

# University Curriculum Education Activities Towards Circular Economy Implementation

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**Abstract:** The successful implementation of circular economy (CE) requires the joint participation of the whole society in China. University is one of the main drivers of CE, and its curriculum education activities of CE is an important way to implement CE education, which includes the training activities for professional talents for society and the general education activities of CE for students of non-CE major. The former focuses on how to meet the needs of the national CE strategy for professional talents, while the latter aims to improve the CE awareness and knowledge of undergraduates, so as to promote the CE education radiation to the whole society through the social practice and other activities. The novelty of this study lies in the in-depth investigation and analysis of the current situation of the construction, curriculum setting and personnel training of the major of Resource Recycling Science and Engineering (RRSE) in Chinese universities. There are some barriers in curriculum education activities toward the CE implementation, including the relatively lagging professional development, the imperfection of the curriculum system, the lack of professional teachers and the absence of CE general education. In response, universities could maximize the contribution of CE curriculum education to CE implementation by strengthening the construction of RRSE major, deepening the reform of curriculum system, creating a talent pool of professional teachers, and adding general education courses of CE through multiple channels. These strategies have strong applicability that can be used for reference by other universities.

**Index Terms:** circular economy, curriculum, education activities, talent cultivation, general education, resource recycling science and engineering, education radiation.

## 1 INTRODUCTION

According to the traditional concept, the CE implementation is a task in the field of industrial production, which has nothing to do with universities anyway. In fact, the successful implementation of CE requires the joint participation of the entire society including higher education institutions [1]. As one of the driving forces for promoting the CE, universities need to play a vital role in the CE implementation. From a legal point of view, relevant national laws on CE clearly stipulate that higher education institutions have an inescapable responsibility to promote the transition to a CE model [2]. From the perspective of talent demand, the urgent demand of the talent market for the talents who master the theory and skills of CE also determines that universities and universities need to strengthen the cultivation of CE professionals. From a cultural and conceptual perspective, CE is a kind of economic model advocated in knowledge-based society, the implementation of the CE systems and technology relied on CE concept, including values, notions and consumption view, and development view [3]. Therefore, the education function of universities should be exerted to ensure the understanding, support and cooperation of the whole society for the CE implementation. Additionally, from the perspective of the university's own development, only by serving the national development strategy can higher education give full play to its role in promoting national economic and social development. In recent years, China has put up the high quality of the CE education demonstration base as educational platform to carry out the public promotion, publicity and education of CE concept, that mainly focused on the enterprises with CE

practice and CE industrial park, and supported the national CE education demonstration base by using the CE development special funds through the way of "replace subsidies with awards" [4]. However, these educational bases still focus more on industry and have little educational impact on the whole society, especially the public. As the engine of knowledge and technology, universities could and should provide reliable support for the CE education in the whole society [5]. However, the role of universities in the CE implementation has not been sufficiently recognized and supported, and the contribution of university curriculum education to the CE education has not been paid enough attention either at present. Therefore, this study aims to analyze the contribution of university curriculum education to the CE implementation and explores how to maximize the contributions.

## 2 METHODOLOGY

This study mainly uses the literature method and the investigation method. Through the literature review of the previous research that is relevant to curriculum education activities towards the CE education, the subject and object of this study are identified. To ensure the review was comprehensive, the articles published in core periodicals and peer-reviewed journal over the last 15 years in English and Chinese are selected. In addition, a number of other papers and monographs were found in the references of selected articles based on the criteria of the relevance to the topic and the popularity in terms of citations. Besides, an investigation that focused on the situation of the professional development of RRSE major, the construction of curriculum system and personnel training in universities in China was conducted to find out the contributions of university curriculum education activities for CE implementation and existing problems, and explore to put forward specific countermeasures to solve these problems.

## 3 LITERATURE REVIEW

As the engine of knowledge and technology, the dominant role of universities in carrying out education for sustainable development has been widely recognized. The research of international scholars on the role of higher education

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institutions mainly focuses on the curriculum setting and the improvement of teaching strategy. Kirchherr J. and Piscicelli L. [6] highlighted that lecturers could accelerate the transition towards CE by developing seven exercises in a course designed to introduce undergraduate to the CE concept, which includes a drill game, buzzword bingo, a teardown lab, an eco-industrial park simulation, policy instruments, a circular party and circular futures. Andrews D. [7] argued the knowledge and ability to apply the principles of the CE must be embedded in the curriculum so that they also become integral to design practice. In his opinion, not all students will embrace design for sustainable development but it is no doubt that teaching them about the CE will enable sustainability issues to be addressed implicitly. Leubea M. and Walcherb D. [8] argued that circular product design is the key problem to make that shift towards the CE, and appealed to renew the Curricula of Design Schools. Fonseca L. et al. [9] used a systematic review utilizing a structured approach to analyze Portuguese higher education institutions BSc and MSc courses and the content analysis of their curricular units, and found that sustainability is covered in most Social Sciences, Engineering, and Management, BSc and MSc courses, offered by the top 8 Portuguese Higher Education Institutions, but the Education for Sustainable Development was lacking a consistent body of knowledge. Hall N. and Colby F. [10] argued that a CE approach to curriculum design can motivate deep learning, through experimental practice, deep-dive research and systems thinking, and provided a structural framework of a CE agenda to fashion education curriculum, establishing a novel approach that could be applied to other specialist fashion education institutions. Andara A. et al. [11] carried out a survey on a sample of 189 students to test the current sustainability literacy, and created four annual pathways along the roadmap to develop sustainability skills during the four-year university course in engineering, which includes promotion of a recycling campaign through a CE, creation of educational videos regarding sustainability, reinforcement of reasoning and argumentative skills by preparing a debate on environmental issues, and preparation of the students to apply environmental management models to solve sustainability issues within the company. Kopnina H. [12] presented a literature review that describes the application of circular methodologies to education for sustainability, which has been slow to adopt circular systems to the curriculum, and discussed how Bachelor and Master level students apply their understanding of these frameworks to corporate case studies. Nunes B. et al. [13] reviewed the environmental activities of 50 universities ranked highly in terms of their environmental credentials or their environmental science courses, and then presented how universities can affect material flows, promote sustainability outside of the formal curriculum, and act as catalysts with business. In China, the existing researches also focus on the issues that how universities should carry out sustainable development education through discipline construction and curriculum reform. Cui X. et al. [14] investigated the current situation and development advantages of RRSE (RRSE) major in university, and explored the necessity, training objectives and construction modes of this major. Liu X. et al. [15] constructed the curriculum system aiming at talent cultivation through the investigation and research on the talent demand of local economic construction and the talent cultivation program of the RRSE major in various universities. Xue J. et al. [16] summarized the problems encountered in the teaching

process of the professional elective course Clean Production and CE, and proposed countermeasures to improve the teaching quality from the aspects of textbook construction, case base construction and diversified teaching methods. Gong J. et al. [17] highlighted that higher education development strategy should be adjusted in terms of the CE concept, implement the human resources strategy of CE, enforce the discipline construction and general education of CE, and build a CE culture on campus to realize the scientific development of higher education. Yao W. [18] argued that universities should advocate CE as an elective course, so as to enable students to participate in CE activities at the ideological, behavioral and practical levels. Through the analysis of the existing research, it is found that the curriculum education activities towards CE implementation include the cultivation of professional talents of students in RRSE major, which mainly aims at conveying CE professionals to the society, and the general education of CE implemented for non-CE students, which is to improve the CE awareness and knowledge of undergraduates to realize the CE education radiation to the whole society. Therefore, this study mainly focuses on the current situation of the development of RRSE major in Chinese universities, analyzes the problems existing in the curriculum education of Chinese universities towards CE implementation, and then explores to put forward the ways to effectively exert university curriculum education.

## 4 CURRENT SITUATION OF UNIVERSITY CURRICULUM EDUCATION TOWARDS CE

### 4.1 Major Related to CE

The cultivation of recycling talents is the basis and guarantee of the development of CE industry. In order to meet the urgent demand for talents in the implementation of CE strategy in China, the undergraduate major of RRSE has been set up with the approval of the Ministry of Education, which is of great significance to the construction of a resource-conserving and environment-friendly society. The students of this major mainly studies the recycling technology of waste resources, the remanufacturing of key mechanical parts, the performance and application of recycled materials, energy conservation and emission reduction benefit analysis and other related scientific and technical issues of resource recycling. As a new interdisciplinary major encouraged by our nation, RRSE involves the intersection and integration of environmental engineering, chemical engineering and technology, applied chemistry, material engineering, machinery manufacturing and automation, electronic information engineering, management and other disciplines. As CE implementation started later than developed countries in China, the professional development of RRSE also lags behind. Since the undergraduate major of Renewable Resources Science and Technology (RRST) established in 1996, more than 10 schools have applied for the program. In 2010, the Ministry of Education set up RRSE major and uniformly changed the original major RRST into RRSE [18]. The universities involved in the major name changed includes Yunnan Normal University, Beijing Jiaotong University Haibin College and North China University of Water Resources and Electric Power, etc. Through the statistics that carried out by early 2016, there are only 30 universities in China that had set up RRSE major, such as Peking University, Tsinghua university and Nankai university [14]. In this study, by consulting the list of newly-registered undergraduate majors

published by the Ministry of Education each year from 2007 to 2018, it is found that before 2016, six other universities had set up the RRSE major, namely Hehai University, Anhui University of Technology, Jilin Institute of Chemical Technology, Henan Agricultural University, Yunnan Normal University, and Northwest Agriculture and Forestry University. Among them, Yunnan Normal University and Northwest Agriculture and Forestry University withdrew the major in 2016 and 2018 respectively. From 2016 to 2018, there are a total of 15 universities have added the RRSE major, which is increasing year by year. These universities are Zhejiang University, Shanxi University, a private university named Zhengzhou Institute of Industrial Technology and others. There are also some colleges and universities applying for the program that have not been approved by the Ministry of Education, such as Leshan Normal College and Henan Institute of Science and Technology. By the end of 2019, there are 49 universities and colleges with RRSE, as shown in Table 1. Of all the provinces in China, Beijing, Shandong, Liaoning, Jiangsu and Henan have the largest number of universities offering majors in RRSE. Also, there are still no universities offering this major in 7 provinces, such as Hebei and Chongqing.

#### 4.2 Curriculum System and Teaching Staff

According to the catalogue of undergraduate majors newly released by the Ministry of Education, the major of RRSE is belong to the chemistry and pharmacy discipline. However, the faculty that RRSE major belonging is different because of the different advantages of disciplines and development target in every universities, for example, the Chemical Engineering faculty in East China University of Science and Technology, the Environmental Science and Engineering faculty in Nankai University and the Materials and Manufacturing faculty in Beijing University of Technology. These also reflect that there must be some differences in the focus of professional curriculum in different universities. The RRSE major mainly adopts a combination of curriculum teaching and base

**TABLE 1**  
UNIVERSITIES THAT ESTABLISHED RRSE MAJOR

University	provinces /cities
Peking University	Beijing
Tsinghua University	Beijing
Beijing University of Technology	Beijing
Beijing Jiaotong University	Beijing
Haibin University	Beijing
Shandong University	Shandong
Shandong Agricultural University	Shandong
Shandong University of Science and Technology	Shandong
Shandong Agricultural Engineering University	Shandong
Dalian University of Technology	Liaoning
Northeastern University,	Liaoning
Shenyang University of Technology	Liaoning
Shenyang University of Chemical Technology	Liaoning
Jiangsu Institute of Technology	Jiangsu
Hehai University	Jiangsu
Nanjing Tech University	Jiangsu
Changzhou University	Jiangsu
North China University of Water Resources and Electric Power	Henan
Henan Agricultural University	Henan
Zhengzhou Institute of Industrial Application Technology	Henan
Luoyang Institute of Technology	Henan
Wuhan textile University	Hubei
Central south University for Nationalities	Hubei
Wuhan University of Engineering	Hubei

Nankai University	Tianjin
Tianjin University of Technology	Tianjin
Hunan University	Hunan
Hunan Normal University	Hunan
Fuzhou University	Fujian
Fujian Normal University	Fujian
Xi'an University of Architecture and Technology	Shanxi
Shangluo Institute	Shanxi
Changchun University of Technology	Jilin
Jilin University of Chemical Technology	Jilin
Qiqihar University	Heilongjiang
Northeast Petroleum University	Heilongjiang
Kunming University of Science and Technology	Yunnan
West Yunnan University of Applied Technology	Yunnan
Anhui University of Science and Technology	Anhui
Anhui University of Technology	Anhui
Qinghai Normal University	Qinghai
Shanxi University	Shanxi
Neijiang Normal University	Sichuan
Zhejiang University,	Zhejiang
East China University of Science and Technology	Shanghai
Nanchang University,	Jiangxi
Maotai Institute	Guizhou
Wuzhou Institute	Guangxi
Foshan Institute of Science and Technology	Guangdong
Ningxia Institute of Technology	Ningxia

training to train talents [19]. Students in this major will mainly learn the basic theoretical knowledge, and combine engineering training exercises to understand the basic conditions of China's resource distribution, industrial layout and environmental protection, so that they have the basic theoretical research and engineering ability to work in technology development and management field. By inducting the curriculum systems of various universities, it is found that the commonly used curriculum system is mainly composed of theoretical teaching parts, including general education courses, subject basic courses and professional core courses, and concentrated practical teaching, as shown in Table 2. In terms of the construction of teaching team, there is no ready-made faculty of this major at the beginning of the establishment because the major of RRSE is a new discipline. Most colleges and universities formed interdisciplinary teaching and research teams across departments on the basis of their respective strengths in related disciplines and further integration of the experts and scholars from the different faculties and other related fields, such as Nankai university.

**TABLE 2**  
GENERAL CURRICULUM SYSTEM OF RRSE MAJOR

Category	Target	Illustrate
General education courses	Basic skills and personal qualities	Foreign language, Legal basis, Computer, Mathematics, Chemistry, etc.
Discipline foundation courses	Basic knowledge and skills within the discipline	Chemistry, Materials, Recycling, Environment, Mining and Metallurgy subjects
Professional core courses	professional core skills	Resource regeneration process and equipment, Solid waste disposal and recycling, etc.
Concentrated practical teaching	Ability to practice and innovate	Cognitive practice, Metalworking practice, Course practice, Production experiment, Graduation practice, Graduation design, etc.

#### 4.3 Personnel Training and Employment

Colleges and universities are the main source for cultivating



the talents of RRSE major and management talents that are urgently needed by society. In recent years, there is an average of about 1,200 students that graduated each year in the RRSE major [20]. By reviewing the admissions plans issued by universities, this study statistics the enrollment of RRSE major in universities that clearly show data from 2017 to 2019, as shown in Table 3.

**TABLE 3**

<i>ADMISSIONS PLANS OF RRSE MAJOR IN CHINESE UNIVERSITIES</i>			
University	2017	2018	2019
Beijing University of Technology	38	19	0
Tianjin University of Technology	66	70	70
Changchun University of Technology	40	40	0
Anhui University of Technology	42	42	80
Fuzhou University	35	35	35
Shandong University of Science and Technology	40	40	0
Neijiang Normal University	35	30	40
Qinghai Normal University	40	40	0
Shangluo Institute	35	35	72
North China University of Water Resources and Electric Power	55	49	55
Shenyang University of Chemical Technology	30	60	60
Anhui University of Science and Technology	36	36	36
Summation	492	496	448

It can be seen from the table that the total enrollment of the RRSE major of the listed universities has not changed much in the three years. However, considering that the list in the table does not contain the universities that have added this major since 2017, the overall enrollment scale should increase year by year. However, it is important to note that the number of universities that withdraw the major may also change from year to year. Graduates majoring in RRSE are employed in a wide range of employment fields, including R & D and management in metallurgical and chemical companies, R & D and design of new technologies in scientific research institutes, production and management in enterprises using solid waste resources, management and service work in the circular economy park in, CE planning and consulting work in a specialized consulting agency, management and decision-making work in the government department. Taking Xi'an University of Architecture and Technology as an example, it can be generally understood that the main destination of graduates of this major is to participate in work and continue their studies to obtain higher degrees, as shown in Table 4.

**TABLE 4**

<i>GRADUATE DESTINATION OF RRSE MAJOR FROM 2015 TO 2018</i>				
Graduate destination	2015	2016	2017	2018
Work	14	35	35	26
Postgraduate study	17	7	11	16
Enlist in the army	0	8	1	2
Go abroad	0	5	2	1
Freelance	1	1	0	2
Unemployed	2	1	3	0

#### 4.4 General Education of CE

General education emphasizes all-round human development. The integration and development of general education and professional education can not only promote effective communication and exchange between different disciplines, but also help to cultivate high-quality talents with both moral literacy and professional skills [21]. For non-CE major

undergraduates, especially engineering students, conducting a CE general education course can not only help students integrate the concept of CE into the production practice of their specialty and then affect the CE concept in their professional field, but also can spread CE concept to the whole society through undergraduates' social practice activity and promote CE behavior in everyday life, such as green consumer behavior. At present, some universities have set up sustainable development or environmental protection courses in the general education curriculum system, but few universities have incorporated CE courses into the system. In Table 5, the elective courses of general education offered by three universities are listed.

**TABLE 5**

<i>ELECTIVE COURSES OF GENERAL EDUCATION IN UNIVERSITIES</i>	
University	Optional courses in general education
East China university of science and technology	Humanities, social sciences, engineering, natural sciences, innovation and entrepreneurship
Peking University	Mathematics and natural sciences, social sciences, philosophy and psychology, history, language, literature, art and aesthetic education, social sustainable development
Zhejiang university	Literature and art, history and culture, society and economy, leadership and communication, technology and design

## 5 PROBLEMS AND COUNTERMEASURES OF UNIVERSITY CURRICULUM EDUCATION TOWARDS CE

Based on the analysis of the current situation, it is found that there are still many problems in the curriculum education activities of universities towards the CE implementation. Only through effective strategies and targeted solutions can universities better promote the CE transition in the whole society.

### 5.1 Development of Majors Related to CE

The development of RRSE major is relatively lagging behind than developed countries, and it is necessary to attach importance to professional construction to lay a solid foundation for promoting the CE transition. Obviously, if a university does not offer RRSE major, it will not hire professional teachers in this major, and it is very unlikely to train CE professionals and undergraduates with CE concepts and knowledge. That is to say, there are only a limited number of universities in China offering relevant majors of CE, so the educational activities directed by lecturers towards CE cannot be implemented smoothly in all colleges and universities. Related majors of CE are emerging, and their development is still in its infancy. On the one hand, engineering universities that have not yet established the RRSE major, including mining and metallurgical universities, metallurgical universities, chemical universities, and materials universities, should all apply to add CE majors based on the development of traditional specialty disciplines, improve its own discipline group, promote the development of specialty disciplines to cross disciplines and marginal disciplines, and actively implement the national strategy of strengthening the country with human resources in CE. On the other hand, colleges and universities that have established this CE major should scientifically target the training of talents based on own actual

situation and social needs, firmly grasp the direction of service development and promote employment, deepen the reform of institutional mechanisms, innovate education models, adhere to the talent training model of integration of production and education and cooperation between schools and enterprises, and actively cultivate qualified application-oriented talents that meet the needs of green development.

### 5.2 Improvement of Curriculum System

The curriculum design is incomplete and the reform of the professional curriculum system should be deepened. The curriculum system is composed of courses set by the major according to the arrangement and combination of teaching content and process, which is a relatively complex and dynamic state, and is the core of professional talent training, whose rationality determines the quality of the professional talent training [15]. As a new interdisciplinary major, there are still some problems in curriculum such as the lack of classical course materials, the emphasis on theoretical knowledge imparting in the course system, the separation between theoretical teaching and practical teaching, and the incoordination between theoretical knowledge and practical skills, which lead to the poor practical ability of graduates and the difficulty in adapting to the needs of enterprises in employment. Universities should strengthen the idea of serving local areas and build a special curriculum system oriented by industry needs. Firstly, it is necessary to adhere to the basic principles of broadening the foundation and increasing the practical teaching links to carry out the reform of course teaching content. It is also necessary to comprehensively consider the knowledge requirements involved in this specialty and tightly focus on the circular development goals to establish the professional curriculum in the following fields, including the chemical, materials, comprehensive utilization technology, mineral and metallurgical extraction technology and environmental protection. The distinctive curriculum system and professional direction should be built in accordance with the needs of the local industry [22]. Secondly, teaching activity should be combined with production practice. Enterprise technicians could be invited to participate in the compilation, teaching organization, teaching and assessment of teaching syllabus, and compile textbooks for major courses with engineering application as the background, so that students' theoretical learning and practical production are closely combined. Furthermore, it is necessary to innovate curriculum assessment methods. The professional employment requires relatively higher practical ability. Therefore, credits should be focused on practical teaching in the assessment of the curriculum. It is also recommended to increase the content of practice in the assessment of the theoretical curriculum to guide students to strengthen the cultivation of practical operation and innovative ability.

### 5.3 Construction of Professional Teacher Team

There is a shortage of teachers in RRSE major, so it is necessary to create a talent pool of high-quality teachers to ensure the quality of talent cultivation. Strong professional construction is closely related to high-level teachers. Strengthening the dominant position of teachers in university education and focusing on the establishment of a high-quality, high-level team of subject-professional teachers is the top priority of the current new professional construction [23].

Firstly, it is necessary to increase efforts to introduce talents in this field, formulate various preferential conditions to recruit high-level talents, especially to introduce discipline leaders and backbone teachers of main courses urgently needed in the construction of the new major, further optimize the faculty structure, and create good internal conditions for the establishment of the new major. The second is to attach importance to the training of existing talents, give full play to the guiding role of old teachers, promote the development of young teachers, support teachers to study and visit, and improve the level of the whole teaching staff. Additionally, to optimize the employment structure of teachers, relevant high-level professionals can be hired as part-time teachers in the new profession, to achieve a reasonable allocation of social education resources, and gradually build a high-quality teacher team with a reasonable structure and great potential for development, to help the establishment of new professions good foundation. Furthermore, the construction of a "double-skilled" teacher team could be improved, for insurance, to pay attention to the training of dual-skilled talents, arrange teachers to regularly conduct production practice in enterprises, and also hire enterprise technical staff to teach and exchange.

### 5.4 Enrichment of General Education Curriculum

The elective courses related to CE need to be further enriched to enhance the CE awareness and knowledge of undergraduates. National Bureau of Statistics of China shows that the number of university graduates in China has exceeded 7 million every year since 2013 [24], that is to say, university students are a so huge group that they could become disseminators of the concept of CE after graduation, improve the CE awareness in the whole society, and promote the CE implementation. However, there are few general education courses on CE for non-CE majors at present. On the one hand, some leaders and teachers of application-oriented universities consider that general education is of limited practical significance, and they tend to focus on professional skills, and are unwilling to put general education in the same important position as professional education. On the other hand, some students pay little attention to general education. Due to the fierce competition in the current society, students always have a strong sense of pragmatism and attach more importance to professional courses. The general education class is treated worthlessly by the students because of the failure to recognize the importance of general education for personal growth and social development. There is a great significance for the personal growth of undergraduates and social development to list the general education course of CE as the content of general education of all majors in universities [25]. The teaching management department of colleges and universities should strengthen the overall arrangement of general education on circular economy. The first is to raise awareness of the importance of general education in circular economy, and establish a specialized general course management organization and assessment mechanism to ensure the sound development of general education. Secondly, the CE general education curriculum should be established in a scientific way. Universities should strengthen the scientific justification of the courses to be offered, rationally set course modules, carefully arrange course content, scientifically organize and implement course teaching, so as to integrate general education and professional education to

complete the goal of general education of CE. The third is to pay attention to the development of online course resources to ensure the needs of circular economy teaching. At present, especially in universities that have not established the CE major, the professional teachers are scarce. Colleges and universities should improve the integration of teachers in the region, and carry out general education on CE through a combination of full-time and part-time teachers and online and offline teaching.

## 6 CONCLUSIONS

The effective implementation of CE curriculum education in universities is an important guarantee for the implementation of the human resources strategy of CE. Universities have the responsibility and ability to contribute to the promote of CE transition through the curriculum education activities of CE. Colleges and universities in China could actively promote the construction of CE major, deepen the reform of CE curriculum system, create a team of professional teachers and set up general education courses of CE, so as to solve the problems of lagging development of CE major in the implementation of CE curriculum education activities. In the future research, researchers can explore the aspects of the CE curriculum setting, teaching methods, teaching effect evaluation methods, and graduate career development of RRSE major in universities, and analyze the advantages and problems of CE curriculum education in universities to resolve obstacles in a targeted manner to maximize the contribution of higher education's CE curriculum education to the transition towards the CE model at the entire social level.

## REFERENCES

- [1]. J. Gong, "On the Legal System of CE in Higher Education in China", *Business Times*, no.16, pp.115-116, 2010
- [2]. T. Shevchenko and D. Qu, "University's Pro-circular Activities in Transition to Circular Economy Model in China," *Sustainable Development*, vol.1, no.1, pp.46-51, 2019
- [3]. M. Liang and M. Zhu, "Characteristics of CE and Its Relationship with Sustainable Development", *East China Economic Management*, no.12, pp.61-64, 2005
- [4]. National Development and Reform Commission, "Circular on the Implementation Plan of Special Fund for CE Development to Support the Construction of National CE Education Demonstration Base", *Renewable Resources and CE*, vol. 6, no. 5, pp.1-2, 2013
- [5]. D. Qu and T. Shevchenko, "Educational Potential of Chinese University for the Implementation of Circular Economy Model," *New Stages of Development of Modern Science in Ukraine and EU Countries*, pp.434-450, 2019
- [6]. J. Kirchherr and L. Piscicelli, "Towards an Education for the CE (ECE): Five Teaching Principles and a Case Study", *Resources, Conservation & Recycling*, no.150, 2019
- [7]. D. Andrews, "The CE, Design Thinking and Education for Sustainability", *Local Economy*, vol.30, no. 3, pp. 305-315, 2015
- [8]. M. Leube and D. Walcher, "Designing for the Next CE: An Appeal to Renew the Curricula of Design Schools," *The Design Journal*, vol. 20, no. 1, pp. 492-501, 2017
- [9]. L. Fonseca, A. Portela, B. Duarte, J. Queirós and L. Paiva, "Mapping Higher Education for Sustainable Development in Portugal," *Management and Marketing*, vol. 3, no. 3, pp. 1064-1075, 2018
- [10]. N. Hall and F. Colby, "AMFI's Reality School: A CE Agenda for Fashion Education," *Art, Design and Communication in Higher Education*, vol.17, no. 1, pp. 11-24(14), 2018
- [11]. Andara, R. Belver, M. Salvador and R. Nicolás, "Roadmapping towards Sustainability Proficiency in Engineering Education," *International Journal of Sustainability in Higher Education*, vol.19, no.2, pp. 413-438, 2018
- [12]. H. Kopnina, "Green-washing or Best-Case Practices? Using CE and Cradle to Cradle Case Studies in Business Education," *Journal of Cleaner Production*, no.219, pp. 613-621, 2019
- [13]. B. Nunes, S. Pollard, P. Burgess, G. Ellis, I. Rios and F. Charnley, "University Contributions to the CE: Professing the Hidden Curriculum," *Sustainability*, vol.10, no.8, pp.2719, 2018
- [14]. X. Cui, Y. Di, C. Zhou, X. Liu, N. Nan and S. Xu, "Training Mode of Applied Talents in RRSE from the Perspective of CE," *Renewable Resources and CE*, no.1, pp.12-15, 2018
- [15]. X. Liu, R. Li, C. Zhou and X. Cui, "Construction of Curriculum System of RRSE Major Serving Local Economic Construction," *Renewable Resources and Recycling Economy*, vol.10, no.12, pp.6-9, 2017
- [16]. J. Xue, S. Hu, Y. Gao, L. Li and W. Zhang, "Problems and Countermeasures in the Teaching of Clean Production and CE," *China Metallurgical Education*, no.6, pp.52-54, 2018
- [17]. J. Gong, Q. Wei, N. Miao and L. Xin, "The Development Strategy Selection of Higher Education under the Legal Background of CE," *Journal of Educational Academic*, no.1, pp.56-57, 2010
- [18]. W. Yao, "Analysis of China's CE Education," *Technology Economics*, no.2, pp.19-20, 2006
- [19]. N. Lv, C. Su, Y. Zhou and H. Wang. "Thinking on Improving Production Practice of RRSE," *Journal of Anhui University of Technology (social science edition)*, vol.34, no.6, pp.75-76, 2017
- [20]. M. Liu, Y. Liu, H. Wang, F. Chen and S. Hou, "Reflections on the Training of Professionals in RRSE under the New Situation of "One Belt and One Road"," *Guangzhou Chemistry*, vol.42, no.5, pp.65-68, 2017
- [21]. R. Zhang, "General Education and Professional Education: Practical Game of Higher Education Development," *China Adult Education*, no.5, pp.26-29, 2017
- [22]. X. Cui, Y. Di, N. Nan, X. Liu and C. Zhou, "Practice and Effectiveness of the Talent Training Model of RRSE under the Combination of Industry and Education and College-enterprise Thinking," *Renewable Resources and Recycling Economy*, vol.11, no.7, pp.7-10, 2008
- [23]. M. Liu, C. Zhang and Y. Liu, "Construction and Exploration of Resources Recycling Science and Engineering from the Perspective of Circular Economy," *Renewable Resources and Recycling Economy*, vol.10, no.3, pp.17-19+33, 2017

- [24]. National Bureau of Statistics of China, "China statistical yearbook 2018". available at: <http://www.stats.gov.cn/tjsj/ndsj/2018/indexeh.htm>
- [25]. X. Chen, "Dilemma and Countermeasures of Effective Teaching of General Education Courses in Universities," Jiangsu Higher Education, no.9, pp.78-82, 2019