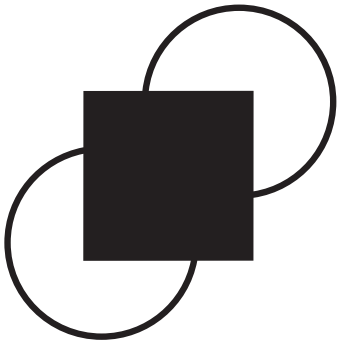
iCERi 2024

17TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION

CONFERENCE PROCEEDINGS

11-13 NOVEMBER 2024
iated.org/iceri



iCERi 2024

17TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION

CONFERENCE PROCEEDINGS

11-13 NOVEMBER 2024
iated.org/iceri

Published by
IATED Academy
iated.org

ICERI2024 Proceedings
17th annual International Conference of Education, Research and Innovation
11-13 November, 2024
Seville, Spain

Edited by
Luis Gómez Chova, *University of Valencia, Spain*
Chelo González Martínez, *Polytechnic University of Valencia, Spain*
Joanna Lees, *CEU Cardinal Herrera University, Spain*

DOI: 10.21125/iceri.2024
ISBN: 978-84-09-63010-3
ISSN: 2340-1095

Book cover designed by J.L. Bernat

These proceedings are published by IATED Academy. The registered company address is Plaza Legión Española 11, 46010 Valencia, Spain.

Bibliographic Information

Book Title
17th annual International Conference of Education, Research and Innovation

Book Series
ICERI Proceedings

Editors
Luis Gómez Chova
Chelo González Martínez
Joanna Lees

Publication Year
2024

Publisher
IATED Academy

Publisher Address
Valencia, Spain

Book ISBN
978-84-09-63010-3

Series ISSN
2340-1095

DOI
10.21125/iceri.2024

Conference Name
ICERI2024

Dates
11-13 November, 2024

Location
Seville, Spain

Topics
Education
Educational Research
Educational Technology

Editorial policy and Publication ethics:

The papers published in these proceedings reflect the views only of the authors. The publisher cannot be held responsible for the validity or use of the information therein contained.

The International Academy of Technology, Education and Development (IATED) aims to publish conference proceedings that contain original research articles of high quality meeting the expected ethical standards. The publication guidelines are provided for authors who submit articles to IATED conferences to maintain high ethical standards.

IATED shall guarantee the high technical and professional quality of the publications and that good practices and ethical standards are maintained. If unethical behaviors are identified, an investigation will be initiated, and pertinent actions will be taken.

More information about the publication ethics of IATED is available at iated.org/publication_ethics

Preface

The ICERI2024 Conference Proceedings contain the papers presented at the 17th annual International Conference of Education, Research and Innovation. This conference was held in Seville from the 11th to 13th of November 2024.

This annual conference was attended by educators, researchers and technologists from more than 70 countries with the purpose of networking with other professionals and sharing their knowledge about education, pedagogical technologies, and educational innovations. To fulfil this goal, networking activities, plenary sessions, parallel thematic sessions, and networking activities and workshops were offered. Keynote speeches were delivered by global educational experts. You can see their talks at IATED Talks: https://iated.org/talks/.

ICERI2024's scope was focused on the topics listed here: Pedagogical Methods and Innovations, Technology in Teaching and Learning, Inclusive Learning, Special Education, Emerging Technologies in Education, International Cooperation, Teacher Training and Educational Management, Curriculum Design, Accreditation and Quality in Education, University-Industry Cooperation and Open Educational Resources.

The ICERI2024 International Program Committee is composed of lecturers and researchers from across the world. A blind peer review process was followed to ensure the quality of the final publication. During this process, the following criteria were evaluated: content relevance, clear structure, clarity, originality, and alignment with the conference topics and disciplines.

As IATED strives to guarantee high technical and professional quality of the publications, and that good practice and ethical standards are maintained, all authors included in this publication signed the copyright transfer agreement. More information about our publication ethics is available at: https://iated.org/publication_ethics. As always, we wish to extend our most sincere thanks and best wishes to all members and delegates who have contributed to the ICERI2024 Conference Proceedings.

Organizing and Program Committee

Organizing Committee

Program Chairs
Luis Gómez Chova, *University of Valencia, Spain*
Chelo González Martínez, *Polytechnic University of Valencia, Spain*
Joanna Lees, *CEU Cardinal Herrera University, Spain*

Local Arrangements Chairs
David Martí, *Int. Academy of Technology, Education and Development, Spain*
Mª Jesús Suesta, *Int. Academy of Technology, Education and Development, Spain*
Meghan Stockwell, *Int. Academy of Technology, Education and Development, Spain*
Javi Doménech, *MSX International Techservices, Spain*
Miguel Peiró, *Progresa Vocational Training Center, Spain*

Publication Chairs
Agustín López Martínez, *University of Barcelona, Spain*
Ignacio Candel Torres, *Capgemini, Spain*

Publicity Chairs
Eladio Duque, *Int. Academy of Technology, Education and Development, Spain*
Juanan Herrero, *Graphimage Graffor, Spain*

Web Masters
Jose Luis Bernat, *Int. Academy of Technology, Education and Development, Spain*
Javier Martí, *IVIRMA Global IT, Spain*

Panel Chairs

Keynote Speakers
Bart Rienties – *The Open University, United Kingdom*
Pat Yongpradit – *Code.org, United States*

Workshop Chairs
Aiden Carthy – *Technological University Dublin, Ireland*
Bart Rienties – *The Open University, United Kingdom*
Chiara Ciociola – *LINKS Foundation, Italy*
Elizaveta Osipovskaya – *University of Porto, Portugal*
Harriet Richmond – *University of Warwick, United Kingdom*
Mairi Macintyre – *University of Warwick, United Kingdom*
Pat Yongpradit – *Code.org, United States*
Péter Tasi – *Aston University, United Kingdom*
Richard O'Connor – *Hands-on practitioner, United Kingdom*
Veronica Ruberti – *LINKS Foundation, Italy*
Yesim Kunter – *University of Warwick, United Kingdom*

Session Chairs

Achim Dannecker – *University of Applied Sciences and Arts Northwestern Switzerland FHNW, Switzerland*
Adrian Millward-Sadler – *FH Joanneum University of Applied Sciences, Austria*
Ahmed Mohamed – *United Arab Emirates University, United Arab Emirates*
Alexandra Lazareva – *University of Agder, Norway*
Ali Khodi – *UCSI University of Malaysia, Malaysia*
Alison Whelan – *Newcastle University, United Kingdom*
Amanda Costello – *University of Bolton, United Kingdom*
Anastasia Petratos – *Nelson Mandela University, South Africa*
Anja Pfennig – *HTW Berlin, Germany*
Anne Cathrine H. Asplin – *University of South-Eastern Norway, Norway*
Anne Spafford – *Mississippi State University, United States*
Astrid Myklebust – *Norwegian University of Science and Technology, Norway*
Beata Godejord – *Nord University, Norway*
Bert Zulauf – *Heinrich Heine University Düsseldorf, Germany*
Branko Mihaljević – *RIT Croatia, Croatia*
Catherine O'Donnell – *Ulster University, United Kingdom*
Christian Master Östlund – *University West, Sweden*
Christophe Courtin – *Université Savoie Mont Blanc, France*
Christopher Hawkins – *Staffordshire University, United Kingdom*
Claudia Hess – *IU International University of Applied Sciences, Germany*
Claudia Sperrfechter – *Heilbronn University of Applied Sciences, Germany*
Cristina Catallo – *Toronto Metropolitan University, Canada*
Crystal Franklin – *Cleveland State University, United States*
Daisy Abbott – *The Glasgow School of Art, United Kingdom*
Daniel Bosmans – *Haute Ecole Pédagogique BEJUNE, Switzerland*
Daniel Hromada – *Berlin University of the Arts, Germany*
Daniel Otto – *European University for Innovation and Perspective, Germany*
David Cline – *Saginaw Valley State University, United States*
Deborah Bayntun-Lees – *Hult International Business School, United Kingdom*
Deirdre McGillicuddy – *University College Dublin, Ireland*
Diana Shore – *University of Warwick, United Kingdom*
Dimitra Pappa – *NCSR Demokritos, Greece*
Elizabeth Malone – *Manchester Metropolitan University, United Kingdom*
Erin Doherty – *University of Guelph, Canada*
Estelle Chamoux – *Bishop's University, Canada*
Eva Peisachovich – *York University, Canada*
Eveline Wuttke – *Goethe University Frankfurt, Germany*
Fady Michel – *The American University in Cairo, Egypt*
Flavia Ramos-Mattoussi – *Florida State University, United States*
Francesca Dagnino – *National Research Council, Italy*
Gabriela Seccardini – *Université Gustave Eiffel, France*
György Kovács – *Luleå University of Technology, Sweden*

Hanna Haydar – *City University of New York, United States*
Helene Wilkinson – *AUT University, New Zealand*
Isabel Cristina Ribau Coutinho – *Universidade Nova de Lisboa, Portugal*
Janet Alsup – *Purdue University, United States*
Jeannie Golden – *East Carolina University, United States*
Jennifer Gallup – *Idaho State University, United States*
John Sabatini – *University of Memphis, United States*
Joy Lewis – *A. T. Still University School of Osteopathic Medicine in Arizona, United States*
João Pedro Costa – *Universidade de Lisboa, Portugal*
Julian Green – *Cardiff Metropolitan University, United Kingdom*
Kevin Burden – *The University of Hull, United Kingdom*
Koji Maeda – *Nara University of Education, Japan*
Kristina Mullamaa – *University of Tartu, Estonia*
Laura McGibney – *South East Technological University, Ireland*
Leevke Wilkens – *TU Dortmund University, Germany*
Liliana Salvador – *ISPA – Univ. Institute of Psychological, Social and Life Sciences, Portugal*
Manoj Ravi – *University of Leeds, United Kingdom*
Martin Hagan – *St. Mary's University College, United Kingdom*
Meghan Millea – *East Carolina University, United States*
Mercedes Valiente López – *Universidad Politécnica de Madrid, Spain*
Michael Wagner – *Drexel University, United States*
Miklós Zsombor Tóth – *Eötvös Loránd University, Hungary*
Nakisa Alborz – *Exponent Inc., United States*
Neill Wylie – *South East Technological University, Ireland*
Niamh O' Brien – *South East Technological University, Ireland*
Oenardi Lawanto – *Utah State University, United States*
Oli Howson – *The Open University, United Kingdom*
Pasi Juvonen – *LAB University of Applied Sciences, Finland*
Pedro Agua – *Instituto Universitário Militar, Portugal*
Peter Gorder – *University of Colorado Colorado Springs, United States*
Peter Mazohl – *Europäische Bildungsinitiative, Austria*
Philip Bonanno – *University of Malta, Malta*
Rachel White – *Virginia Commonwealth University, United States*
Rob de Andrade – *Stamford Public Schools, United States*
Robert Lightfoot – *Texas A&M University, United States*
Rodrigo Florencio da Silva – *Instituto Politécnico Nacional, Mexico*
Rune Andersen – *University of Agder, Norway*
Ruth Vancelee – *Munster Technological University, Ireland*
Sandra Brosnan – *Munster Technological University, Ireland*
Scott Atkinson – *Royal Academy of Engineering, United Kingdom*
Sean Buckreis – *Barry University, United States*
Serigne Mbaye Gningue – *Emirates College for Advanced Education, United Arab Emirates*
Shane Wilson – *Atlantic Technological University, Ireland*
Sharm Manwani – *Henley Business School, United Kingdom*
Sibylle Kunz – *IU Internationale Hochschule, Germany*
Stefan Forsström – *Mid Sweden University, Sweden*

Suvi Siven – *Laurea University of Applied Sciences, Finland*
Suzann Girtz – *Gonzaga University, United States*
Taze Fulford – *Mississippi State University, United States*
Thomas Lavery – *BMSG, United Kingdom*
Tord Talmo – *Norwegian University of Science and Technology, Norway*
Ulrika Lundh Snis – *University West, Sweden*
Ursula Georgy – *Cologne University of Applied Sciences – TH Koeln, Germany*
Veronika Stoffova – *Trnava University, Slovakia*
Wim Casteels – *AP University of Applied Sciences and Arts Antwerp, Belgium*
Yong Joon Park – *Indiana State University, United States*
Youjin Yang – *Indiana State University, United States*

International Program Committee

A. Craig Loewen – *University of Lethbridge, Canada*
Adriana Agnes Repellin-Moreno – *Universidad Panamericana, Mexico*
Aileen Cotter – *Cork Institute of Technology, Ireland*
Akihiro Maeda – *Ryukoku University, Japan*
Alia Ammar – *Drexel University, United States*
Ana Paula Lopes – *Polytechnic of Porto (P.PORTO) - Porto Accounting and Business School (ISCAP) - CEOS.PP, Portugal*
André Villeneuve – *Université du Québec à Trois-Rivières, Canada*
Ann Rosnida Md Deni – *Sunway University, Malaysia*
Anna Kimberley – *Haaga-Helia, Finland*
Anna Romagnuolo – *Università della Tuscia, Italy*
Breno Deffanti – *Graded - The American School of São Paulo, Brazil*
Carlton Wood – *Open University, United Kingdom*
Catherine O'Donnell – *Ulster University, United Kingdom*
Cecilia Stari – *Universidad de la República, Facultad de Ingeniería, Uruguay*
Christa Tigerstedt – *ARCADA - University of Applied Sciences, Finland*
Christopher Evans – *Cardiff University, United Kingdom*
Craig Walker – *Oklahoma State Department of Education, United States*
Cynthia Rosas Magallanes – *Instituto Mexicano del Seguro Social, Mexico*
Daniel Abrahams – *University of Arkansas - Fayetteville, United States*
David Jennings – *University College Dublin, Ireland*
Declan Doran – *Technological University of the Shannon, Ireland*
Dorota Gawryluk – *Bialystok University of Technology, Poland*
Elmaziye Ozgur – *Eastern Mediterranean University, Cyprus*
Ewa Bogacz-Wojtanowska – *Jagiellonian University, Poland*
Fedor Duzhin – *Nanyang Technological University, Singapore*
Fernando Ortiz-Rodriguez – *Universidad Autonoma de Tamaulipas, Mexico*
Filomena Soares – *Polytechnic of Porto (P.PORTO) - Porto Accounting and Business School (ISCAP) - CEOS.PP, Portugal*
Frank Brosow – *University of Education Ludwigsburg, Germany*
Helmut Wöllik – *Carinthia University of Applied Sciences, Austria*
Hiroyuki Obari – *Globiz Professional University, Japan*

KNOWLEDGE ABOUT BIOECONOMY: AN EXPLORATORY STUDY WITH AFRICAN HIGHER EDUCATION STUDENTS

M.I.B. Ribeiro[1,2], A.I.R. Fernandes[3], A.P.R. Fernandes[4], A.J.G. Fernandes[1,2]

[1]Instituto Politécnico de Bragança, Centro de Investigação de Montanha (PORTUGAL)
[2]Instituto Politécnico de Bragança, Laboratório Associado para a Sustentabilidade e Tecnologia em Regiões de Montanha (PORTUGAL)
[3]Universidade do Minho, Escola de Direito (PORTUGAL)
[4]Universidade do Porto, Faculdade de Ciências (PORTUGAL)

Abstract

Bioeconomy is seen as a means and an end to achieving sustainability encompassing the social, environmental, and economic spheres, with a scientific framework based on technological innovations that increase social well-being through promoting and disseminating knowledge. In this context, this research aimed to examine African higher education students' understanding and level of knowledge about Bioeconomy. Effectively, they will be the ones who will act as qualified labor for sustainable and biotechnological development, and they will be the future leaders of nations. To this end, a quantitative, cross-sectional, and descriptive study was developed based on a questionnaire applied to 407 African higher education students between April and May 2022. A non-probabilistic sampling was chosen for convenience, as this is an exploratory study. The questionnaire was created on the Google Forms platform and subsequently published on the researchers' social networks: Facebook, Twitter, Instagram, and WhatsApp. The questionnaire was organized into two sections. The first section contained questions that allowed the characterization of the student. The second section included 16 statements with 3 possible answers, namely "True," "False," or "I don't know". Questions identified correctly were assigned 1 value, and those selected incorrectly or "I don't know" were assigned 0 values. Then, the level of knowledge was classified as follows: (1) 0-19%: very insufficient; (2) 20-49%: insufficient; (3) 50-69%: sufficient; (4) 70-89%: good and (5) 90%-100%: very good. The sample included students of five nationalities, namely Cape Verdean (50.9%), Guinean (20.1%), Santomean (14.0%), Angolan (11.8%) and Mozambican (3.2%). The majority of students came from rural areas (88.0%), were female (56.0%), and lived in a household consisting of, at most, 4 members (69.3%) with a household income of less than 705 euros/month. Although the sample includes students from 74 institutions located outside or in Portuguese territory, most were undergraduate students at the Instituto Politécnico de Bragança (65.8%). The results showed that all respondents knew the term "Bioeconomy" (51.1%). The terms related to Bioeconomy known by the largest number of respondents were "Recycling economy" (53.1%) and "Green economy" (52.3%). The least known term was "Linear economy" (36.1%), followed by the terms "Sharing economy" (38.8%) and "Ecoeconomy" (46.9%). The level of knowledge about Bioeconomy was insufficient. Considering the respondents' nationality, it was found that the level of knowledge was higher and sufficient among Mozambicans and lower and insufficient among Angolans. The distribution of respondents by level of knowledge was as follows: 25.6% very insufficient, 22.4% insufficient, 36.4% sufficient, 15.5% good, and 0.2% very good. Regarding the students' opinion on the process of replacing fossil resources with renewable ones, favoring the transition to a sustainable Bioeconomy, on a scale from 1 (absolutely against) to 7 (absolutely in favor), the average recorded was 5.29 (SD = 1,596). In the present study, respondents of Mozambican nationality were more favorable to the process than respondents of Santomean nationality, followed by Guineans, Cape Verdeans, and Angolans. Gaps in students' knowledge about Bioeconomy were identified, which can and should be addressed by higher education institutions.

Keywords: Bioeconomy, Knowledge, Higher Education, Students, Sustainability.

1 INTRODUCTION

Bioeconomy is seen as a means and an end to achieving sustainability encompassing the social, environmental, and economic spheres, with a scientific framework based on technological innovations that increase social well-being through promoting and disseminating knowledge [1]. It involves the production, use, conservation, and regeneration of biological resources, including knowledge, science, technology, and innovation, to provide sustainable solutions (information, products, processes, and services) within and between all economic sectors and enable a transformation towards a sustainable economy [2].

Sustainability is a current issue triggered by environmental disasters caused by human actions that put life on the planet at risk. Therefore, it is urgent to harmonize conflicts between the economic, environmental, and social spheres by rescuing ancient knowledge from traditional communities and developing clean and innovative technologies capable of mitigating the impacts of human actions while generating financial returns and social well-being. Furthermore, there has been a growing demand for products that cause less socio-environmental impact, resulting from increased food activism, concerns about food safety and quality, waste reduction, concern for traditional communities and farmers, criticism of the current economic model, and notions of conscious and political consumption, leading to a reorientation of Bioeconomy strategies aimed at meeting the new demand driven by more conscious consumers. At the same time, these social changes are prompting more significant attention to the Bioeconomy, establishing it as an agent of "social transformation" [3] necessary to develop alternative directions in post-industrial society.

The concept of Bioeconomy is associated with changes in sustainable development and involves transitions in production and consumption within systems [4]. Researchers identified three main visions for the Bioeconomy [5, 6]:

1 The biotechnology vision that prioritizes economic growth and job creation;

2 The bioresources vision that benefits environmental sustainability and economic growth through bio-based production;

3 The bioecology vision that prioritizes environmental sustainability, to the detriment of the economic (economic growth) and social (job creation) spheres.

The Bioeconomy offers the opportunity to achieve more sustainability by adopting new approaches to deal with future challenges [7]; it is a transversal perspective on social transformation towards long-term sustainability and the confinement of the non-renewable Economy [8]. Based on innovation and knowledge generation from biotechnology, the replacement of fossil resources with renewable ones, the reuse of waste, bioecology, and the valorization of ecosystem services, the applications of the Bioeconomy cover several areas, namely, human and animal health, agriculture, industry, informatics, cosmetics, energy, and engineering. It is increasingly prominent in international debates and is also cataloged as a strategy for economic differentiation in reducing waste generation and combating hunger and climate change [3, 5, 9].

Bioeconomy is considered by numerous scientists, politicians, and managers as a means of achieving sustainability, as the Economy depends on nature. The Environment and the Economy must be balanced in the same equation, neither reducing economic action to a mere mechanism nor nature to just a source of raw materials. However, for the Bioeconomy to be widely incorporated, it must have broad social acceptance as the people who will make it happen, especially the young people of the current and future generations. Thus, higher education plays a crucial role in a successful transition of the Bioeconomy, especially in strengthening competitiveness and creating jobs to promote its development [10]. The skills (knowledge) acquired by students play an essential role in a context of change [11], capable of diversifying economies in a sustainable way and ensuring the participation of all, especially young people [12]. The coupling of the concept of Bioeconomy with innovation, known by the slogan "Knowledge-based Bioeconomy" [3], is proof that knowledge is essential to achieve the desired degree of innovation. In other words, the concept of Bioeconomy is strongly linked to economic development and growth centered on investments to increase economic competitiveness [3].

Although African countries are in the early stages of developing bioeconomies, they are part of a growing global movement that seeks to build more sustainable production and consumption practices. Africa is abundant in natural resources, which, combined with its young, dynamic, and educated population, rapidly expanding scientific knowledge, and growing digitalization, provides the continent with the opportunity to reinvigorate progress towards meeting its continental and global development commitments and also leapfrog towards developing a sustainable Bioeconomy. In this regard, African countries can leverage biological knowledge and resources to deliver products, processes, and services that optimize social, economic, and environmental benefits and achieve social prosperity [13].

In this context, this research aimed to examine African higher education students' understanding and level of knowledge about Bioeconomy. Effectively, they will be the ones who will act as qualified labor for sustainable and biotechnological development, and they will be the future leaders of nations.

2 METHODOLOGY

To achieve this objective, a quantitative, cross-sectional, and descriptive study was developed based on an adapted questionnaire [1], which was applied between April and May 2022 to higher education students who met the following inclusion criteria:

1 Attended a higher education degree;

2 Were between 18 and 28 years old;

3 Were africans.

A non-probabilistic sampling was chosen for convenience, as this study was exploratory [14]. To collect the data, a questionnaire was created on the Google Forms platform and subsequently published on the researchers' social networks: Facebook, Twitter, Instagram, and WhatsApp. The questionnaire was organized into two sections. The first section contained questions that allowed the respondent's characterization, namely, nationality, the environment in which they live (rural or urban), gender, age, household size, number of household dependent members, monthly net income of the household, and higher educational institution attended. The second section included 16 statements with 3 possible answers, namely, “True,” “False,” or “I don’t know”. A question identified correctly was assigned 1, and a question selected incorrectly or “I don't know” was assigned 0. Then, to classify the level of knowledge, a qualitative scale was used, applying the following classification:

1 0-19%: very insufficient;

2 20-49%: insufficient;

3 50-69%: sufficient;

4 70-89%: good;

5 90%-100%: very good.

Later, the data was analyzed using IBM SPSS Statistics version 29 software. The data analysis involved descriptive statistics as a sample characterization technique and students’ knowledge assessment. This included the calculation of a central tendency measure (mean) and a dispersion measure (standard deviation), as well as the calculation of absolute (n) and relative (%) frequencies [14].

The confidentiality of the information collected was ensured, as well as the anonymity of the students according to Law 58/2019 on the Protection of Personal Data. Also, in order to participate in the study, the students had to consent and agree with the research procedures.

3 RESULTS AND DISCUSSION

As mentioned before, the questionnaire was disseminated online, and 407 valid responses were obtained. The sample included respondents of five nationalities, namely Cape Verdean (50.9%), Guinean (20.1%), Santomean (14.0%), Angolan (11.8%) and Mozambican (3.2%). Of the total number of respondents, the majority came from rural areas (88.0%), were female (56.0%), and were part of a household consisting of, at most, 4 members (69.3%). Most households' monthly income was less than 705 euros/month. Although the sample includes students from 74 institutions located outside or in Portuguese territory, most students attended a higher education degree at the Instituto Politécnico de Bragança (65.8%), a Portuguese higher education institution, as shown in Table 1.

Table 1. Socioeconomic characterization of the sample (n = 407).

Variables	***Categories***	***Frequencies***	
		n	***%***
Gender	Female	228	56.0
	Male	179	44.0
Nationality	Cape Verdean	207	50.9
	Guinean	82	20.1
	Santomean	57	14.0
	Angolan	48	11.8
	Mozambican	13	3.2

Household size	1 person	102	25.1
	2 people	40	9.8
	3 people	49	12.0
	4 people	91	22.4
	> 4 people	125	30.7
Household income level (euros)	< 705	260	63.9
	705 - 1410	89	21.9
	1411 - 2115	32	7.9
	2116 - 3525	17	4.2
	> 3525	9	2.2
Number of household dependent members	None	134	32.9
	1 person	86	21.1
	2 people	76	18.7
	3 people	50	12.3
	> 3 people	61	15
Higher education institution	Instituto Politécnico de Bragança	268	65.8
	Other	139	34.2
Provenance	Rural	358	88.0
	Urban	49	22.0
Age	18 to 22 years old	213	52.3
	> 22 years old	194	47.7

The results showed that 51.1% of the students knew the term “Bioeconomy” (Figure 1). Similar results were obtained in a study [7] which included Brazilian students (53.2%). In another study, which included 1400 students from forestry engineering and silviculture from 9 European countries [15], the authors found that 66% of students knew the term. The proportion of students who knew the term was slightly higher in another study [16], reaching 70%. However, other study found that only 32% of students in Poland were familiar with the term [17]. The study involving 367 students from the Technical University of Zvolen (Slovakia) and the Czech University of Life Sciences in Prague (Czech Republic) [18] identified significant differences between the different course curricula. However, the main source of information on Bioeconomy issues was the university course attended, followed by the news. Czech students were less satisfied with the Bioeconomy content as they considered it insufficient.

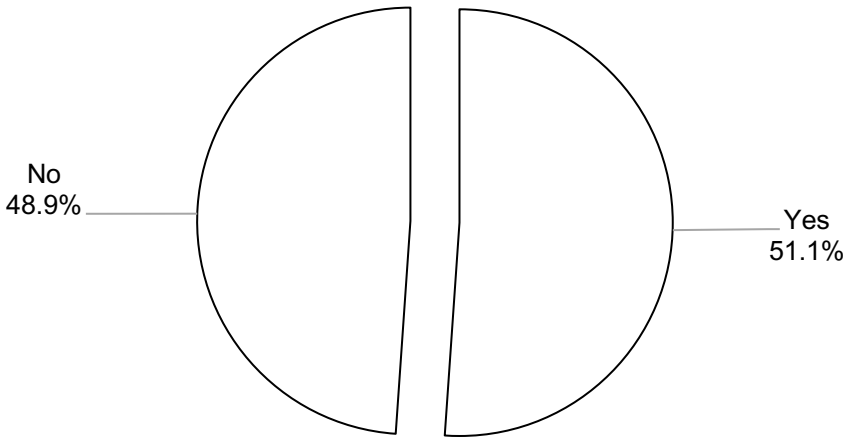


Figure 1. Knowledge about the term Bioeconomy.

The terms related to Bioeconomy known by the most significant number of students were “Recycling economy” (53.1%) and “Green economy” (52.3%). The least known term was “Linear economy” (36.1%), followed by the terms “Sharing economy” (38.8%) and “Ecoeconomy” (46.9%), as shown in Figure 2.

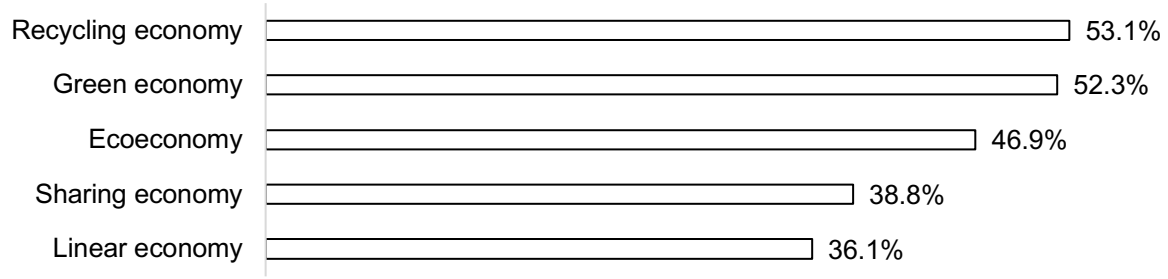


Figure 2. Familiarity with terms related to Bioeconomy.

The level of knowledge recorded about Bioeconomy was negative (Mean = 43.67; SD = 7.456). Taking into account the nationality of the students (Table 2), it was found that the level of knowledge was higher and sufficient among Mozambicans (Mean = 50.00; SD = 29.536) and lower and insufficient among Angolans (Mean = 40.89; SD = 31.632).

Table 2. Level of knowledge about Bioeconomy according to nationality on a scale from 0 to 100.

Nationality	***n***	***Mean***	***Standard deviation (SD)***
Mozambican	13	50.00	29.536
Angolan	48	40.89	31.632
Cape Verdean	207	43.06	27.105
Guinean	82	47.26	27.465
Santomean	98	41.67	24.587
Global	**407**	**43.67**	**7.456**

The distribution of respondents by level of knowledge about Bioeconomy was as follows: 25.6% very insufficient, 22.4% insufficient, 36.4% sufficient, 15.5% good, and 0.2% very good (Figure 3).

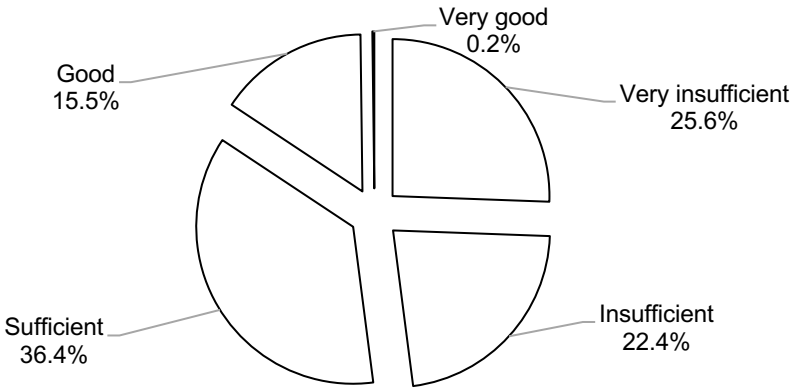


Figure 3. Level of knowledge about Bioeconomy.

The Top-5 statements about Bioeconomy correctly identified by the students were: “Bioeconomy is a concept of sustainability” and “The Bioeconomy's principles are sustainability and innovation”, both recording 60.0%. In third place, the statement “The Bioeconomy is a strategy for achieving the Sustainable Development Goals” was correctly identified by 59,2% of the students. The fourth place with 58,7% of correct answers was “The Bioeconomy involves the use of renewable resources to produce new products”. Finally, the fifth place, with 57,0%, was the statement, “The Bioeconomy is considered a new type of economy based on knowledge and innovation” (Figure 4).

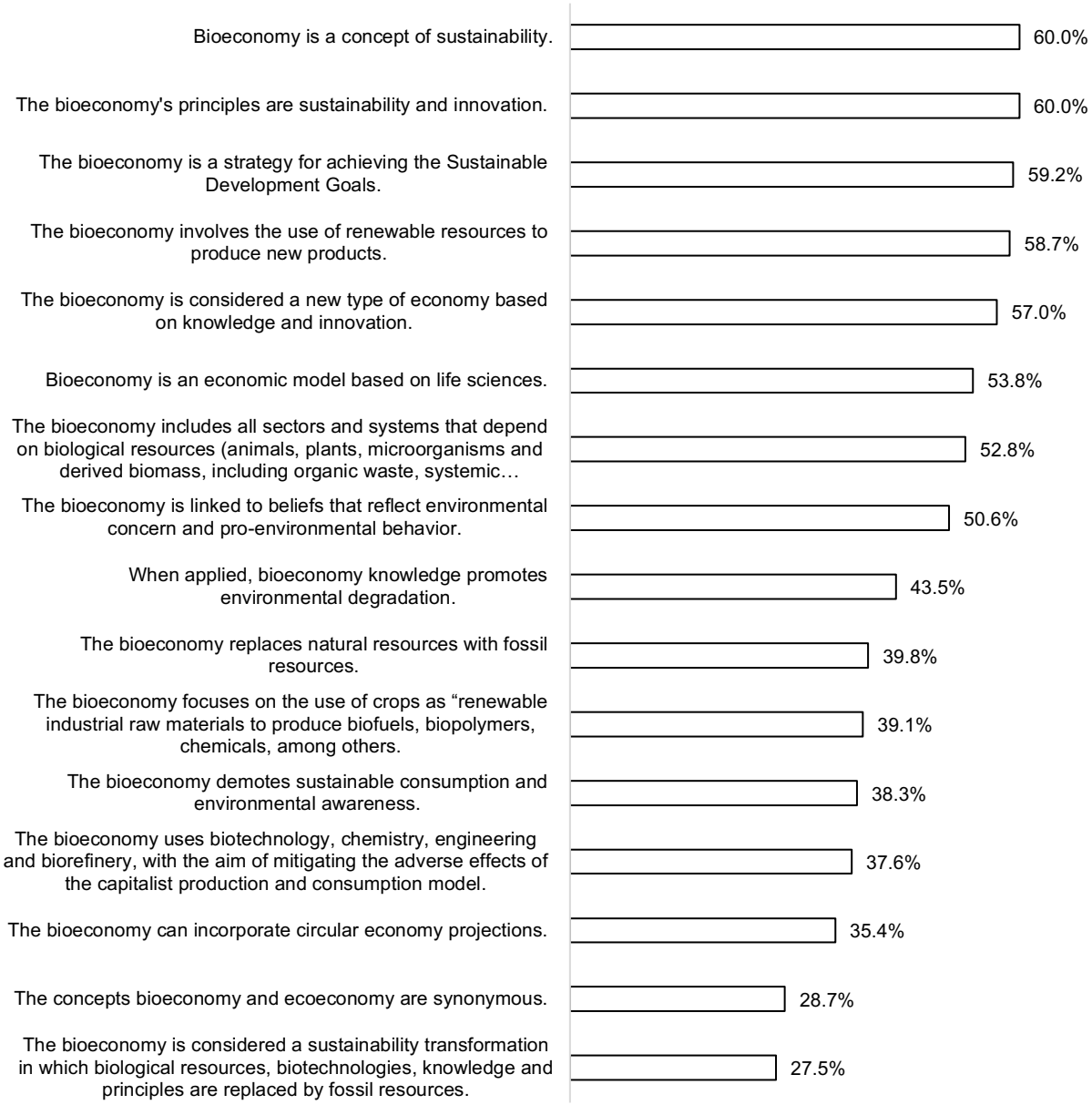


Figure 4. Statements about Bioeconomy correctly identified by respondents.

Regarding the students' opinion on the process of replacing fossil resources with renewable ones, favoring the transition to a sustainable Bioeconomy, on a scale from 1 (absolutely against) to 7 (absolutely in favor), the average recorded was 5.29 (SD = 1,596), as shown in Table 3.

Table 3. Students' opinions about replacing fossil resources with renewable by nationality.

Nationality	*n*	*Mean*	*Standard deviation (SD)*
Mozambican	13	5.50	1.698
Angolan	48	5.40	1.947
Cape Verdean	207	5.37	1.457
Guinean	82	5.17	1.678
Santomean	98	5.00	1.634
Global	**407**	**5.29**	**1.596**

These results corroborate the findings of a study developed in the German population [1]. In the present study, students of Mozambican nationality (Mean = 5.50; SD = 1.698) were more favorable to the process than respondents of Santomean nationality (Mean = 5.00; SD = 1.634), followed by Guineans (Mean = 5.17; SD = 1.678), Cape Verdeans (Mean = 5.37; SD = 1.457) and Angolans (Mean = 5.40; SD = 1.947), as shown in Table 3.

4 CONCLUSION

This research aimed to assess the level of knowledge about Bioeconomy of African higher education students. The students were from five countries with the Portuguese language, namely Cape Verde, Guinea, Sao Tome, Angola, and Mozambique who attended a higher education degree at the Instituto Politécnico de Bragança, a Portuguese higher education institution. The majority were female, from rural households with, at most, 4 people who lived with a monthly income of less than 705 euros/month.

Most students knew the term “Bioeconomy,” but their level of knowledge about Bioeconomy was negative. However, they favor the transition to a sustainable Bioeconomy, that is, replacing fossil resources with renewable ones. Also, it was found that the students’ level of knowledge was insufficient. Considering their nationality, the level of knowledge was higher and sufficient among Mozambicans and lower and insufficient among Angolans. These gaps in students' knowledge about the Bioeconomy can and should be addressed by the higher education institutions. In fact, targeted communication about the Bioeconomy to students and the general public is key to its acceptance and successful development and implementation [18]. One of the main barriers to greater inclusion of young people in the Bioeconomy lies in current education systems, which do not sufficiently support the development of a workforce with interdisciplinary skills [12].

This study presents some limitations, namely, (1) the use of a non-probabilistic sample for convenience does not allow the generalization of the results to the population; (2) the descriptive character of the study and the use of univariate statistics does not allow the study of the association between variables; (3) the cross-sectional design of the study gives a static image of the studied topic in a particular moment in time. For these reasons, future research should use a probabilistic sample, allowing the extrapolation of the results to the population; the use of bivariate and/or multivariate analysis to better analyze the phenomenon to study; and, if possible, develop a longitudinal study to examine the phenomenon in a more dynamic way, that is, considering the time factor.

ACKNOWLEDGEMENTS

The authors are grateful to the Foundation for Science and Technology (FCT, Portugal) for financial support through national funds FCT/MCTES (PIDDAC) to CIMO (UIDB/00690/2020 and UIDP/00690/2020) and SusTEC (LA/P/0007/2020).

REFERENCES

[1] M. Dallendörfer, S. Dieken, M. Henseleit, F. Siekmann and S. Venghaus, “Investigating citizens’ perceptions of the bioeconomy in Germany – High support but little understanding,” *Sustainable Production and Consumption*, vol. 30, pp. 16–30, 2022.

[2] IACGB (International Advisory Council on Global Bioeconomy), *Expanding the Sustainable Bioeconomy - Vision and Way Forward. Communiqué of the Global Bioeconomy Summit 2020*. Berlin: IACGB, 2020.

[3] R. Birner, “Bioeconomy Concepts” in *Bioeconomy: Shaping the Transition to a Sustainable, Biobased Economy* (I. Lewandowski, Ed.), pp. 17–38, Cham: Springer International Publishing, 2018.

[4] M. Ribeiro, C. Tomazini, M. Perondi and A. Fernandes, “Exploring Insights into the Bioeconomy in Strategic Groups,” *Journal of Economics Studies and Research*, vol. 2023, pp. 1-19, 2023.

[5] M. Bugge, T. Hansen and A. Klitkou, “What Is the Bioeconomy? A Review of the Literature,” *Sustainability*, vol. 8, no. 7, pp. 1-22, 2016.

[6] N. Canales and J. Gomez, *Policy dialogue on a bioeconomy for sustainable development in Colombi*a. Stockholm: Stockholm Environment Institute, 2020.

[7] C. Tomazini, M. Perondi, A. Fernandes and M. Ribeiro, “Knowledge level and perceptions of Brazilian university students about Bioeconomy,” *IBIMA Business Review*, vol. 2024, pp. 1-17, 2024.

[8] F. Johnson, N. Canales, M. Fielding, G. Gladkykh, M. Aung, R. Bailis, M. Ogeya and O. Olsson, “A comparative analysis of bioeconomy visions and pathways based on stakeholder dialogues in Colombia, Rwanda, Sweden, and Thailand.” *Journal of Environmental Policy & Planning*, vol. *24*, no. 6, pp. 680–700, 2022.

[9] A. Martinho and M. Jacquinet, *Bioeconomia uma nova área de desenvolvimento económico (Tópico 3 EDS*). Lisboa: Universidade Aberta, 2020.

[10] European Commission, *A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment*. Luxembourg: Publications Office of the European Union, 2018.

[11] A. Kalnbalkite, J. Pubule, and D. Blumberga, “Education for Advancing the Implementation of the Green Deal Goals for Bioeconomy,” *Environmental and Climate Technologies,* vol. 26, no. 1, pp. 75–83, 2022.

[12] J. Dietershagen and H. Bammann, *Opportunities for youth in the bioeconomy – Opportunities and barriers for youth employment and entrepreneurship in the emerging bioeconomy sectors*. Rome: FAO, 2023.

[13] Malabo Montpellier Panel, *Nature’s solutions: Policy Innovations and Opportunities for Africa’s Bioeconomy*, Malabo Montpellier Panel, 2022.

[14] J. Marôco, *Estatística com o SPSS statistics*, Pero Pinheiro: ReportNumber, 2021.

[15] J. Výbošťok, L. Navrátilová, Z. Dobšinská, B. Dúbravská, B. Giertliová, P. Aláč, M. Suja and J. Šálka, “Bioeconomy perception by students of different study programs – study from Slovakia,” *Central European Forestry Journal*, vol. no. 2, pp. 91–100, 2022.

[16] M. Masiero, L. Secco, D. Pettenella, R. Da Re, H. Bernö, A. Carreira, A. Dobrovolsky, B. Giertlieova, A. Giurca, S. Holmgren, C. Mark-Herbert, L. Navrátilová, H. Pülzl, L. Ranacher, A. Salvalaggio, A. Sergent, J. Sopanen, C. Stelzer, T. Stetter, … and I. Wallin, “Bioeconomy perception by future stakeholders: Hearing from European forestry students,” *Ambio*, vol. 49, no. 12, pp. 1925–1942, 2020.

[17] N. Drejerska, “Employment in vs. Education for the bioeconomy,” in *Proceedings of the 8th International Scientific Conference Rural Development* (A. Raupelienė, Ed.), pp. 991–998, Akademija: Aleksandras Stulginskis University, 2017.

[18] L. Marcineková, P. Palátová, J, Výbošťok, V.Jarský, M. Riedl, B. Giertliová, R. Dudík and J. Šálka, “Students’ perception of bioeconomy as an important factor in communicating and further development of the bioeconomy in Slovakia and the Czech Republic,” *Scandinavian Journal of Forest Research*, vol. 38, no. 4, pp. 265–274, 2023.