is a new polluter and, under a business-as-usual scenario, this is not sustainable. The main effects of today's economic system «include the depletion of natural resources, overconsumption, pollution, and their impact on biodiversity

and ecosystems» (Pietzsch *et alii*, 2017, p. 331). Human interactions with the natural world are currently unsustainable, as considered by the EU:

Current European linear production, consumption and disposal patterns reflect the myth that we live in a world with infinite resources. Over the last few decades, Europeans have been living on a growing ecological deficit, importing almost four times more materials than we have exported [Simon and Zero Waste Europe, 2020, p. 61].

Not only is the current mode of development impossible to maintain in the long run, but it also puts human life in danger. We must abandon the idea that we can have both economic growth and environmental sustainability (Parrique *et alii*, 2019).

The linear conception of production (fig. 1) is based on two assumptions: (1) that there is an unlimited supply of energy and raw materials; and (2) that the environment has an infinite capacity to absorb pollution and waste (Cooper, 1994, p. 2). This mode of production, which has been called a «bigger-better-faster-safer» syndrome (Stahel, 2016, p. 436), is based on a linear model. Today, from an economic point of view, it includes all «activities, from tangible production to intangible contracts, routines and regulations» (de Jesus *et alii*, 2018, p. 3002). None of the economy escapes from this linear system of sequential actions. Production is conceived of as a succession of stages from raw material extraction, manufacturing goods, sales and consumption, to disposal (Pietzsch *et alii*, 2017, p. 324). So far, this system has worked because it was based on «resource abundance, modernization, and technological fixes» (Gutberlet, 2016, p. 59). However, certain limits have been reached and any assumption that resources are endless is proving to be wrong, as negative environmental effects have intensified apace in the last few decades.

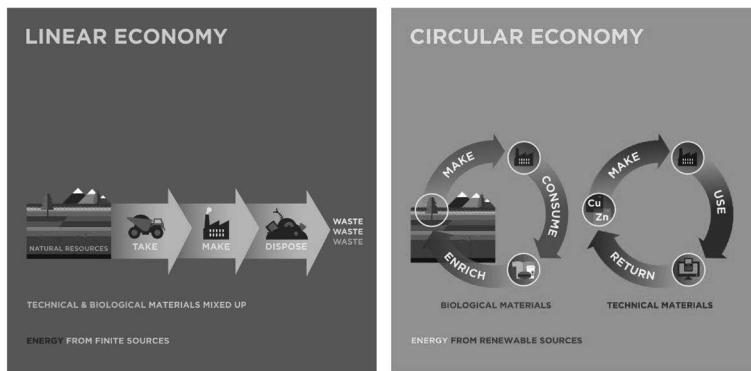


Fig. 1 – Linear vs circular economy.

Source: Ellen MacArthur Foundation (nd, p. 9)².

² For a more detailed image of circular economy, see Ellen MacArthur Foundation and McKinsey Center for Business and Environment (2015, p. 9).

Biomimicry can help us to find an alternative way forward. For example, we can aim to mirror «natural life cycles where dead organic material decomposes to become a nutrient for the next generation of living organisms» (Andrews, 2015, p. 309). We thus move from a linear mode of production to a circular one (see fig. 1), where waste becomes a resource and closes the loop (Stahel, 2016; Witjes, Lozano, 2016). This circular economy can be defined as:

A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. (Geissdoerfer *et alii*, 2017, p. 764).

Materials are kept within the system, thus reducing their impact and our dependency on nature, while moving towards sustainability (Sauvé *et alii*, 2016). A circular economy is an alternative mode of production to the linear system. It assumes that energy and raw materials are finite, and that the environment has a finite capacity to absorb pollution and waste. This new paradigm was first developed since the 1980s and its implementation is still at early stage of development (Cooper, 1994; Ghisellini *et alii*, 2016; Cardoso, 2018).

Increasingly, however, this model is being embraced and the circular economy is becoming an official key word in official strategies within China and the EU (de Jesus *et alii*, 2018). The European Green Deal³ sets an ambitious EU agenda for achieving a sustainable Europe through the promotion of a circular economy (European Commission, 2020a), and the EU is working towards its implementation (Bonviu, 2014; Wysokińska, 2016) in order to foster economic development that is also respectful to the natural environment. This is proceeding despite a number of cultural, market, regulatory and technological barriers (Kirchherr *et alii*, 2017).

Some key aspects of a circular economy include:

- a special focus on urban and industrial waste;
- implementation depends on all actors of within a society;
- extracted resources and materials produced should be kept within a cyclical flow (Pietzsch *et alii*, 2017, p. 326).

Historically, sustainability has been based on the behavioural concepts of the three Rs: reduce, reuse, and recycle. These have since developed into the ten Rs⁴: refuse, rethink, reduce, re-use, repair, refurbish, remanufacture, repurpose, recycle, and recover (see fig. 2) that also link to the circular economy. These are ordered with the most important concepts at the top, and the less virtuous ones at the bottom (Potting *et alii*, 2017).

³ For a feasibility assessment of the European Green Deal see Bodin and Stainforth (2019).

⁴ The initial 3Rs framework has been enriched by several new Rs, becoming the 4Rs, 6Rs and even 10Rs (Kirchherr *et alii*, 2017). Worth of mentioning are also the 8Rs of Degrowth (Latouche, 2009).

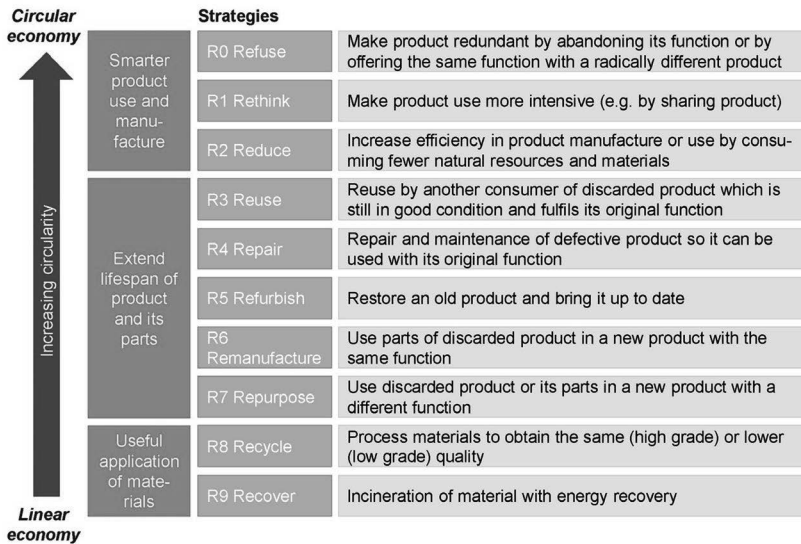


Fig. 2 – The 10R framework.
 Source: Kirchherr *et alii* (2017, p. 224).

Stahel (2016, p. 436) offers an analogy of the two systems: on one side the linear economy flows like a river; on the other a circular economy is like a lake. In the former, resources and energy flow at high speed without being retained, while in the latter resources and energy are retained and circulate within the same ecosystem. Sauvé *et alii* (2016) illustrate the different approaches with respect to sustainable development. In the former, the downstream processes of production and consumption are emphasised. The consequences are multiple: ineffective recycling, absent value chains, and a predilection for using virgin resources. Alternatively, the latter is more resource-oriented, has a more rounded approach and all inputs and outputs of the system are considered. From an economic perspective, a linear system is focused on high levels of immediate revenue, while a circular one postpones revenue and looks for other value (Pheifer, 2017).

So, what does a linear *versus* circular system mean from a waste management perspective? The perspectives of the two systems are totally different:

«Conventional waste management is driven by minimizing the costs of collection and disposal – landfill *versus* recycling or incineration. In a circular economy, the objective is to maximize value at each point in a product’s life» (Stahel, 2016, p. 436).

Waste production is thus inevitable in both systems, but a circular economy is calling for a paradigm shift. In the first, waste is thought of as a by-product to be eliminated from the system. In the second, waste is considered as something to be avoided or minimised, managed from *inside* the system itself.

Being a revolutionary concept, the circular economy needs to be elaborated. For example, while the term is often applied to economic prosperity, few connections to environmental sustainability or social equity have been developed (Kirchherr *et alii*, 2017; Geissdoerfer *et alii*, 2017). The challenges of transitioning to a circular economy have been explored in the literature (Ghisellini *et alii*, 2016; Sauvé *et alii*, 2016), but the main issue is that «as a holistic concept, it collides with the silo structures of academia, companies and administrations» (Stahel, 2016, p. 436). The current productive system argues for watertight compartments, making it hard to set the wider socioeconomic system in motion for the necessary sea change required for socio-ecological sustainability.

4. From recycling to Zero Waste

Given the ever-expanding necessity of production that conflicts with the natural limits of our planet, a transition to a circular mode of production is imperative. While recycling has often been seen as the solution, this is only one aspect of the circular system (Ghisellini *et alii*, 2016). Recycling has long been deemed insufficient and is very low measure for achieving circularity. Cooper (1994, p. 10) stressed that «recycling reduces waste but does not *minimise* it – an important distinction. It is essentially an “end-of-pipe” response», suggesting that the reduction of waste and pollution exhibit different patterns of production and consumption. Krausz (2012) suggests de-emphasising recycling for two reasons. First, because the feel-good aspect to recycling serves to distract stakeholder groups from taking real steps towards a zero waste production, such as eliminating dependence on problematic materials (Krausz, 2012). Second, it diverts much-needed resources from other initiatives that aim to tackle waste production.

Moreover, the process is energy-intensive, involves hazardous by-products and not all material can be recycled (Gutberlet, 2016). Given these limitations, recycling has been dubbed a myth (Buffington, 2016) and a growing body of literature suggests moving up in the 9R ladder in order to be more effective in waste prevention (Cooper, 1994; King *et alii*, 2006; Bekin, Carrigan, Szmigin, 2007; Grosse, 2010; Barr *et alii*, 2013). The world simply cannot recycle its way out of the waste problem (Hannon, Zaman, 2018).

In recent years, usage of the term «Zero Waste» has surged⁵ among producers, advocacy groups and policy-makers (Connett, 2013). Zero Waste presents multiple definitions; the term literally refers to an approach that produces no waste. However, given the diversity of different actors using this term, the extent to which a common definition and application can be found is arguably uncertain.

A broad and widely accepted definition by the Zero Waste International Alliance (2018) is:

⁵ See Books Ngram Viewer for the term Zero Waste books.google.com/ngrams/graph?content=zero+waste&year_start=1920&year_end=2019&corpus=26&smoothing=2&case_insensitive=true/

The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health (np).

This definition refers, firstly, to all man-made objects. Second, it considers all the elements of production. Third, all harmful forms of pollution must be avoided. Oddly, the word «waste» is not used, presumably in order to stress that the approach has a more holistic vision. Zero Waste still requires cohesive strategies in order to reach its goal of systemic change (Murray, 2002).

At first, the term Zero Waste can seem misleading and as referring only to the garbage that is often the most noticeable aspect of a linear mode of production (Palmer, 2009). However, this approach is concerned with the whole life of any object or service. From this perspective, Zero Waste aims to maximise energy retention and minimise resource consumption, and it is thus crucial to take into account all the energy and resources costs related to all the different phases of the circular economy.

Where links between the concept of circular economy and Zero Waste exist, the first implies the second (Ghisellini *et alii*, 2016)⁶. However, Zero Waste, focussing more on waste, has developed a specific waste hierarchy.

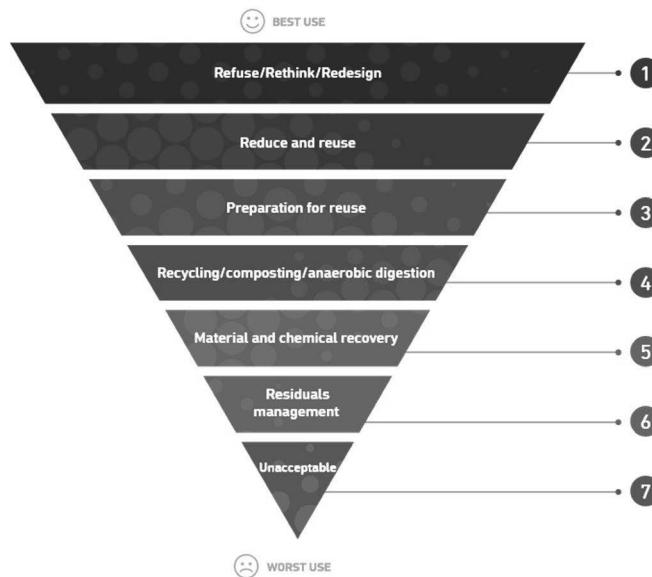


Fig. 3 – Zero Waste hierarchy.
 Source: Simon (2019, np).

⁶ Links between Zero Waste and circular economy are underlined at an official level (cf. European Commission 2014).

Considering the overall product life, Zero Waste Europe recently proposed an innovative waste hierarchy (fig. 3)⁷. This ladder has new important features. It is more sophisticated, having two levels related to products (refuse/rethink/redesign, and reduce and reuse) and five related to waste (preparation for reuse, recycling/composting/anaerobic digestion, material and chemical recovery, residuals management, and unacceptable waste). Moreover, it takes a clear stand on waste management, explicitly outlining the best and worst uses and what is unacceptable. While the previous hierarchy focused on recycling, the main aim of this hierarchy is to «value preservation via designing waste out of the system» (Simon, 2019, np).

Putting the emphasis on the three highest levels (refuse/rethink/redesign, reduce and reuse, and preparation for reuse) means emphasising the importance of the value of each object before it becomes unusable. For example, conservation of value means that products and packaging stay in the economy longer, not as waste but as usable materials and products. In practice, this implies a significant change of view from believing that recycling is the highest level in waste management to that of effective waste design.

While the wider literature shows that the Zero Waste approach can benefit the community, the economy, the environment and industry (Pietzsch *et alii*, 2017), some authors suggest recuperating all the material that has escaped throughout history from anthropogenic circuits (Hogland *et alii*, 2014).

Despite being developed for industrial application, the term has a flexibility that allows it to be used in different fora (Connett, 2013; Zaman, 2015; Hamid *et alii*, 2020), and in recent years a growing body of literature has highlighted the use by grassroots initiatives (Connett, Sheehan, 2001; Connett, 2013; Hannon, Zaman, 2018; Behrsin, 2020; Li, Kao, 2020). While often associated with waste management and policy-making, Zero Waste is also associated with personal lifestyle.

However, Zero Waste has its challenges. The first can be considered as mis-positioning. Krausz *et alii* (2013) show that cities that adopted a Zero Waste to landfill goal have failed, and that such policies have not been achieved anywhere. The key problem is that Zero Waste is applied to waste management, and only to the final life of products (similar to issues regarding recycling):

Strategies for addressing waste upstream are critically absent, with insufficient downstream measures such as recycling the prevailing norm – reinforced by a consistent preference for technical solutions over fundamental behavior change [Krausz *et alii*, 2013, p. 10].

This position is echoed by Pietzsch *et alii*, (2017, p. 333), who remind us that initiatives are «still mostly used to mitigate the negative impacts cau-

⁷This proposal was developed from the waste hierarchy used in the EU (European Union, 2008).

sed after waste generation». What is needed is a total reconsideration of all aspects of production.

A second challenge is more complicated. Conway (2019) rightly asserts that «the “zero” in Zero Waste is impossible because of the second law of thermodynamics, which states that the quality of energy degrades as it is used» (np). Achieving a perfectly zero waste system is thus impossible, so it would be better to call it «almost zero waste» (Sferra, 2013). From this position it thus possible to agree with Hird (2013, p. 118) that «[z]ero waste is neither a possibility nor necessarily an appropriate aspiration». We have to remind ourselves that «[w]aste ... fuels the world’s metabolism. Animals breathe oxygen expired by trees and converted by bacteria. This is not to say the solution – if there is only one – is to sustain our business-as-usual approach» (Hird, 2013, p. 118).

However, the question whether Zero Waste can really attain zero remains to be explored. The current economic system is based on production and accumulation, where waste is a by-product. Zero waste can help us, at least, with semantic clarification. In reality, waste should be conceived «as any material we have failed to use» (Gille, 2010, p. 1050). From this perspective, the Zero Waste approach can enable us to reach a real circular system, working towards successfully using any material we decide to implement in the system. This semantic turn on waste is crucial because it clarifies the necessity to look at the entire production system and focus on systemic change. Moreover, this shift can help to highlight the aforementioned shortcoming of approaches that only focus on recycling or on Zero Waste municipal plans.

To sum up, what is the benefit of using the term Zero Waste? It is a powerful mobilising concept that appeals to consumers, producers and policy-makers. Zero Waste is an approach that pushes us to rethink our linear mode of production, and, consequently, our society. Moreover, it addresses critical aspects of the contemporary mode of production, working towards circularity and helping to focus on all the different phases of any substance or object produced or used. It extends beyond waste management and helps cities move towards a more circular metabolism (Hannon, Zaman, 2018). Furthermore, it offers a holistic vision and calls for greater systemic thinking. Finally, it suggests a hierarchy of principles to guide action and priorities.

Applying Zero Waste in an urban context would be highly beneficial given the high rate of consumption and waste production, and the increasing costs of garbage management (Zaman and Lehmann, 2011; Hannon and Zaman, 2018). Our aim should be a circular and Zero Waste city:

a city that can grow its own food, use water from its own areas, produce energy from its own systems, create jobs and economic activities, regulate the whole system efficiently, and finally recover all resources from waste streams [Zaman, Lehmann, 2011, p. 186].

Working in this direction, Zero Waste Europe offers important tools for grassroots initiatives, policy-makers and city planners to help cities and communities transition towards Zero Waste. They have just published a guide, *The Zero Waste Masterplan* (Simon, Zero Waste Europe, 2020), and developed

an online platform that explores best practices of municipalities and local stakeholders in Europe⁸.

5. *Towards a circular economy and Zero Waste environmental education*

Despite North America and Europe lacking effective educational projects for changing consumption and disposal behaviours (Gutberlet, 2016), waste is often the focus of EE curricula (Palmer, 1995; Grodzinska-Jurczak *et alii*, 2003). However, results are variable, and educational programmes often focus on the lower steps of the 9R ladder (especially recycling) and are not able to ignite deeper behavioural change (Cutter-Mackenzie, 2010; Cutter-Mackenzie-Knowles, Siegel, 2019). The literature acknowledges that, despite being underused, both teaching the circular mode of production (Andrews, 2015) and Zero Waste (Zaman, Lehmann, 2011) can help to foster sustainability awareness in students.

Two educational providers, the Ellen MacArthur Foundation for the Circular Economy, and Seven Generations Ahead for the Zero Waste Approach are providing educational material on circular economy/Zero Waste.

Launched in 2010, the Ellen MacArthur Foundation it is an English charity focusing on accelerating the transition to a circular economy⁹. Over the years it has produced a large amount number of high-profile reports and stories regarding the circular economy. Moreover, it has built an impressive archive of teaching materials, for schools, colleges and higher education, all freely available online¹⁰. In its reports, waste production is identified as one of the mayor issue in contemporary mode of production and several possibilities are highlighted in order tackle it. At the same time, numerous learning activities are designed in order to deliver teaching contents on waste to students. Unfortunately, there is no module only dedicated solely to waste, but the issue is mixed included with in other topics. Furthermore, the approach Zero Waste is mentioned only in passing-by. and it would be worth to have been developed more.

Seven Generations Ahead is an American charity founded in 2001, and works to build ecologically sustainable and healthy communities. It offers educational activities on a broad range of sustainability topics, including one on Zero Waste. Its teaching guide on Zero Waste, *Don't Throw Me Away!: A Zero Waste Curriculum*¹¹, is dedicated designed for students from grade k to grade 7. Despite avoiding the concept of circular economy, is not mentioned, in this publication the circularity of nature is stressed, underlining how waste is a human invention.

In both the cases presented, the teaching materials are very rich and well-articulated, offering videos, lectures, booklets, and practical activities, preparation for teachers is also presented. Practical activities that are well-designed and aimed to engage the students with doing.

⁸ Available at: zerowastecities.eu

⁹ Available at: www.ellenmacarthurfoundation.org/our-story/mission/

¹⁰ Available at: www.ellenmacarthurfoundation.org/explore/

¹¹ Available at: sevengenerationsahead.org/zero-waste/zero-waste-schools/

In order to develop more of these approaches, it is proposed to regularly insert into the EE curricula the ideas of circular economy and Zero Waste in combination, using waste as teaching tool. This effort should be focussed to the educational system at all levels and not only limited to formal education but also to informal settings, with the message reaching the wider society. Through education, public communication and social dialogue «new social values become norms that have the potential to result in behavioural and lifestyle changes that turn away from unhealthy production and consumption patterns» (Gutberlet, 2016, p. 59). To achieve maximum results, EE should be supported in different forms and across different class and age groups.

Waste is indeed a commonly experienced to everyone and so offers the possibility to may be easily visualised and in order to subsequently take concrete actions. At a first level, waste can thus be considered as a resource. Furthermore, thanks to the shift proposed in this article, waste can be a teaching device that draws attention to more complex issues, like circular systems.

Another reason to incorporate the circular economy and Zero Waste into EE curricula is their ingrained attitude stance towards circular systems. Building from on the work of Lucas (1979), Barker and Rogers (2004) explored a cyclical model (fig. 4) of teaching *for* sustainability that is able to connects knowledge (knowledge and understanding of the environment and the human impact of people on it), attitudes (values that reflect feelings of concern for the environment), and actions (the processes to that build sustainability). For an effective educational outcome, knowledge, attitudes and actions should not only link to each other but also interact between them.

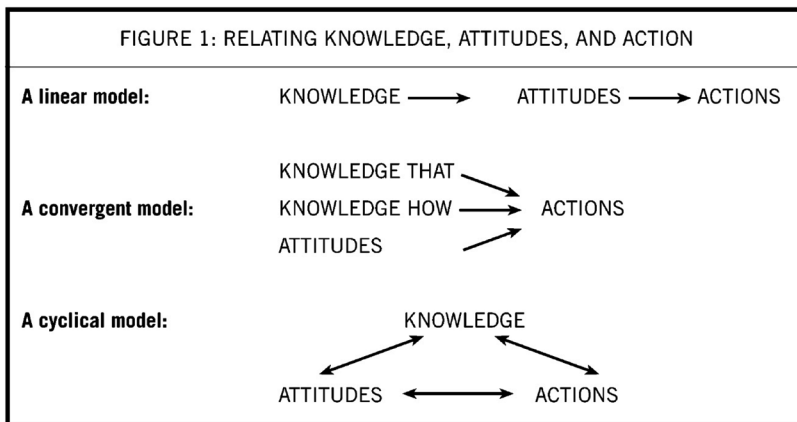


Fig. 4 – Relating knowledge, attitudes, and action.
 Source: Barker and Rogers (2004, p. 16).

Both circular economy and Zero Waste are built conceived in a circular system fashion, not only from a content point of view but as an attitude. In fact, they link already together knowledge, attitudes and actions. Hence, they inherently favour the cyclical model proposed for bringing

about real change. Indeed, circular economy and Zero Waste can help to move *from silos to systems thinking* (Lewis, 2014) that was mentioned earlier, breaking down the existing boundaries between knowledge production, administrative bodies and productive systems, and building a holistic vision of both of the current and future challenges and for the future. In the introduction we highlighted some of the challenges to of implementing education *for the environment* (Thomas, 2005) were highlighted. The challenges of implementing the circular economy and Zero Waste approaches can address them, tab. I summarised the result. Among positive answers them, a crucial challenge that remains is the preparation and training of teachers, a critical aspect in the education system (Postareff *et alii*, 2007), that would need to be trained to this approach.

Tab. I - Challenges of implementing circular economy and Zero Waste in EE.

Challenge	Solution
Knowledge is dangerous and leads to political controversy	Both circular economy and Zero Waste are gaining popular and official acceptance, raising the credibility and reputation of teachers using this approach
Moving from theory to action is difficult; Effective practice calls on teachers to implement practical activities and develop first-hand experience ¹²	Waste is ubiquitous and easy to locate in real experiences. Furthermore, both circular economy and Zero Waste have a solid background of application in the real word. The approach offers strong possibilities for real and effective actions.
Values in EE may conflict with student values and attitudes	The Zero Waste hierarchy provides a solid reference point for new values and attitudes.
Challenges remain in preparing teachers for EE	Provide teachers with training and resources to implement the proposed approach.

Source: author elaboration

In order to pass on to new generations knowledge, attitudes and sustainability practices, EE will play an important role. The ideas of circular economy and Zero Waste can help to develop an education for the environment, both enacting a cyclical model of teaching for sustainability and contributing to solving the challenges of implementing education.

¹² Moving from theory to action, and effective practice have been put together because they address the same solutions.

6. Conclusion

Waste is directly link to our sustainable future (Allon *et alii*, 2020), and circular economy and Zero Waste may help to reach the Sustainable Development Goals (e.g. 2 zero hunger, 6 clean water and sanitation, 9 Industry, Innovation and Infrastructure, 11 Sustainable Cities and Communities, 12 Responsible Consumption and Production¹³ Climate Action). Given its importance, waste, as viewed through the lenses of circular economy and Zero Waste, can be brought into the service of EE, and vice versa.

Despite being hard to map out, all teaching experiences on the ground and circular economy are experienced in some university curricula (Andrews, 2015; Piscicelli, Kirchherr, 2019), and syntheses have already been attempted. However, what is missing are two important aspects. First an in-depth analysis of these experiences. Second, the necessary semantic transformation of the concept of waste. This article contributes to the debate on the education *for* the environment, proposing new perspectives. However, discussion of an actual educational curricula was beyond the scope of this paper. More research is required, both to survey and analyse existing educational practices, before developing new curricula.

Environmental preservation is one of the most pressing concerns of people worldwide (European Commission, 2020b; Ipsos, 2020; Pew Research Center, 2020). At the same time, the terms circular economy and Zero Waste are becoming more widely used.¹³ Given the imperative to avoid environmental catastrophe, this rising popularity opens up key spaces to develop new steps towards real change. Geography can play a crucial role in EE (McKeown-Ice, 1994; Tilbury, Williams, 2002) and given the increasing interest of geographers for circular economy and Zero Waste, this discipline could and should be at the forefront of this effort.

Now is the right time to develop EE in order to help society develop the necessary knowledge, attitudes and actions to confront the challenges ahead of us.

References

- ALLON F., BARCAN R., EDDISON-COGAN K. (eds.), *The Temporalities of Waste*, London, Routledge, 2020.
- ANDREWS D., «The circular economy, design thinking and education for sustainability», in *Local Economy*, 30(3), 2015, pp. 305-315.
- BARKER M., ROGERS L., «“In, about and for”: Exploring the foundations of environmental education», in *Set: Research Information for Teachers*, 2, 2004, pp. 15-18.

¹³ In official documents the EU supports, if only vaguely, Zero Waste and circular economy through education (see European Commission 2005; 2014; 2020a).

- BARR S., GUILBERT S., METCALFE A., RILLEY M., ROBINSON G.M., TUDOR T.L., «Beyond recycling: An integrated approach for understanding municipal waste management», in *Applied Geography*, 39, 2013, pp. 67-77.
- BAUD I.S.A., POST J., FUREDY C. (eds), *Solid waste management and recycling: actors, partnerships and policies in Hyderabad, India and Nairobi, Kenya*, New York, Kluwer Academic Publisher, 2006.
- BEHRSIN I., «Controversies of justice, scale, and siting: The uneven discourse of renewability in Austrian waste-to-energy development», in *Energy Research & Social Science*, 59, 2020, pp. 101-252.
- BEKIN C., CARRIGAN M., SZMIGIN I., «Beyond recycling: 'commons-friendly' waste reduction at new consumption communities», in *Journal of Consumer Behaviour: An International Research Review*, 6(5), 2007, pp. 271-286.
- BODIN E., STAINFORTH T., *First analysis of the European Green Deal*, Institute for European Environmental Policy, 2019.
- BONVIU F., «The European economy: from a linear to a circular economy», in *Romanian Journal of European Affairs*, 14, 2014, pp. 78-91.
- BUFFINGTON J., *The Recycling Myth: Disruptive Innovation to Improve the Environment*, Santa Barbara, ABC-CLIO, 2016.
- CARDOSO J.L., «The circular economy: historical grounds», in DELICADO A., DOMINGOS N., DE SOUSA L., *Changing Societies: Legacies and Challenges*, Vol. iii, The Diverse Worlds of Sustainability, 2018, pp. 115-127.
- CONNETT P., SHEEHAN B., *A Citizen's Agenda for Zero Waste: a Strategy that Avoids Incinerators and Eventually Eliminates Landfills*, Canton, GrassRoots Recycling Network, 2001.
- CONNETT P., *The Zero Waste solution: Untrashing the planet one community at a time*, Vermont, Chelsea Green Publishing, 2013.
- CONWAY T., *I'M Upset: The «Zero Waste» People Must Be Stopped*, 2019 (theoutline.com/post/7500/i-m-upset-the-zero-waste-people-must-be-stopped?zd=1&zi=byavhgtl).
- COOPER T., *Beyond recycling: The longer life option*, London, New Economics Foundation, 1994.
- CUTTER-MACKENZIE A., «Australian waste wise schools program: Its past, present, and future», in *The journal of environmental education*, 41(3), 2010, pp. 165-178.
- CUTTER-MACKENZIE-KNOWLES A., SIEGEL L., «A Critical Cartography of Waste Education in Australia: Turning to a Posthumanist Framing», in So W.W.M., Chow C.F., Lee, J.C.K. (eds.), *Environmental Sustainability and Education for Waste Management*, Springer, Singapore, 2019, pp. 207-220.
- DE JESUS A., ANTUNES P., SANTO R., MENDOÇA S., «Eco-innovation in the transition to a circular economy: An analytical literature review», in *Journal of Cleaner Production*, 172, 2018, pp. 2999-3018.

- DEMIRBAS A., «Waste management, waste resource facilities and waste conversion processes», in *Energy Conversion and Management*, 52(2), 2011, pp. 1280-1287.
- ELLEN MACARTHUR FOUNDATION, *Exploring the circular economy World Largest Lesson*, 2nd, (<https://www.ellenmacarthurfoundation.org/assets/downloads/Exploring-the-Circular-Economy-supports-L2-V2.ppt>).
- ELLEN MACARTHUR FOUNDATION, *Mckinsey Center for Business and Environment, Growth within: A circular economy vision for a competitive Europe*, Ellen MacArthur Foundation, 2015.
- EUROPEAN COMMISSION, *Circular Economy Action Plan: For a cleaner and more competitive Europe*, 2020a.
- EUROPEAN COMMISSION, *Protecting the environment – Eurobarometer survey*, 2020b (ec.europa.eu/commission/presscorner/detail/en/QANDA_20_330).
- EUROPEAN COMMISSION, *Taking sustainable use of resources forward: A thematic strategy on the prevention and recycling of waste*, Brussels, European Commission, 2005.
- EUROPEAN COMMISSION, *Towards a Circular Economy: A Zero Waste Programme for Europe*, Brussels, European Commission, 2014.
- EUROPEAN UNION, «Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives», in *Official Journal of the European Union*, 312(22), 2008, pp. 3-30.
- GEISSDORFER M., SAVAGET P., BOCKEN N.M., HULTINK E.J., «The Circular Economy—A new sustainability paradigm?», in *Journal of Cleaner Production*, 143, 2017, pp. 757-768.
- GHISELLINI P., CIALANI C., ULGIATI S., «A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems», in *Journal of Cleaner Production*, 114, 2016, pp. 11-32.
- GILLE Z., «Actor networks, modes of production, and waste regimes: reassembling the macro-social», in *Environment and Planning A*, 42(5), 2010, pp. 1049-1064.
- GRODZINSKA-JURCZAK M., BARTOSIEWICZ A., TWARDOWSKA A., BALLANTYNE, R., «Evaluating the impact of a school waste education programme upon students', parents' and teachers' environmental knowledge, attitudes and behaviour», in *International Research in Geographical and Environmental Education*, 12(2), 2003, pp. 106-122.
- GROSSE F., «Is recycling “part of the solution”? The role of recycling in an expanding society and a world of finite resources», in *Surveys and Perspectives Integrating Environment and Society*, 3(1), 2010, pp. 1-17.
- GUTBERLET J., «Ways Out of the Waste Dilemma: Transforming Communities in the Global South», in MAUCH C. (ed.), *A Future without Waste? Zero Waste in Theory and Practice*, Munich, RCC Perspectives. Transformations in Environment and Society, 2016, pp. 55-68.

- HAMID S., SKINDER B.M., BHAT M.A., «Zero Waste: A Sustainable Approach for Waste Management», in *Innovative Waste Management Technologies for Sustainable Development*, 2020, pp. 134-155.
- HANNON J., ZAMAN A.U., «Exploring the phenomenon of zero waste and future cities», in *Urban Science*, 2(3), 2018, p. 90.
- HIRD M.J., «Waste, landfills, and an environmental ethic of vulnerability», in *Ethics and the Environment*, 18(1), 2013, pp. 105-124.
- HOGLAND W., KACZALA F., JANI Y., HOGLAND M., BHATNAGAR A., «Beyond the zero waste concept», in *Linnaeus Eco-Tech*, 2014.
- HOORNWEG D., BHADA-TATA P., *What a Waste: A Global Review of Solid Waste Management*, Washington, World Bank, 2012.
- IPSOS, *Most in the U.S. and around the world agree climate change is as serious a crisis as Covid-19*, 2020 (www.ipsos.com/en-us/news-polls/climate-change-earth-day-2020).
- KAZA S., YAO L.C., BHADA-TATA P., VAN WOERDEN F., *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*, Washington, World Bank, 2018.
- KIRCHHERR J., REIKE D., HEKKERT M., «Conceptualizing the circular economy: An analysis of 114 definitions», in *Resources, conservation and recycling*, 127, 2017, pp. 221-232.
- KRAUZ R., *All for naught? A critical study of zero waste to landfill initiatives*, PhD dissertation, Lincoln University, 2012.
- KRAUZ R., HIGHEY K.F.D., MONTGOMERY R., «Zero Waste to Landfill: An Unacknowledged Supermegaproject», in *Linc. Plan. Rev.*, 5, 2013, pp. 10-26.
- LATOUCHE S., *Farewell to growth*, Cambridge, Polity, 2009.
- LEWIS E., *Education for sustainability at a primary school: from silos to systems thinking*, PhD dissertation, Routledge, 2014.
- LIN G.C., KAO S.Y., «Contesting Eco-Urbanism from Below: The Construction of 'Zero-Waste Neighborhoods' in Chinese Cities», in *International Journal of Urban and Regional Research*, 2020, pp. 72-89.
- LUCAS A., *Environment and environmental education: Conceptual issues and curriculum implications*, Melbourne, Australia International Press, 1979.
- MCKEOWN-ICE R., «Environmental education: A geographical perspective», in *Journal of Geography*, 93(1), 1994, pp. 40-42.
- MOORE S.A., «Garbage matters: Concepts in new geographies of waste», in *Progress in Human Geography*, 36(6), 2012, pp. 780-799.
- MURRAY R., *Zero Waste*, London, Greenpeace Environmental Trust, 2002.
- PALMER J.A., «Environmental thinking in the early years: Understanding and misunderstanding of concepts related to waste management», in *Environmental Education Research*, 1(1), 1995, pp. 35-45.
- PALMER P., *History of the Zero Waste systems company*, 2009 (zerowasteinstitute.org/?page_id=202).

- PARRIWUE T., BARTH J., BRIENS F., KERSCHNER C., KRAUS-POLK A., KUOKKAKKEN A., SPANGENBERG J.H., *Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability*, European Environmental Bureau, 2019.
- PEW RESEARCH CENTER, *Environmental Protection Rises On The Public's Policy Agenda As Economic Concerns Recede*, 2020 (www.people-press.org/2020/02/13/as-economic-concerns-recede-environmental-protection-rises-on-the-publics-policy-agenda/).
- PHEIFER A.G., *Barriers & enablers to circular business models*, Brielle, 2017.
- PIETZSCH N., RIBEIRO J.L.D., DE MADEIROS J.F., «Benefits, challenges and critical factors of success for Zero Waste: A systematic literature review», in *Waste Management*, 67, 2017, pp. 324-353.
- PISCICELLI L., KIRCHHERR J., «Towards an education for the circular economy (ECE): five teaching principles and a case study», in *Resources, Conservation and Recycling*, 150, 2019, p. 104406.
- POSTAREFF L., LINDBLOM-YLÄNNE S., NEVGI A., «The effect of pedagogical training on teaching in higher education», in *Teaching and teacher education*, 23(5), 2007, pp. 557-571
- POTTING J., HEKKERT M.P., WORRELL E., HANEMAAIJER A., *Circular economy: measuring innovation in the product chain*, The Hague, PBL Publishers, 2017.
- SAUVÉ S., BERNARD S., SLOAN P., «Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research», in *Environmental Development*, 17, 2016, pp. 48-56.
- SFERRA A., *Obiettivo «quasi zero». Un percorso verso la sostenibilità ambientale*, Milano, Franco Angeli, 2013.
- SIMON J.M., «A Zero Waste hierarchy for Europe New tools for new times: From waste management to resource management», in *Zero Waste Europe*, 2019 (zerowasteurope.eu/2019/05/a-zero-waste-hierarchy-for-europe/).
- SIMON J.M., *Zero Waste Europe*, The Zero Waste Masterplan, Brussels, Zero Waste Europe, 2020.
- SPORK H., «Environmental education: A mismatch between theory and practice», in *Australian Journal of environmental education*, 8, 1992, pp. 147-166.
- STAHEL W.R., «The circular economy», in *Nature*, 531(7595), 2016, pp. 435-438.
- TAHERZADEH M.J., ROCHARDS T. (eds.), *Resource recovery to approach zero municipal waste*, Boca Raton, CRC Press, 2016.
- THOMAS G., «Facilitation in education for the environment», in *Australian Journal of Environmental Education*, 21, 2005, pp. 107-116.
- TILBURY D., WILLIAMS M. (eds.), *Teaching and learning geography*, London, Routledge, 2002.
- VALENZUELA F., BÖHM S., «Against wasted politics: A critique of the circular economy», in *Ephemera: theory & politics in organization*, 17(1), 2017, pp. 23-60.

- WITJES S., LOZANO R., «Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models», in *Resources, Conservation and Recycling*, 112, 2016, pp. 37-44.
- WYSOKIŃSKA Z., «The “new” environmental policy of the European Union: A path to development of a circular economy and mitigation of the negative effects of climate change», in *Comparative Economic Research*, 19(2), 2016, pp. 57-73.
- ZAMAN A.U., «A comprehensive review of the development of zero waste management: lessons learned and guidelines», in *Journal of Cleaner Production*, 91, 2015, pp. 12-25.
- ZAMAN A.U., Lehmann S., «Urban growth and waste management optimization towards “zero waste city”», in *City, Culture and Society*, 2(4), 2011, pp. 177-187.
- ZERO WASTE INTERNATIONAL ALLIANCE, Zero Waste Definition, 2018 (zwia.org/zero-waste-definition/).

Economia circolare e Rifiuti Zero per l'educazione ambientale

Oggi più che mai, l'educazione ambientale è necessaria per far fronte alle sfide ecologiche che derivano da secoli di interventi umani sul pianeta. Due nuovi approcci - economia circolare e Rifiuti Zero - possono contribuire a programmi di educazione ambientale. Il primo si riferisce a un sistema economico non lineare che conserva il più possibile energia e materie prime. Il secondo sottolinea l'importanza di limitare la quantità di rifiuti prodotti. Questo articolo esplora il significato del rifiuto e ciò che economia circolare e Rifiuti Zero potrebbero significare per l'educazione ambientale e, in definitiva, *per* l'ambiente.

Économie circulaire et Zéro Déchet pour l'éducation environnementale

Aujourd'hui plus que jamais, l'éducation environnementale est nécessaire pour relever les défis écologiques causés par plusieurs siècles d'activité humaine sur la planète. Deux nouvelles approches - l'économie circulaire et le Zéro Déchet - peuvent contribuer aux programmes d'éducation environnementale. Le premier est un système économique non-linéaire qui retient autant que possible l'énergie et les matières premières. Le second souligne l'importance de limiter la quantité de déchets produits. Cet article explore la signification des déchets, et ce que l'économie circulaire et le Zéro Déchet pourraient signifier pour l'éducation environnementale et, par extension, *pour* l'environnement.

