

Article

The Role of Universities in Sustainable Development and Circular Economy Strategies

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Abstract: In this article, the conditions and determinants of the introduction and development of the circular economy (CE) in Poland were presented against the background of the widely discussed essence of circular economy, with particular emphasis on the Polish mining sector. In addition, the European Green Deal—an action plan for a sustainable economy for the entire European Union, was discussed. Particular attention was paid to the role of human resources in the area of supporting research and stimulating innovation, and in the area of activating education and training. These issues are further discussed in the next chapter by presenting the forms, ways and scope of education for sustainable development in the international context. Another chapter describes the EIT Raw Materials KAVA 5 RIS competition in Poland (in Kraków) at AGH-UST from 2019 to 2022, an international project in a consortium of four universities whose main objective is to strengthen entrepreneurship in the V4 countries in line with the recommendations of the “Green action plan for SMEs” in a way to meet the requirements of circular economy. The initiatives and trainings carried out within the framework of this project were discussed, and the results of the student survey on the level of knowledge achieved regarding entrepreneurship in the area of the raw materials industry were analysed. The validity and necessity of continuous education in eco-responsible citizenship has thus been confirmed.

Keywords: circular economy; sustainable development; education for sustainable development; Green Deal

Citation: Sukiennik, M.; Zybała, K.; Fuksa, D.; Kęsek, M. The Role of Universities in Sustainable Development and Circular Economy Strategies. *Energies* **2021**, *14*, 5365. <https://doi.org/10.3390/en14175365>

Academic Editor: María Ángeles Martín-Lara

Received: 13 August 2021

Accepted: 26 August 2021

Published: 28 August 2021

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1. Introduction

Changing the current direction of the European economy from a linear to circular economy can only be achieved by implementing the principles of a sustainable economy and vice versa, as a circular economy is the path to sustainability. Education is a basic prerequisite for achieving sustainable development and a key tool for achieving this goal. An education should link and balance the three spheres of thinking: economic, social and environmental, and that requires interdisciplinary teaching. Additionally, it is not only about imparting theoretical knowledge, but above all about shaping pro-ecological attitudes, not only in individuals but in whole societies. Although the prevailing view is that education for sustainable development is broad in scope and for the circular economy narrow in scope, it should not be separated. Education must take place at the highest levels of key issues and quality [1].

This article brings a reader closer to the essence of circular economy and discusses in this context the conditions and determinants of the introduction and development of the circular economy in Poland, with particular emphasis on the Polish mining sector. In addition, the European Green Deal—an action plan for a sustainable economy for the entire European Union—was discussed. The role of human resources in the area of supporting research and stimulating innovation, and in the area of activating education and training,

were emphasised. These issues are discussed more extensively in the next chapter characterising the role, forms and scope of education for sustainable development in the international context. Another describes the ongoing EIT Raw Materials KAVA 5 RIS competition in Poland (in Kraków) at AGH-UST from 2019 to 2022, an international project in a consortium of foreign universities whose main objective is to strengthen entrepreneurship in the V4 countries in line with the recommendations of the “Green action plan for SMEs” by the European Commission in 2014, in a way to meet the requirements of a circular economy. Actions, initiatives and trainings carried out within the framework of this project were discussed, and the results of the student survey on the level of knowledge achieved regarding entrepreneurship in the area of the raw materials industry were analysed.

The authors express the view that the role of universities in shaping pro-ecological attitudes, engaging the community in sustainable development activities or finally living in accordance with the principles of the circular economy is important. To prove this, the Limbra project and its impact on the awareness of participants in this task were analysed. The role of universities in the life of societies on a global scale is beyond dispute. In the case of shaping the foundations for higher ideas, which include sustainable development and the circular economy that follows it, education and systematic change in the concept of the functioning of the world and people seem to be naturally fulfilled by universities. Their mission, inscribed in the statutes of universities, is to shape the foundations of society. This is a new role of universities, resulting from the constantly changing world, but in the opinion of the authors, important and necessary to implement, which is also a kind of novum.

2. Materials and Methods

2.1. Circular Economy as a Contemporary Trend in Life

Nowadays, caring for the environment is situated at a high level. At present, the use of raw materials has an adverse effect on the environment, which is why it is so important to keep them in the economy for as long as possible. The appropriate use of resources and the maximum reduction of their adverse impact on the environment are the main objectives of the circular economy. We identify the circular economy as the consumption of resources through the minimisation of waste, the preservation of their value for as long as possible and, above all, closed cycles in the use of necessary raw materials [2] (Figure 1).

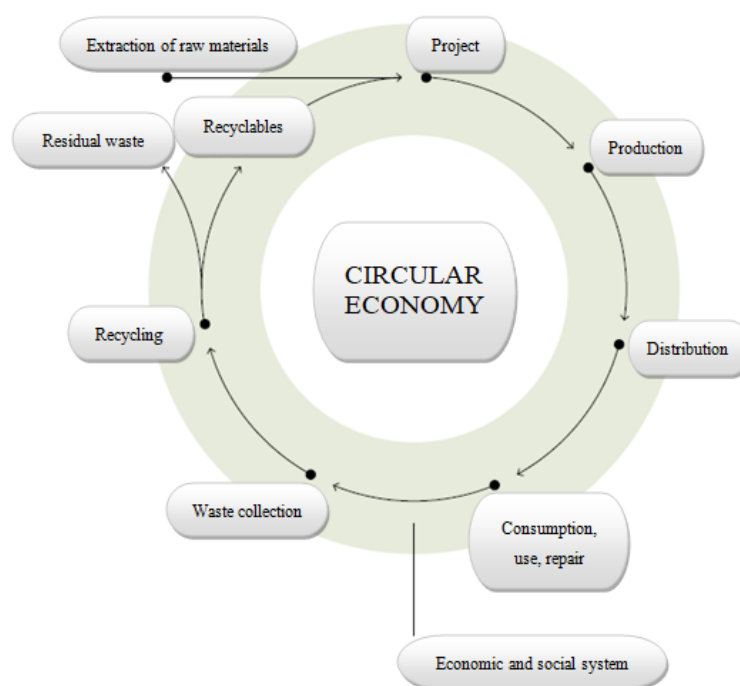


Figure 1. Diagram of circular economy, source: own study based on [1].

When defining the circular economy, the description provided by the Ellen MacArthur Foundation [3] is quoted most often: “circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models” [4].

The definition indicates that initiating action and implementing the principles of circular economy should be a priority. In Poland, it is necessary to define these activities as economic development with appropriate economic and legal instruments, by using indicators to monitor the progress of its implementation and relying on the latest IT solutions. The global development model is based on two main assumptions:

1. The added value of raw materials, materials and finished products is maximised along the value chain (from designer to consumer).
2. Waste generated is minimised, while waste arising is managed in accordance with requirements (prevention of large quantities of waste, preparation for re-use, recycling and disposal) [5].

In the circular economy model, the use of raw materials from secondary sources was pointed out. The proposed solutions address many areas of economics, energy efficiency, increased repair and reuse services, the imposition of producer responsibility rules and the assessment of the durability and lifespan of a product. All proposals are geared towards expanding recycling. Introducing the principles of circular economy into a company contributes to the development of new jobs, expands access to raw materials and favours the environment [6].

The idea of the circular economy requires a great deal of investment, but also legislative and organisational measures. All recycling activities must go through the required waste procedures. This is providing quite a bit of control over raw materials, but it definitely hinders the work of developing economic symbiosis [6].

2.2. Circular Economy in Poland

Poland is implementing the circular economy system very slowly. This is due to the diversity of organisation of each group seeking to implement the changes. The solution may be to build an international system for implementing a circular economy in Polish enterprises, so that the scheme is based on one main strategy and at the same time incorporates all the principles of the economic cycle. The European Environmental Bureau has introduced a project aimed at creating this strategy, entitled “Poland’s way to circular economy” [1]. The project was co-developed with experts specialising in selected stages of the product life cycle, from the sourcing of raw materials to the production, sale, consumption and management of residual waste. In addition, representatives of the social economy, a sociologist and a clergyman were involved in the development of the project. It is very important to keep excluded groups, social capital and cultural orientations in mind when intending to overhaul the current system and create a new plan. Each conversation that takes place is multifaceted but focused on a single objective. An international project developed by a group of experts and the advice of individual groups is an additional guarantee of reliability and can already illustrate the challenges you face when entering the circular economy during the planning phase. Figure 2 presents the diagram of striving towards the circular economy [7]. The exit from the linear structure leads to a reuse economy that aims to close the circle. The Reuse Economy uses only recyclable materials in its design.

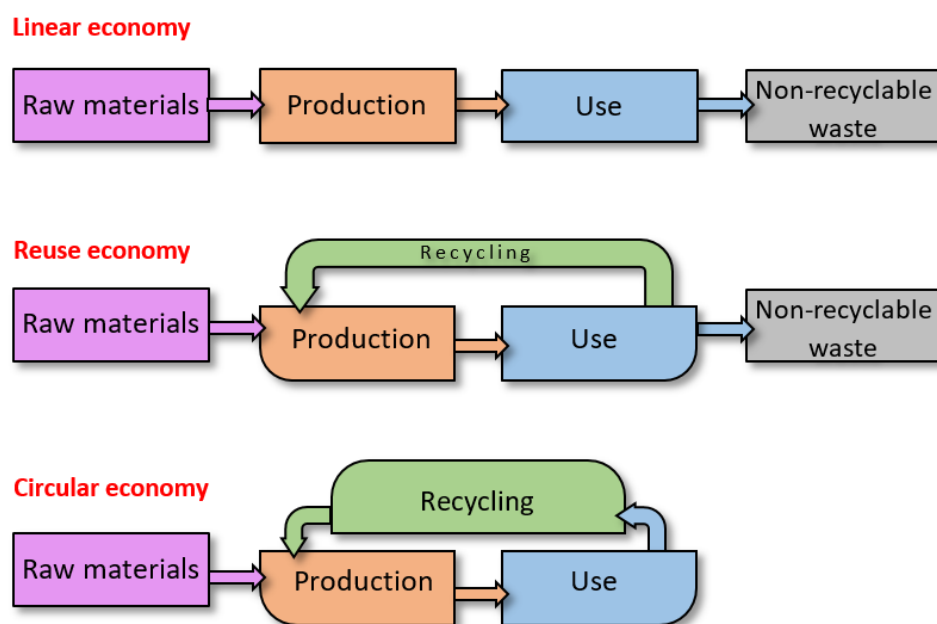


Figure 2. Diagram of linear and circular economy; source: own study based on [8].

The development of the circular economy in Poland will largely depend on the decisions of stakeholders. The attitude of local government officials to the new rules may influence positively or negatively the further development of the circular economy in all organisations and enterprises. In addition, the opinions of stakeholders often influence the decisions of the government, which may be guided by their views in taking further action. There has been a lot of support for the circular economy idea from both sides so far. The idea of circular economy is supported, above all, by critics of the current system existing in Poland, the so-called linear economy, which, in short, means extraction, then use, and finally the discarding of a given product [9].

Summarising all the planning and research on the circular economy model, we can conclude that it is no longer a mere concept but a fundamental economic model. The circular economy system has been developed in the ISO standard and other documents of international organisations. All assumptions point to one goal—to minimise resource consumption along the value chain. It is important to remember that achieving the goal also focuses on parts of the entire value chain, starting with the introduction of waste management or source technology solutions. The introduction of the circular economy into the European Union has greatly increased the number of its definitions. Currently, the concept is comparable to clean production, sustainable development, industrial parks and a zero-waste strategy. Noting the considerable number of understandings of the circular economy, the following one should be the most important: [10].

1. Maximum extraction with minimum waste. Industrial reuse and recycling, i.e., moving towards the complete closure of material cycles.
2. The introduction of circular economy assessments in the value chain, which includes both suppliers and customers of a specific product and is the basis for creating cyclicity and new business models, which should be based on cooperation and responsibility between actors. The design phase plays the most significant role in this case, while the objectives of circular economy should be included as criteria for project evaluation.
3. Seeking a solution that contributes to economic development while minimising environmental impact. The action requires policy support and continuous promotion of new economic and environmental methods.

4. Circular Economy linked to innovation and new environmentally friendly technologies.

New technologies in various fields of science are making the move towards Circular Economy increasingly innovative. There are often barriers that need to be resolved in terms of purchasing practices, scaling rules and financial models, and then guided by cities and industry towards Circular Economy [11].

Reports and studies that have been prepared for corporate financial models may initially show that economy generates higher costs, given its pioneering nature, but the return on investment and productivity may ultimately prove to be much higher. Public procurement is an instrument that can decisively support the move towards the circular economy. With their help, cities or communes will be able to influence the market and at the same time stimulate production and service provision in line with the idea of the Circular Economy. Projects targeting public procurement typically include maintenance and repair, while also creating long-term relationships with the use of new business models. Such actions lead to competition with companies offering services in the idea of a linear economy. Companies should indicate a strong interest in reuse, repair and recycling. The willingness to move in this direction is constantly growing, however there is still a lack of research on the evaluation and indicators of the circular economy at the micro level [12].

2.3. Circular Economy in the Polish Mining Sector

Mineral resources are the basis for the development of the world economy and, as a result, the demand for them is constantly increasing. It is important to note that as the extraction of mineral resources increases, the range of mineral processing increases and the amount of mining and processing waste increases. Poland is one of the largest producers of post-mining waste; 11.2% of this waste is generated here in relation to the whole world. In addition, the management of mineral resources depletes resources in existing sources. This has to do with a linear production model, so attention has been focused on appropriate waste management, resulting in a circular cycle of extraction and processing of raw materials [13].

The mining system contributes to the rapid economic and social development of the region. However, then again, it causes negative impacts on the environment (e.g., water and landscape). The exploitation of mineral deposits is usually accompanied by the extraction of waste rock. This activity is noticed in the form of landfills on the surface of the land, which occupies agricultural and forest areas, while posing a threat to water and soil quality [14].

The formal and legal regulations applicable in Poland governing the handling of mining waste oblige the mining company to subject it to recovery processes. If this is not possible or cannot be economically justified, the waste may be disposed of in dedicated facilities. The polluter is obliged to obtain a permit to operate a separate extractive waste facility and to keep ongoing quantitative and qualitative records in accordance with the waste catalogue. In view of the waste produced by the mines and the amount of landfill, it is reasonable to look for possibilities to manage it. In relation to mining, the main objective of circular economy is to explore the possibility of effectively returning the raw materials accumulated in the waste to the mining industry [15].

In mining, KGHM Polska Miedź SA is the largest domestic producer of waste. The waste generated can be divided into two categories: waste resulting from mining activities and ore processing, which accounts for approximately 92% of all other waste. There are numerous difficulties in introducing different ways of using waste. The copper industry can leave behind large stockpiles of materials that may become useless ballast for the environment, or become the raw material base of the region for future use [16].

All phases of mining activities impose burdens on the investor or plant owner to obtain the required permits for waste collection. Given how much is produced in mining, it

is imperative that they are minimised or eliminated altogether through a circular economy. Work related with the circular economy should be undertaken during joint change and co-created with other industries. The orientation of new solutions and technologies should result in the efficient use of waste [16].

2.4. Industrial Strategy in the Green Deal

The assumptions of the European Green Deal involve actions carried out by each country towards the achievement of common EU goals, in view of the findings that Europe needs a new strategy for growth in order to transform the Union into a modern, resource-efficient and competitive economy. The basic assumptions are presented in Figure 3.

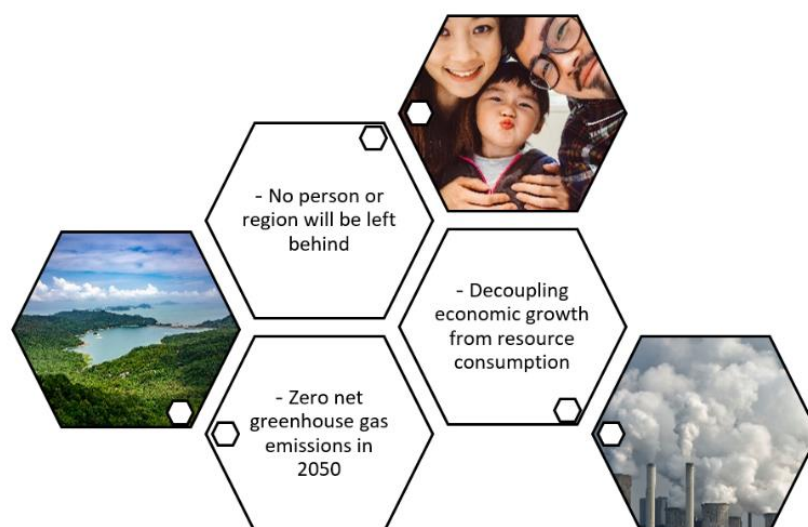


Figure 3. Diagram presenting linear and circular economies, source: own study based on [17].

The European Green Deal is defined as an action plan for a sustainable economy for the entire European Union (Figure 4). The document states that this effect can be achieved by transforming climate and environmental challenges into new opportunities, but in all policy areas. It is also explicit that this transformation should be equitable and inclusive [18].

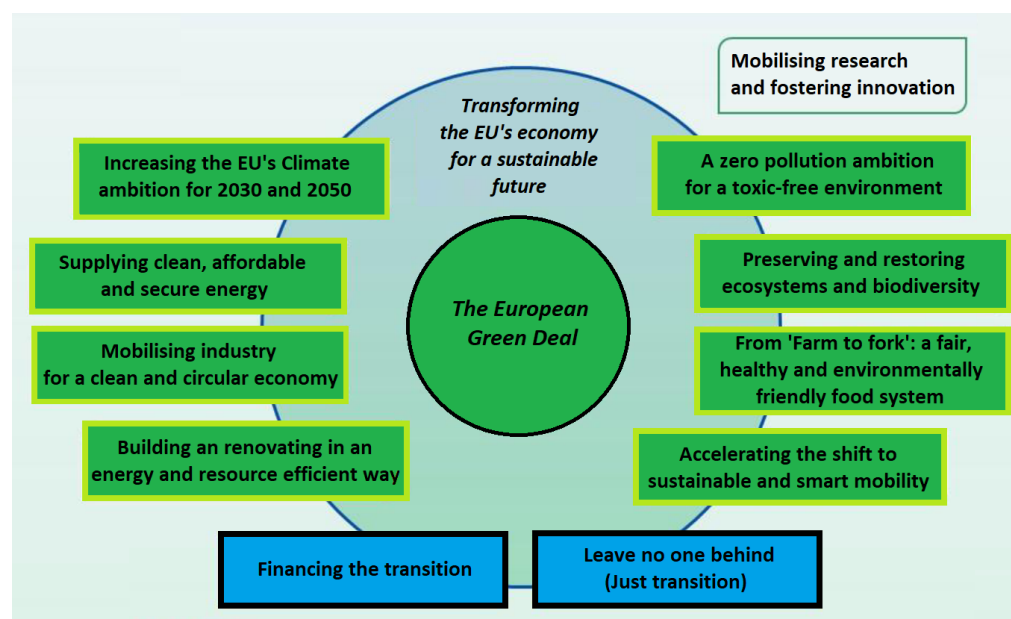


Figure 4. The European Green Deal, source: own study based on [17].

One of the areas where the provisions of the European Green Deal will be of particular importance is action relating to the provision of clean, affordable and secure energy. The general assumptions in this area are guided by the following provisions [17]:

- Further decarbonisation of the energy system is key to achieving the 2030 and 2050 climate targets;
- Member states will submit their revised energy and climate plans by the end of 2019 and the Commission will assess the level of ambition of these plans and the need for additional measures if the targets set are insufficient;
- The transition to clean energy should involve and benefit consumers. Renewable energy sources will play a key role. The intelligent integration of renewable energy sources, energy efficiency and other sustainable solutions in all sectors will allow decarbonisation at the lowest possible cost;
- Measures should be implemented in order to protect from energy poverty those households that cannot afford to acquire necessary energy services to ensure a basic standard of living;
- Achieving climate neutrality also requires smart infrastructure. Increased cross-border and regional cooperation will help reap the benefits of the transition to affordable clean energy [18].

Allowing for the Issue of Sustainable Development in All EU Policies

Achieving the intentions set out in the European Green Deal requires considerable investment, both in terms of investment and human resources. By focusing on human resources, the authors mean actions that are well thought out and dedicated to particular objectives. In terms of the Green Deal provisions, the special role of human resources is relevant in two areas: supporting research and stimulating innovation, and activating education and training.

In the area of supporting research and boosting innovation, the assumptions bringing us closer to the Green Deal include new technologies, sustainable solutions and innovation. This challenge will often be beyond the capacity of individual Member States, but Horizon Europe is here to help. Together with other programmes, it will play a crucial role in stimulating domestic public and private investment. At least 35% of the Horizon Europe budget will be used to fund new climate solutions that are relevant to the implementation of the Green Deal. The European Innovation Council will allocate funding and capital investment and provide business acceleration services to high-potential start-ups and SMEs to support them in achieving breakthrough innovations in the Green Deal that can be rapidly scaled up in global markets. Therefore, trainers, teachers and coaches have an important role to play; strengthening the awareness of potential investors of the idea of the circular economy will contribute to the subsequent operation of start-ups that are circular.

With regard to the activation of education and training, the measures taken should provide measurable results. It is assumed that schools, training institutions and universities are well prepared to work with students, parents and the wider community on the changes needed for successful transition. A European competence framework will be prepared on the EU side to help develop and assess knowledge, skills and attitudes on climate change and sustainable development. It will also provide support materials and facilitate the exchange of good practice within EU networks of teachers training programmes.

Proactive re-skilling and up-skilling is required to derive benefits from environmental transition. The proposed European Social Fund will play an important role in helping European workers acquire the skills they need to move successfully from declining to growing sectors and to adapt to new processes. The Skills Agenda and Youth Guarantee will be updated to increase employability in the green economy [17].

2.5. Aim and Objectives

The aim of this publication is to indicate the importance of the role of universities in shaping the way to achieving the goals of sustainable development and the principles of the circular economy. The goals and principles in legal acts are not always easy to implement in the life of the wider community. In Figure 5, the authors present the process of making the individual elements of societal organization aware, including the role and place of universities.

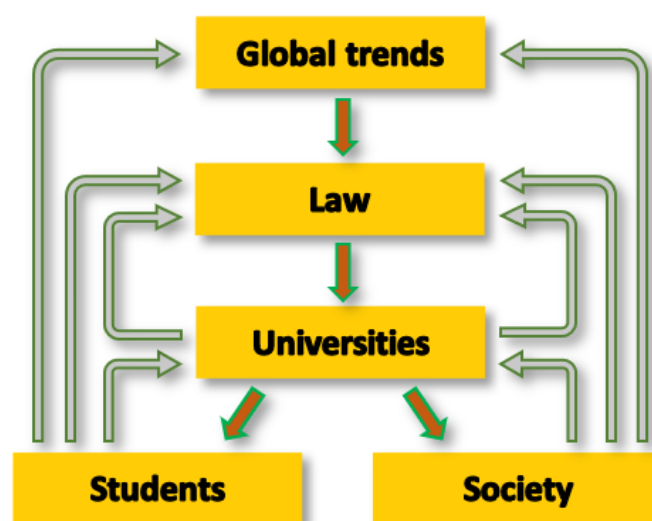


Figure 5. Diagram of propagation elements of development and principles of the circular economy.

Activities leading to the achievement of the chosen goal were shown on the example of UST AGH, a university located in Krakow. At the Faculty of Civil Engineering and Resource Management, an analysis of the activities undertaken by the university was carried out to educate students in the field of sustainable development and the principles of the circular economy. As shown in Figure 1, the role of universities is important. Universities are the most common promoters of new ideas, and the reputation they have allows them to more easily reach both students and the general public.

3. Results

3.1. The Essence and Role of Sustainable Development in Education for the Whole World

Sustainable development is one of the most important goals of the modern world to be achieved, but a very broad concept as well. It can therefore be seen multidimensionally, as a harmonious growth process relating to all spheres of human functioning. This growth must respect the external (natural) environment. The idea of sustainability is often associated with the world of business and economics and brings with it a huge range of issues that should be used in teaching processes. This includes current social issues such as the world of values, tolerance towards disparities, the phenomenon of exclusion, and harmonious individual and social development. Many of the solutions developed under the concept of sustainability in development are of interest to education. Therefore, the concept of sustainable development should inspire the development of new content in education in its broadest sense, and thus influence the development of its research field, since the idea became global in its range [19].

The concept of sustainable development is also underpinned by an ethical framework, i.e., the need to take into account the equal right of others to use natural resources as they are given. This care for the environment and its resources should stem from the idea of social justice, in which differences in culture, nationality, economic and political

systems and geographical location disappear. It should also be stressed that the idea of sustainable development must involve a change in thinking, namely a change in the logic of planning for the future. It is about moving away from the economic dimension to value creation [20], or the shared responsibility and solidarity of present and future generations [21].

The need to harmonise the sphere of economic and social life, and in particular the problems of rational and harmonious development, has become the focus of education at various levels. Education is essential in developing mature attitudes of eco-responsible citizenship, and is the most important and effective way to promote and disseminate the idea of sustainability.

The first international decision on environmental education was the establishment at the United Nations conference in Stockholm in 1972 of an international programme of school and out-of-school environmental education of an interdisciplinary nature. In 1975, the Belgrade Conference adopted the International Charter on Environmental Education—the so-called Belgrade Charter—which set out the objectives of environmental education and the provisions indicating the need to include it in all teaching systems. At the Tbilisi Conference, in 1977, the tasks of environmental education were clarified and the authorities of UNESCO member states were obliged to include in their educational policies environmental education programmes, both formal and informal, for all age groups and to provide the necessary resources for their implementation. At the United Nations Earth Summit in Rio de Janeiro in 1992, “Agenda 21” was adopted, which advocated the necessity to provide all people with an access to environmental knowledge. It emphasised that environmental protection, economic growth and human development are interdependent and mutually shaping. In 2002, the UN General Assembly proclaimed the Decade of Education for Sustainable Development 2005–2014, which emphasises that education is to become a key enabler of desirable transformations relating to human development.

It is clear from this that an essential condition for achieving sustainable development is the environmental education of societies. Education for Sustainable Development (ESD) today should include in its programmes the impact of human activity on the environment and the resulting consequences, and above all raise the environmental awareness of children and young people and society as a whole. This is an education with an interdisciplinary dimension, carried out from the earliest years until adulthood, and, importantly, it is a continuous process. It should include, in addition to society as a whole, all groups of the population, including professional and social groups whose activities have a significant impact on the environment and scientific workers and professionals with natural and social interests related to the environment [22].

ESD is a very complex process and should be carried out with the active participation of the whole community. It should be based on the continuous acquisition of knowledge from various fields of science and life, encompassing the totality of knowledge about the environment and the social and economic development of the country and the world. One of its superior aims is to educate future generations in a climate of respect for the environment, and to demonstrate a particular understanding of sustainable development [19].

It is important that education for sustainable development is an integral part of general education. ESD issues include how to solve problems that threaten life on our Earth, such as the protection of natural resources, culture, poverty reduction, gender equality, social tolerance and economics. It is postulated that the education process, within the ESD, should start at the general school stage and end at higher education. However, the field of beneficiaries of global education in its broadest sense should also include adults and working people, in which case EDS will be integrated into a programme of continuing education. In contrast, EDS should cover all sections of society. It is important that the programme covers executives, senior management, commercial directors and industry managers [23].

Education for sustainable development should also be cultivated in the field of adult development (andragogy), as part of the concept of lifelong learning. Third-age university

students are usually pensioners and people involved in local community activities at an institutional level. It is necessary to provide them with knowledge about current social problems in the global and local dimension, as well as to use their competences in this field. Most of them devote time to social activities, so these people can competently spread new ideas by reaching out to the communities in which they work, encouraging a change in thinking in terms of sustainability [19]. Thus, educational institutions should become centres for the transmission of values on which future generations will build a sustainable world. All these activities will increase public awareness and understanding of what the ESD initiative is.

The concept of sustainable development can also be made more attractive to the domestic education system. Subjects such as basic entrepreneurship and economics, with an emphasis on practical issues, are part of the incentive for young people to take action to increase their competitiveness in the changing labour market. Information should be provided on the changing profile of employment, using auxiliary institutions and agencies for this purpose. We are talking about careers advice centres or career offices (universities). Such centres enable graduates to plan individual paths for their career advancement. It can be concluded that these are suitable places for the realisation of postulates resulting from the idea of sustainable development [19].

Education is effective when it is based on up-to-date curricula and delivered with quality. This requires a continuous reform of the ESD curricula relating to all levels of school education. Such reforms should be accompanied by adequate investment in teacher training to develop the skills necessary to operate effectively using contemporary pedagogical methods. This can include peer-to-peer educational programmes and learning outside the classroom, changing classroom dynamics (placing students as creators of learning), and combining theoretical knowledge with action.

The special role of higher education in the ESD should also be highlighted. This level of education is responsible for shaping the abilities and mentality of most professionals in key positions. Higher education undeniably makes an important contribution to accelerating the required change through teaching, applied research, and collaboration with industry and student organisations. Higher education institutions are able to extend ESD teaching beyond the lecture theatre; they can actively promote the ESD mindset by running ESD-related study circles or, for example, a waste-free canteen initiative. In addition, universities can enter into partnerships with local businesses and industry, obtaining mutual benefits and introducing the ESD framework directly at a local and regional level. Investment in research into methods of implementing sustainability and transformation at a larger scale will multiply the benefits listed, as well as the number of beneficiaries. The creation of a fund for students and researchers to start their own sustainable projects is an excellent solution. Another solution is for universities to organise postgraduate studies and courses for teachers, administrative staff, journalists and other people with responsibility and interest in environmental issues. Universities should publish and promote textbooks and scripts that deal broadly with environmental issues, highlighting development as seen in social, economic and cultural terms [24]. Innovative approaches to education can help shape future citizens with greener attitudes and more sustainable habits.

To summarise, education for sustainable development should consist of continuous education not only for children and young people, but also for adults. These activities should be carried out by adequately prepared groups of educators and be included in a well-thought-out system involving cooperation with schools, universities and NGOs. ESD should cover every scope and all levels of formal and non-formal education, and be interdisciplinary and intergenerational [24].

3.2. The Limbra Project as an Action for Circular Economy

From 2019 to 2022, within the framework of the EIT Raw Materials KAVA 5 RIS competition, an international project in consortium is being implemented in Poland, in Kraków, at AGH-UST: University of Miskolc (leader), AGH-UST, Technical University of Kosice, Tecnalia Ventures, S.L., Sociedad Unipersonal, Fundación Tecnalia Research & Innovation, VŠB—Technical University of Ostrava. The main objective of this project is to strengthen entrepreneurship in the V4 countries in line with the recommendations of the “Green action plan for SMEs” in a way to meet the requirements of the circular economy.

This project approaches the problem of brain drain with complexity thinking and offers multilevel solutions: with SME development training, and with other events, we improve undergraduate and postgraduate engineering students’ entrepreneurship knowledge with regard to the special needs of generations Y and Z and to the changing demand for skills. The motto of the project is: “Be a stay-at-home entrepreneur”!

People with higher qualifications make up ca. 20–25 percent of the outward migrant population in the ESEE region, and this figure is even higher in the industrial sector, with special regard to the raw materials subsector. Here, we note that under the term ‘raw materials sector’ we mean not only the group of companies that take part in the discovery, development and processing of raw materials, but the academic sector, research centres and other non-profit organizations linking directly or indirectly (i.e., offering services, educating the workforce of the future) to these companies as well. It covers the entire value chain of raw materials, and therefore exploration, extraction, processing, refining, re-use, recycling and substitution. The overall objective of LIMBRA is to limit brain drain in the raw materials sector and to enhance the entrepreneurial activity in the Visegrád Four countries. It targets the currently untapped entrepreneurial potential of those young undergraduates and postgraduates (in Bachelor and Masters courses which are related directly or indirectly to the raw material sector) and career starters, some of whom would probably consider going to work abroad.

The periphery-sending countries are located in the ESEE region and, with regard to the V4, it can be stated that Poland, Slovakia and Hungary are mobility promoter countries; the Czech Republic is a mobility faller. In this region the theory of subjective well-being can partly provide a solution to the problems described above. Recent studies on mobility emphasize not only the high levels of emigration among highly skilled people, but the fact that this group is overrepresented in return migration as well. The research studies on student mobility and skilled migration show evidence that international students are likely to stay in their origin country after finishing their studies (because national identity is revaluated). Using this conclusion, we combine three programmes to reduce the negative outcomes of the brain drain. Firstly, entrepreneurial skills need to be improved via short training courses for undergraduate and postgraduate engineering students (and to career starters). The goal of the programme is to train professionals and develop their knowledge on the main fields of business life, and to take a strategic approach to ensure the development and sustainability of their enterprises. The programme would also like to enhance progress in the participants’ careers and motivate them to start their own business, just as it promotes the advantages of being an entrepreneur through mentoring and support.

Secondly, the culture of family business (our motto is “Be a stay-at-home entrepreneur!”), has to be promoted via wider society learning and promotion programmes. Thirdly, we give international experiences to the participants as well, recognizing that higher education should focus on real life problem solving by students to support the “youth on the move” and “an agenda for new skills and jobs” initiatives by enhancing the performance of the education system, facilitating the entry of students to the labour market and developing students’ skills in real life cases. In this subprogramme, students coming from different countries will work together on a product design or technology, creating a business plan and finally making a presentation.

The participants of different WPs, obtaining basic business knowledge and starting their own small companies, become committed to taking part in further projects and

events. They will be part of the regional innovation ecosystems. In the long run, the SMEs' activity increases and contributes to further innovation initiatives. At the end, based on the results and experiences obtained in the Centers of Excellence (in Miskolc) and LIMBRA, synergic effects will arise, and in the long run the innovation activities will improve in the peripheral regions.

3.3. The Limbra Project and Its Impact on Higher Education in Circular Economy

As part of the implemented project, a number of related activities were carried out in Poland. These activities can be divided into two groups:

1. Research-related activities for the benefit of resource economies in Poland.
2. Activities related to promoting and fostering the circular economy among students, pupils and local communities.

In group one, a report was developed to find a market gap in the area of minerals in Poland. To this end, the following activities have been carried out:

- an in-depth analysis of the mineral resources market in Poland;
- a PESTEL analysis was carried out for the raw materials market in Poland;
- an analysis of business activity profiles according to the Statistical Classification of Economic Activities in the European Community (NACE) was performed to identify those areas where activities are related to the mineral resources market in Poland;
- analysis of data from the Raw Materials projects carried out in Poland (based on four databases);
- a keyword analysis was carried out on selected projects to identify those which were/are the most popular;
- aggregation of relevant keywords to NACE areas of activity;
- current trends (we mean here the market gap) in the raw material industry in Poland are indicated;
- a PESTEL analysis was carried out for the diagnosed gap;
- a survey was conducted among students of raw materials industries to ask about their knowledge of the raw materials industry and their desire to remain in a career in this area;
- an analysis was made of selected economic actors operating within the diagnosed gap, in order to find out the "inner voice" of the actors present on the market.

Within the framework of these measures, the IT area in the raw materials industry was singled out in the first place as a market gap, i.e., an attractive area for new businesses. Next, positions in the analysis were occupied by the Internet and business. They are complementary, so to speak, to the IT that emerged in the first place—the Internet is closely related to it, and in the face of the prevailing pandemic it has probably become even more important for doing business in every industry, including the raw materials industry. Additionally, the keyword business has such a broad application that it encompasses all processes related to business. You can read the report here: [25].

As part of the activities carried out in connection with promoting and fostering the circular economy among students, pupils and local communities, the following were and are being implemented:

1. In 2020, the summer school "Entrepreneurship in the Raw Materials Industry in Poland" was conducted at AGH UST. During the classes, a group of AGH-UST students learned about issues related to the Polish raw materials industry. The classes were conducted by both Polish and foreign lecturers and the business side. The lecturers represented world-leading players in the raw materials industry: University of Miskolc, Hungary; Fundación Tecnalia Research & Innovation, Spain; TUKE—Technical University of Kosice, Slovakia; VŠB—Technical University of Ostrava, Czech Republic; PBI Group Poland, Polish Mining Group, City of Kraków and of course AGH University of Science and Technology. Examples of topics discussed during the classes are as follows:

- How to establish a company? Experience from Czech Republic;
 - Start-up my own experience (Slovakia);
 - How to create high impact innovation teams?
 - How to set up a Start-up—guide;
 - Academic entrepreneurship;
 - Creation of Spin-off companies;
 - Financial Analysis of a Business Activity—selected aspects;
 - Characteristics of the mineral raw materials market in Poland;
 - Innovations in the Raw Materials in Poland—selected aspects;
 - Corporate Social Responsibility in Raw Materials in Poland.
2. Thematic Event is a series of meetings open to a wide audience: in 2019 and 2020 it was Scientists' Night, in 2021 Earth Day. In the year 2019, open classes titled "The Future of the AGH-UST" were conducted in the AGH-UST buildings:
- Earth Treasure Hunters—everyone wants to be like Indiana Jones and go on a journey to the interior of the earth. Welcome adventurer! Does treasure always have to be shiny and expensive? During the activities, children will be able to see, touch and carry out simple experiments with rocks and minerals used to make everyday objects. Little explorers will learn how to grow crystals themselves at home. Sounds serious, but it's so easy! Our scientists have prepared numerous tasks and experiments for you, but beware the treasure is at the end of the journey;
 - Lean Management Laboratory—as part of a workshop on Lean Management, a simulation of a production process, e.g., with Lego, Enigma, is planned. Teams of six people will be invited to take part in the simulation. Their task will be to design and arrange the production process (according to the given initial assumptions) in such a way as to achieve the best possible results, i.e., the highest possible profits, during the simulation of this process. Participants of the workshop will have the opportunity to gain not only theoretical knowledge, but will also learn how to improve their own work, creating solutions for more efficient use of resources, energy, space and time. During the workshop, participants will develop the skills of cooperation and teamwork, as well as team communication, creativity, logical thinking and consistent working time organization;
 - Sensory Laboratory—for the participants of the Małopolska Researchers' Night, laboratory activities are planned in the sensory laboratory of SKNZ, where participants will perform consumer tests on food products. Each participant will receive approximately 4 samples of the same type of foodstuff (depending on the budget it could be chocolate, drinks, cakes, etc.) and a questionnaire to collect detailed opinions. The participants will make judgements using their senses (smell, taste, sight, touch, hearing). The research will be supervised by members of the Management Student Academic Circle, who will later analyse the results.
- In 2020, due to the pandemic and the ban on assemblies in force at the time, the same events were held remotely. In 2021, the web conferencing under the name "A DAY BEFORE EARTH DAY! BE READY ...", was also open.
3. During the Intensive Contact Week, AGH-UST students gained knowledge about project management and the development of innovative solutions. This week-long event marks the beginning of the work of the REAL-LIFE PROBLEM-SOLVING TASK, a project to solve a manufacturing problem presented by a Raw Materials industry. The case, on which members of 4 European universities (Poland, Czech Republic, Slovakia, Hungary) are working, was presented by Lafarge company. The task concerns the search for alternative raw materials for the production of cement clinker. The project will end in December this year and will be summarised at an online meeting. The final result will be four solutions proposed by each team.

4. Mentoring programme—this activity runs from March 2021 to January 2022. It is carried out under the slogan: Become an active entrepreneur in Poland! Within this activity, five AGH-UST students have to develop a business plan for their idea, which concerns a business activity in the area of mineral resources. Students are mentored and trained in the ranges needed to build a business plan. The ideas, submitted by students, are:
 - LEMon—creation of an institution providing and developing Lean Management solutions aimed at improving the economic and environmental efficiency of enterprises from the broadly understood;
 - CERM—circular economy of raw materials;
 - RawCluster—creation of a cluster supporting the raw materials industry;
 - SaPla—project of a sales platform for the raw materials market;
 - ARMoDiM—analysis of the activities of raw materials companies in the field of digital marketing.

4. Discussion

Effects and Changes in Awareness Observed through Activities within the Limbra Project

As described above, one element of the project was the Summer School. The final element of the school was an evaluation survey, with the aim of determining its effectiveness. Respondents answered questions such as: How would you rate your level of knowledge on raw materials entrepreneurship before the summer school? How would you rate your level of knowledge on raw materials entrepreneurship after the summer school?

Respondents were asked to answer on a scale of 1 to 5. Eighteen people responded to the survey. The average value for the first question cited was 2.28, while the mean score for the second one was 4.11. Thus, it can be considered that the average increase in the assessment of the level of knowledge of entrepreneurship in the area of the raw materials industry was 1.83. The detailed distribution of the increase in respondents' self-esteem is shown in Figure 6.

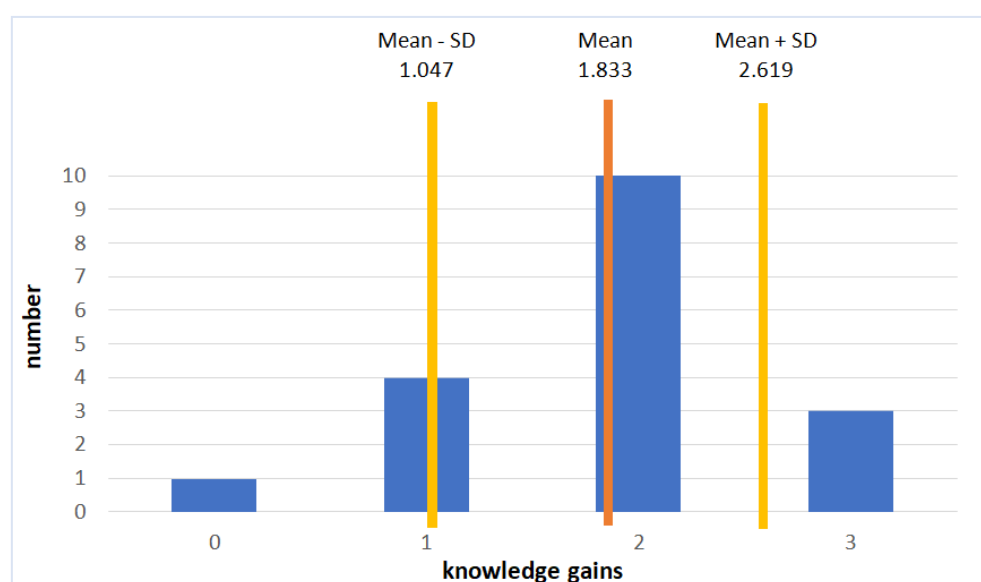


Figure 6. Histogram of gains in knowledge by self-assessment by the learners.

The largest number of participants (10 persons) assessed the increase of their knowledge in the field of entrepreneurship in the area of the raw material sector as 2 points on the adopted scale; in the opinion of one person, the training did not give him/her

any additional knowledge, and in the case of three persons the increase was as high as 3 points.

The determined standard deviation (0.78) indicates a small spread, so the vast majority of the training participants clearly increased their knowledge of the commodity industry (by an average of 1.83 points on a scale from 1 to 5). The determined increase in the self-assessment of the learners' knowledge was confronted with the answers to an additional question: How would you rate your activity during class?

As a result of this confrontation, a bubble diagram was plotted, presented in Figure 7.

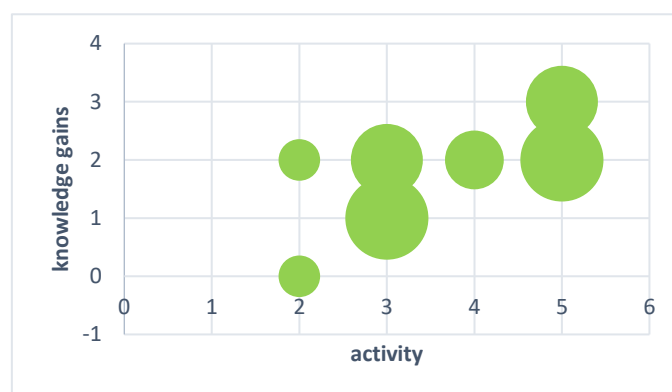


Figure 7. The relationship between participant activity and subjective knowledge gain.

From the data in Figure 6, it can be read that the rated knowledge gain of the learners depends on their level of activity. The more active the listeners were, the better they rated the increase in their knowledge. The size of the bubbles corresponds to the number of respondents, so it can be seen that the largest proportion of them rated their activity at 3 or 5, and only two of the eighteen interviewees rated their activity at 2. Only one respondent to the questionnaire felt that her knowledge had not increased as a result of the training, but she herself admitted that her level of involvement in the training was the lowest.

The survey conducted was a preliminary study. In order to draw concrete (statistically significant conclusions) it would have been necessary to subject a larger group of people to such a study; unfortunately, this was not possible in this case. However, when analysing the results presented, it can be concluded that this study has shown that the training carried out has had a positive effect and the trained people have clearly increased their level of awareness of entrepreneurial knowledge in the area of raw materials.

5. Conclusions

Environmental education should consist of continuing education from an early age. This should include not only children and young people but also adults (lifelong learning programme, Universities of the Third Age). The entire education process should take place in a deliberate system involving cooperation with schools, universities and NGOs, and should be led by properly prepared groups of educators. Environmental education should be extended to all areas and levels of formal and non-formal education. It is important that it should be interdisciplinary and intergenerational.

In case of children and young people (primary and secondary schools), environmental education should focus on [24]:

- developing the ability to observe the environment and gather information about it;
- learning about the laws and interdependencies governing nature, as well as those occurring between nature and man;
- shaping the human being who is aware of their unity with the natural and social and cultural environment;

- developing problem-solving skills in accordance with the knowledge and values acquired;
- stimulating sensitivity to the beauty of nature and spatial order;
- developing an attitude of respect for life and health, both their own and that of all other beings;
- conducting active forms of education in the field, e.g., green schools.

In higher education institutions, on the other hand, environmental education should consist of [24]:

- preparing professionals for professional work in the field of environmental protection;
- conducting post-graduate studies to supplement knowledge in the field of environmental protection, including courses for teachers, administrative staff, journalists and other persons responsible for and interested in environmental issues;
- providing higher education in non-vocational, universal so-called European studies;
- providing informal environmental education through the organisation of open universities (Universities of the Third Age) and lectures;
- actively promote the ESD mentality by running study circles related to this topic;
- working together with local businesses and industry so that there is a mutual benefit in implementing the ESD framework directly at local and regional level;
- investing in research into ways of implementing sustainable development and change at a larger scale;
- establishing funds for students and researchers to start their own sustainable projects;
- publishing and promoting textbooks and scripts on environmental issues, highlighting development as seen in social, economic and cultural terms;
- co-implementing international projects, such as the Limbra project presented herein.

As the analysis of the results from the conducted questionnaires shows, the implementation of the Limbra project and such initiatives raise the awareness of the participants and lead, in this case, to building a permanent pro-environmental attitude and to supporting the raw material market in Poland.

When analysing the results of the surveys, it can be concluded that conducting entrepreneurship training in the area of the raw materials industry brings good results. Participants of the training in this field unanimously declared a significant increase in knowledge.

It is suggested to conduct such trainings on a regular basis, not only among students but also among teachers. This will allow for the gradual introduction of this subject in various lectures that students take in the study program.

The authors believe that only the continuous education of eco-responsible attitudes is an effective way to quickly and effectively implement the idea of sustainable development, including the closed loop economy, on a global scale.

It is logical, which has been confirmed by research, that environmental education is the foundation of strategies and actions aimed at sustainable development and the circular economy. Only global and global environmental education can be an effective prevention of the degradation of the natural environment—our planet. Increasing awareness, and above all knowledge of how to live in harmony with nature, without wasting wealth, is the basis for creating an eco-citizen of the Earth.

Adding to this the role of universities, which should shape the awareness of students, who then become conscious members of both local and global communities, a new vision of the world based on the circular economy has a chance to permanently appear in human life. The first training in this field conducted at AGH-UST in Poland shows that there is a marked increase in awareness among students. This gives an optimistic view of the future of the world economy in line with the idea of sustainable development and the circular economy.

Author Contributions: Conceptualization, M.S., K.Z., D.F. and M.K.; methodology, M.S., K.Z., D.F. and M.K.; software, M.S.; validation, M.S., K.Z., D.F. and M.K.; formal analysis, M.S. and D.F.; investigation, M.S., K.Z., D.F. and M.K.; resources, M.S., K.Z., D.F. and M.K.; data curation, M.S.; writing—original draft preparation, M.S., K.Z., D.F. and M.K.; writing—review and editing, M.S. and D.F.; visualization, M.S., K.Z., D.F. and M.K.; supervision, M.S.; project administration, M.S. and D.F.; funding acquisition, M.S. All authors have read and agreed to the published version of the manuscript.

Funding: This paper presents results of research conducted in AGH University of Science and Technology no. 16.16.100.215.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study was the subject of research by an international team in the LIMBRA project, Decreasing the negative outcomes of brain drain in the raw material sector, EIT Raw Materials, KIC Project Number 18197.

Conflicts of Interest: The authors declare no conflict of interest.

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