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Assessing The Determinants of Participation in the Circular Plastic Economy by Nigerian Students

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Abstract

Purpose

This study addresses the critical subject of building capacity for the circular economy in the global south. It complements the literature by providing information on the role of higher education institutions in developing skills for the circular plastic economy.

Design/methodology/approach

This study used a mixed method approach drawing on reflective analysis on qualitative data from five (5) focus groups and twelve (12) semi-structured interviews, and structural equation modelling of quantitative data from 151 students across four (4) Nigerian Universities.

Findings

The results indicate that Nigerian university students are more likely to participate in the circular plastic economy through a high prominence of soft power features such as increased awareness, inspiration, idea generation, encouragement, and capacity building.

Originality/value

This study makes a novel contribution by using empirical evidence to determine the predictors of student participation in the circular plastic economy. This understanding is important for the development and implementation of appropriate policies that promote participation in the circular plastic economy. Furthermore, given the typical youthful age bracket of university students, any plans to achieve a systemic shift in the plastic value chain must involve the young generation.

Research limitations/implications

The main limitation of this study is with the sample. A larger dataset including other tertiary institutions such as private universities, polytechnics and schools of vocational studies would strengthen the results.

Practical implications

The study underlines the importance of targeted policy interventions and pedagogic innovations to drive awareness and knowledge building among Nigeria's youth population.

Keywords: Belgrade Framework, Circular Economy; Epistemic Agency, Plastics; Students.

1 Introduction

Recently, plastic pollution has become a significant topic in the sustainability discourse. While efforts to address this issue have mainly focused on regulations banning specific plastic products (Syberg et al., 2021) there is a growing focus on transitioning towards a more efficient and circular plastic value chain (Oyinlola et al., 2023). To achieve a circular plastic economy, there must be an effective system in place for collecting, sorting, and recycling plastic waste to minimize leakages. However, developed economies have a collection rate of only about 32%, and low-income countries often lack the necessary waste infrastructure to manage plastic waste properly (Jambeck et al., 2015).

The Circular Economy (CE) offers a viable solution for sustainably managing plastics (Dedehayir et al., 2018). It promotes the principles of reduce, reuse, and recycle, aiming for a systemic redesign of product lifecycles and consumption patterns (Ghisellini et al., 2016).

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3 However, translating CE principles from theory to practice faces significant hurdles,
4 underscoring the gap between academic discourse and real-world application.
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8 Central to overcoming these challenges is epistemic agency, defined as the proactive
9 engagement in one's learning and understanding advancement (Muukkonen et al., 2011). It
10 suggests that individual learning, shaped by relational pedagogies and flexible environments,
11 can drive motivation and action towards sustainable practices. Yet, the development of
12 epistemic agency is complex, influenced by social, cultural, and political dynamics that can
13 both enable and constrain knowledge exchange and freedom (González-Howard and McNeill,
14 2020). Epistemic agency is a fundamental dimension of self-efficacy needed to support
15 entrepreneurial engagement. (Akgun and Sharma, 2023) argue that epistemic agency is
16 developed through critical inquiry and is “focused on knowledge advancement and a sustained
17 process of creating and improving shared ideas via collective contribution” Pg 2.
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27 Higher Education Institutions (HEIs), especially universities, are recognized as key players in
28 fostering innovative educational frameworks that support sustainable development (Collado et
29 al., 2022). Through knowledge building and theoretical model deployment, universities have
30 the potential to significantly contribute to the CPE movement. Nevertheless, the extent of their
31 impact, particularly in regions like Nigeria, remains uncertain amidst various challenges
32 including funding, infrastructure, and faculty adequacy (Nunes et al., 2018).
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39 Nigerian universities have undergone substantial transformation, integrating technological
40 advancements to enhance education quality and accessibility. Initiatives ranging from e-
41 learning platforms to entrepreneurship education highlight a commitment to fostering
42 epistemic agency and practical competencies among students (Akubuilu and Okorie, 2013;
43 Kaegon and Nwaeke, 2020). However, Nigerian universities face significant barriers,
44 including underfunding and brain drain, which hinder the full realization of innovative
45 educational policies. Yet, the growing demand for education and technological integration
46 offers promising avenues for overcoming these obstacles, emphasizing the need for
47 government support and private sector involvement (Etuk, 2015).
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57 This study makes a novel contribution to the circular economy literature, by using empirical
58 evidence to determine the predictors of some Nigerian university students' participation in the
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3 circular plastic economy. The study is important for the development and implementation of
4 appropriate policies that promote participation in the circular plastic economy. Furthermore,
5 given the typical youthful age bracket of university students, any plans to achieve a systemic
6 shift in the plastic value chain must involve the young generation.
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10 The rest of the paper is structured as follows. Section 2 presents the theoretical framework and
11 hypothesis development. Section 3 presents an in-depth description of the methodology and
12 sample employed in this study. Section 4 presents the results from the quantitative and
13 qualitative study. Section 5 discusses the results, and its implication, section 6 outlines the main
14 conclusions, limitations of the study and suggests areas for further research.
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20 **2 THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT**

21 Building capacity of students for the circular plastic economy can be classed as environmental
22 education. Therefore, this study adopted the principles of The Belgrade Charter, which was
23 developed as a framework for environmental education in 1975. Despite being a historical
24 document, the content is still relevant in modern times. Over the years, there have been several
25 studies around the framework, for example, a study reviewed some debates and questions
26 over Environmental Education (EE) and Education for Sustainable Development (ESD), one
27 of which asked, “Is EE becoming ESD?”, where the authors recommended the adoption of a
28 collaborative and locally applicable approach instead of competing terminologies (McKeown
29 and Hopkins, 2003). A study about the initiation of the “Green School” in Israeli education
30 credited the Belgrade Charter (UNESCO, 1976) and the Tbilisi Declaration (UNESCO, 1977)
31 for pioneering the need for environmental education as they introduced the need for change
32 while raising the social consciousness of environmental crisis and enhancing personal and
33 collective responsibilities. The study however recommended the need for further clarity on the
34 value of introducing “Green School” as a vital appendage of schools’ existence (Marcus, 2012).
35 The ideology on the need for creating awareness about environmental issues was also supported
36 by (Basu et al., 2022), especially in HEI’s.
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50 The Belgrade framework states environmental education objectives should be based on 6 key
51 pillars shown below, which are in alignment with various studies and recommendations:
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- 54 • “*Awareness*: To help individuals and social groups acquire an awareness of and
55 sensitivity to the total environment and its allied problems.
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- *Knowledge*: To help individuals and social groups acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.
- *Attitude*: To help individuals and social groups acquire social values, strong feelings of concern for the environment and the motivation for actively participating in its protection and improvement.
- *Skills*: To help individuals and social groups acquire the skills for solving environmental problems.
- *Evaluation ability*: To help individuals and social groups evaluate environmental measures and education programmes in terms of ecological, political, economic, social, and educational factors.
- *Participation*: To help individuals and social groups develop a sense of responsibility and urgency regarding environmental problems to ensure appropriate action to solve those problems.”

The framework highlighted in the Belgrade document can possibly be adopted as a baseline model in the design and evaluation of impact in environmental education in universities. The Belgrade framework is presented in Figure 1.



Figure 1: The Belgrade Framework

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3 This study focuses on developing CE participation in low-income countries, where
4 environmental concerns are generally less prioritised. However, it is worth noting that
5 recycling and reuse is first inbuilt into everyday practice as a result of the prevalence of
6 indigenous knowledge cultures that honour mother earth. Secondly, poverty and negative
7 capabilities make recycling and reuse obligatory though this may not be beneficial as the
8 processes and structures for indigenous recycling and reuse are delinked from the modern
9 knowledge systems and epistemic agency; leading to even greater environmental concerns and
10 lack of awareness and proficiency. Thirdly, the carbon footprint of many in low-income
11 countries who often have poor access to high polluting materials is perceived to be relatively
12 low and insignificant compared to those in high-income countries. There is a debate about
13 historical responsibility (Füssel, 2010) because of environmentally poor technologies used
14 through the industrial revolution by some countries amid increasing scientific accounts for
15 shared planetary responsibilities. The roles and responsibility of all citizens regardless of social
16 economic exposure to the climate crisis is always rationalised by economic capabilities.

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19 In light of the above, this study tests the following five hypotheses:

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22 **H1:** There is a positive relationship between awareness of the circular plastic economy and
23 student participation in the circular economy practices. This follows from the fact that literacy
24 of the circular economy is required to shape environmental citizenship behaviour (Nuringsih
25 and Nuryasman, 2022). Literacy can be promoted by knowledge production and exchange,
26 facilitation by knowledgeable experts promotes sustainable futures as it fosters students social-
27 ecological transformation and awareness (Kowasch, 2022).

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30 **H2:** There is a positive relationship between perceived knowledge developed through
31 collective and collaborative development of the circular plastic economy and student
32 participation in the circular economy. This hypothesis stems from the fact that environmental
33 knowledge provides a solution to ecological problems and promotes sustainable consumption
34 (Owojori et al., 2022; Ratner et al., 2021). Enhanced knowledge of environmental education,
35 which also includes the circular economy, influences university students' attitudes and
36 behaviours favourably with those studying Engineering, Social and Human Sciences the most
37 impacted (Paço and Lavrador, 2017).

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40 **H3** There is a positive relationship between attitude to the circular plastic economy and the
41 student participation in the circular economy. Previous studies have noted that environmental

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3 education influences attitude formation which drives ecological supportive actions(Boiyo et
4 al., 2015).

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7 **H4** There is a positive relationship between evaluation ability of the circular plastic economy
8 and the student participation in the circular economy. This hypothesis is in line with literature
9 that recommends evaluation of the drivers, barriers and practices of the circular economy,
10 which is necessary for promoting innovations to reduce waste, increase resource-efficiency and
11 achieve sustainability(Kristensen and Mosgaard, 2020).

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16 **H5** The relationship between perceived knowledge and student participation in the circular
17 economy is mediated by students' skills set. The relationship between knowledge and
18 commitment to circular economy agenda is a subject of ongoing scholarly interest. In this
19 paper, the authors further interrogate the process by going beyond the "know what"
20 (knowledge) to exploring the complementary or supplanting role of "know how" (skill) in the
21 process of participation and engagement in the circular plastic economy (Nuringsih and
22 Nuryasman, 2022). The literature highlights the need to equip people with knowledge and
23 skills, through capacity building, in order to drive active participation in the circular
24 economy(Awan et al., 2021). Thus, a proposal for hypothesis 5: the relationship between
25 knowledge and students' participation in the circular economy is mediated by students' skills
26 set.

37 **3 Methodology**

38 The study adopted a mixed-methods approach (Creswell, 2014) to systematically collect and
39 review qualitative and quantitative data which was then analysed. The study used a
40 convenience sampling approach for the questionnaires and focus group discussions with the
41 Nigerian university students. Ethical approval was sought from and granted by the Faculty of
42 Health & Life Sciences Faculty Research Ethics Committee at De Montfort University with
43 approval number 3927. The research was conducted in line with the guidelines of the British
44 Educational Research Association (BERA).

50 **3.1 Data collection**

51 Quantitative data was collected through an electronic survey of students. All respondents of
52 the survey were participants of the British Council Circular Plastic Economy Innovation (BC-
53 CPEI) Hub project, which involved a series of training workshops (Oyinlola et al., 2024). The
54 participants for the project were randomly selected via invitation from professors, university
55 departments, social media profiles, and several WhatsApp university groups. Participants who
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were interested were asked for basic demographic information, contact information, and their area of study or specialisation. This was done to make sure the cohort was balanced in terms of gender, study level, and course of study. All participants who were able to commit to the training programmes were selected. The project commenced with ideation workshops held in each of the universities between March and April 2022, which was mandatory for all participants. At the start of the workshop, participants received the link to an online survey (hosted on Google Forms). Using a 5-point Likert scale (see Table 3), the questionnaire was created to capture students' perceptions on the circular plastic economy. The survey was in English, which is the official language of learning in Nigeria, so all participants understood the questions. The survey received responses from 151 different students from across the four universities. The questions in this survey are presented in Appendix 1. It is pertinent to note that the training programme took place during the period when most Nigerian universities were shut for 8 months due to industrial action by academic staff. This significantly reduced the number of participants that were recruited.

Table 1 shows the summary of the respondents' profiles and a more detailed summary of the result is shown in Appendix 2.

Table 1: Profile of Questionnaire Respondents

<u>Variable</u>	-	<u>Frequenc</u> <u>y</u>	<u>Percent</u>
<u>Gender</u>	Male	103	68.2
	Female	48	31.8
	Total	151	100
<u>Age</u>	18-24	71	47
	25-34	56	37.1
	35-44	17	11.3
	45-54	7	4.6
	Total	151	100
<u>University</u>	Ahmadu Bello University	56	37.1
	University of Nigeria	23	15.2
	University of Lagos	40	26.5
	Obafemi Awolowo University	29	19.2
	Other	3	2.0
	Total	151	100
<u>Current Level of Study</u>	Post PhD	5	3.3
	PhD	17	11.3
	Masters	44	29.1
	Undergraduate	82	54.3
	Others	3	2.0
Total	151	100	

Field of Study			
Agriculture		1	0.7
Arts		6	4
Built Environment		7	4.6
Business Administration		4	2.6
Computer Science		7	4.6
Education		6	4
Engineering		61	40.4
Environmental Sciences		4	2.6
Humanities		7	4.6
Law		2	1.3
Medicine		5	3.3
Sciences		41	27.2
Total		151	100

Furthermore, qualitative data was collected by focus group discussion with staff and students. Details of the focus groups can be found in Table 2. Participants for the focus group discussions were selected using a purposeful sampling approach, which is frequently employed in qualitative research for the identification and selection of information-rich cases (Palinkas et al., 2015). Some students who participated in the ideation workshop were identified as ideal participants based on their engagement, and lecturers were chosen at random from the four universities. Using Microsoft Teams, a total of five focus group discussions (FGD) were conducted in English Language. The discussion questions were informed by findings from the semi-structured interviews and the literature review.

Table 2: Details of focus groups

Date	Focus group	Number of Participants	Description
29/06/22	OAU - Staff and Students	8	Staff and students from various departments of Obafemi Awolowo University.
14/07/22	UNILAG – Staff	6	Staff from various departments of University of Lagos
28/07/22	UNILAG Students	5	Student entrepreneurs from University of Lagos
15/07/22	UNN Staff	4	Staff from University of Nigeria
19/07/22	Finalists of Innovation challenge	6	Students from Ahmadu Bello University, Obafemi Awolowo University, University of Nigeria, University of Lagos. Participants were finalists of the innovation challenge hosted by the circular plastic innovation hub

3.2 Variables and Measures

The study identified the key pillars of the Belgrade framework and used them to develop questions for the quantitative and qualitative research which were used to gain insights from the students. These are presented in Table 3. The authors note that the limitation inherent in the self-reported nature of the "knowledge" variable, and also its operationalisation as a single item measure in this study. However, this limitation is mitigated by complementary data from the focus group discussions, where, among others, an exploration of participants' sources of awareness and knowledge is presented. The summaries of the focus group discussions presented in tables 8 and 9 underline the importance of knowledge platforms in the university and on the internet as critical precursors of participants in circular plastic innovation and activities.

Table 3: Research Codes and Questions

Pillars	Indicator code	Focus Group Questions
Awareness	AWS1	What is your level of awareness of the link between plastic pollution and climate change [No awareness, little awareness, moderate awareness, high awareness, excellent awareness]
	AWS2	Are you aware of any regulations in your immediate environment to improve plastic waste management? [Yes, No]
Perceived Knowledge	KNE1	How do you rate your knowledge about the circular plastic economy? [No knowledge, little knowledge, moderate knowledge, very good knowledge, excellent knowledge]
Attitude	ATE1	How concerned are you about the impact of plastic waste on the environment? [Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned]
Skills	SKI1	How do you rate your ability to generate financial value (e.g., income/profit) from a circular plastic product? [None, low, moderate, high, excellent].
	SKI2	How do you rate your ability to generate financial value (e.g., income/profit) from a circular plastic service? [None, low, moderate, high, excellent]
Evaluation Ability	EVA1	How will you rate the plastic-waste problem in your community? [not all severe, slightly severe, moderately severe, highly severe, extremely severe]
	EVA2	How effective are the waste collection and management systems used in the country? [ineffective, moderately effective, fairly effective, very effective, effective]
Participation	PAN1	Have you ever been part of a business that contributes to the circular plastic economy? [Y/N]
	PAN2	Have you taken any action to manage plastic waste in your environment? [Y/N]

	PAN3	Have you been involved in an initiative to reduce, reuse or recycle plastic waste? [Y/N]
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3.3 Controls

The study used age, gender and geographic location of the selected Universities as controls:

- **Age**, as past studies argued that older people are more sensitive to environmental concerns (Ali et al., 2022; Ololade and Rametse, 2018).
- **Gender**, as some studies have shown gender as being significant in the investigation of circular economy innovations as women were discovered to be more worried about climate change and show positive mindsets towards the environment (Atlason et al., 2017). Females accounted for between 25-40% of respondents in each of the universities.
- **Geographic location**: some studies have observed that circular economy practices and habits are location sensitive, for example, (Bathelt and Henn, 2017) presented an assumption on innovation that “local locations lead to local growth”. In this study, the location is identified based on educational institutions as educators have a pivotal role to provide relevant curricula to impact the development of successful innovative business ventures (Bauman and Lucy, 2021). The four universities selected are a good geographical and regional representation of Nigeria as they are part of the 5 universities termed as first-generation universities - West: University of Lagos with a student population of 57,000; Obafemi Awolowo University with enrolment of 30,000, North: Amadu Bello University with 49,954 students, East – University of Nigeria, Nsukka with a student population of 36,000. Three of these universities emerged from the Education Ordinance of 1952 as Nigerians agitated for local education during the colonial era freedom debates. Almost all other universities in Nigeria are directly or indirectly linked to these premier institutions. The total student population across the four universities is 172,954.

3.4 Data Analysis

The study analysed the quantitative data using Structural Equation Modelling (SEM) with STATA software. SEM was used because of its perceived robust nature in many disciplines (Khan et al., 2020). The model tests for association among the four observed variables and our model’s outcome variable (“Participation”). It also tests if “Skills” can mediate the relationship between knowledge and participation. This facilitates the testing of our hypotheses (hypotheses 1 – 5). The path diagram in Figure 2 depicts the model.

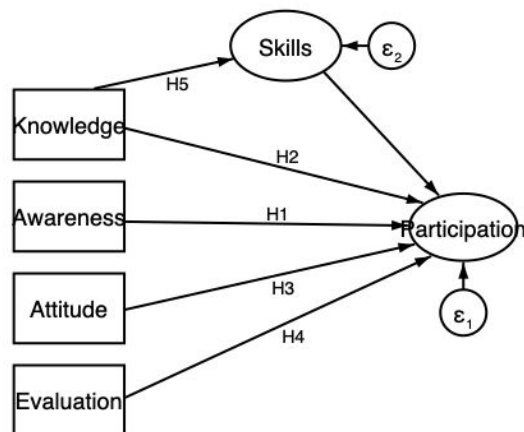


Figure 2: Path diagram of the model

It is important to note that the sample size met the suggested rule of thumb for SEM analysis i.e., ten times the number of indicators (Hair et al., 2012) as 90 observations would have met the rule of the thumb for the model.

A reflective thematic analysis (Braun and Clarke, 2021) method was used to systematically analyse the qualitative data gathered from the focus group discussions. This was implemented through the iterative collection and analysis of data from the focus group discussions with the university students to derive a theory. The data used were aggregated from focus group discussions with a random selection of the university students and student innovators. The outcomes were initially analysed using open codes which were then grouped into categories. The insights from the discussions allowed for theoretical sampling as it compared findings from the data while providing more information on the existing codes. The codes and categories were continuously refined in an axial coding process and then fused together into a selective category which formed the basis for the concluding theory.

4 RESULTS

4.1 Structural model

Figure 3 the graphical result of the model and Table 4 the results showing the indicators' coefficients, their corresponding standard errors and the variance for each of the latent variables' indicators. For ease of interpretation, the total effects Table (Table 5) which shows direct, indirect and total effects of each path in the model.

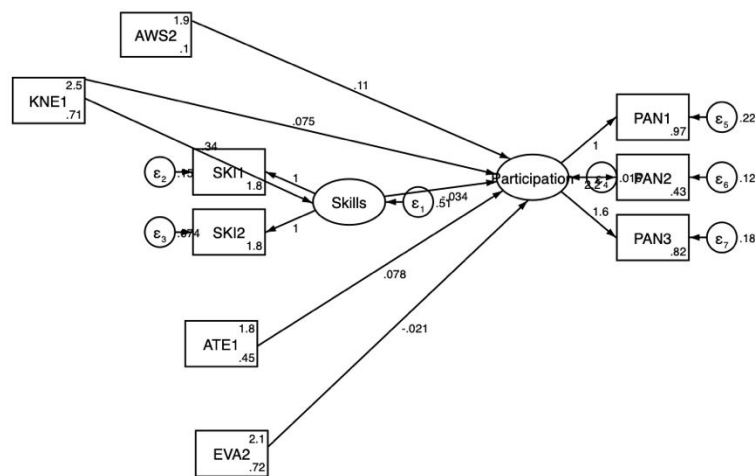


Figure 3: SEM Graphical Output

In the measurement model, perceived knowledge has a positive and significant impact on skills with a positive coefficient of 0.339 which is statistically significant at $p < 0.01$. Constraining the ability to generate financial value from a plastic product to 1, skill has a positive and significant impact on the individual’s ability to generate financial value from a plastic service with a coefficient of 1.047 which is statistically significant at $p < 0.01$. On the measurement of participation, with the first indicator for participation (that an individual has been a part of a business that contributes to the plastic circular economy before) constrained to 1, it found participation to positively affect individual’s taking action to manage plastic waste in the environment (PAN2) with the coefficient of 2.216 which is statistically significant at $p < 0.01$. The latent variable participation also strongly affects individual’s involvement in initiatives to reduce, reuse or recycle plastic waste (PAN3) at $p < 0.01$ with a coefficient of 1.609 (Table 4). Table 5 gives individual level measurement of impacts and significance of the measurement model before presenting the total effects of the structural model.

Table 4 SEM Results Table

Variables	(1) Participation	(2) Skills	(3) SKI1	(4) SKI2	(5) PAN1	(6) PAN2	(7) PAN3	(8) var
Skills	-0.0338 (0.0235)		1	1.047*** (0.133)				
AWS2	0.106*							

	(0.0587)							
KNE1	0.0747**	0.339***						
	(0.0318)	(0.0787)						
ATE1	0.0782***							
	(0.0296)							
EVA2	-0.0211							
	(0.0190)							
Participation			1	2.216***	1.609***			
			(0)	(0.761)	(0.535)			
var(e.SKI1)							0.149**	
							(0.0722)	
var(e.SKI2)							0.0744	
							(0.0774)	
var(e.PAN1)							0.218***	
							(0.0269)	
var(e.PAN2)							0.119***	
							(0.0308)	
var(e.PAN3)							0.180***	
							(0.0266)	
var(e.Participation)							0.0160	
							(0.0102)	
var(e.Skills)							0.513***	
							(0.0920)	
Constant		1.838***	1.772***	0.968***	0.434*	0.817***		
		(0.208)	(0.203)	(0.173)	(0.248)	(0.204)		
Observations	151	151	151	151	151	151	151	151

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Total Effects Table – Measurement and Structural

	Coefficient	Std. error	Z	P>z
Measurement				
SKI1				
Skills	1	(constrained)		
KNE1	0.3389	0.0787	4.3100	0.0000
SKI2				
Skills	1.0469	0.1328	7.8800	0.0000
KNE1	0.3548	0.0764	4.6400	0.0000
PAN1				
Participation	1.0000	(constrained)		
Skills	-0.0338	0.0235	1.4400	0.1510

AWS2	0.1061	0.0587	1.8100	0.0710
KNE1	0.0633	0.0289	2.1900	0.0290
ATE1	0.0782	0.0296	2.6400	0.0080
EVA2	-0.0211	0.0190	1.1100	0.2650
PAN2				
Participation	2.2156	0.7613	2.9100	0.0040
Skills	-0.0748	0.0493	1.5200	0.1290
AWS2	0.2352	0.1098	2.1400	0.0320
KNE1	0.1402	0.0425	3.3000	0.0010
ATE1	0.1733	0.0596	2.9100	0.0040
EVA2	-0.0468	0.0393	1.1900	0.2340
PAN3				
Participation	1.6092	0.5346	3.0100	0.0030
Skills	-0.0543	0.0370	1.4700	0.1420
AWS2	0.1708	0.0804	2.1200	0.0340
KNE1	0.1018	0.0398	2.5600	0.0110
ATE1	0.1259	0.0419	3.0000	0.0030
EVA2	-0.0340	0.0295	1.1500	0.2500
Structural				
Participation				
Skills	-0.0338	0.0235	1.4400	0.1510
AWS2	0.1061	0.0587	1.8100	0.0710
KNE1	0.0633	0.0289	2.1900	0.0290
ATE1	0.0782	0.0296	2.6400	0.0080
EVA2	-0.0211	0.0190	1.1100	0.2650
Skills				
KNE1	0.3389	0.0787	4.3100	0.0000

Furthermore, the hypotheses testing indicates that perceived knowledge building and attitude have positive causal effects on Nigerian university students' participation in circular plastic economy. They were each statistically significant at $p < 0.05$ (Table 4, Table 5 and Table 6). The hypothesis to test whether knowledge building can impact participation through skills gives a coefficient of 0.3339 which is significant at $p < 0.01$. Awareness also has a positive relationship with participation, but it is only significant at $p < 0.1$ level of significance with a p -value of 0.071. The relationship between evaluation skill and participation is insignificant. This implies that individual's assessment of the effectiveness of waste collection management has

no effect on the interest and willingness of the respondents to engage with the circular plastic economy (CPE). The non-significance of evaluation skill should be understood within the context of other significant variables, notably attitude, knowledge and skills. In other words, knowledge, attitudes and skills supplants any potential impact of evaluation skills on CPE participation. This is also not unexpected as evaluation skills, while specific to evaluation, may have been captured as part of overall skills already in the model as a predictor of CPE participation. Overall, the link between the rationale presented in scientific knowledge systems and epistemic agency is very strong, there is also a correlated association with personal or collaborate action which is significant.

Table 6 gives a snapshot position of the results.

Table 6: Hypothesis Testing Table

Hypotheses	Relationship	Path Coefficient	p-value	Conclusion
H1	Awareness and Participation	0.1061	0.071	Positive and significant at $p < 0.1$
H2	Knowledge and Participation	0.0632	0.029	Positive and significant at $p < 0.05$
H3	Attitude and Participation	0.0782	0.008	Positive and significant at $p < 0.05$
H4	Evaluation Ability and Participation	-0.0211	0.265	Negative and not statistically significant
H5	Knowledge, Skills, and Participation	0.339, -0.0338	0.000, 0.151	Total effect of knowledge positive and significant at $p < 0.05$

The outcomes of the hypothesis tests consistently demonstrate statistical significance, with p-values below 0.01, with the exception of H4. The verification of Hypothesis 1 (H1) affirms a robust positive correlation ($p < 0.071$) between awareness and students' engagement in the circular plastic economy. Similarly, Hypothesis 2 (H2) substantiates a positive correlation ($p < 0.029$) between knowledge acquired through collaborative development and students' involvement in the circular economy. Findings pertaining to Hypothesis 3 (H3) validate a substantial positive association ($p < 0.008$) between attitude and students' participation in the circular economy.

Conversely, the assessment of Hypothesis 4 (H4) rebuffs any discernible connection ($p < 0.265$) between evaluation ability and students' participation in the circular economy. In contrast, Hypothesis 5 (H5) aligns with its counterparts (H1, H2, and H3), as the examination affirms the hypothesis, revealing an overall positive association ($p < 0.05$) encompassing knowledge, skills, and students' participation in the circular economy.

4.2 Test of quality for the model

A post estimation test was undertaken on the model by comparing it with the saturated model i.e., the model that is presumed to fit our data covariances perfectly. The model passed the test of misfit with a p-value greater than 5% (10.2 level or 0.102). The model was compared to the baseline model, and it recorded a p-value ($p > \chi^2$) of 0.0000. Rejecting the null hypothesis of baseline versus the saturated gives additional supports for the model. The baseline comparison was also close to 1 with CFI of 0.971 and TLI of 0.955. However, a moderate coefficient of determination was recorded showing that only about 50% of variations in the outcome are explained by the explanatory variables. This is not unexpected, considering the size of the observations.

4.3 Implications and Archetype Development

The focus group discussions with the university students revealed some initial insights which were coded and segmented into three main categories – entrepreneurship desire generation, innovation development enablement and circular plastic economy growth as shown in Table 7 and Table 8

Table 7: Focus Group Insights from University Students

Insights from Focus Group		
Entrepreneurship Desire Generation	EDG 1	Incidences and academic strikes in Nigeria have propelled entrepreneurial thinking.
	EDG 2	Academic environment supports research and collaboration that could facilitate becoming a successful entrepreneur.
	EDG 3	Learning should not just be in the classroom but also peer-to-peer and mentorship by industry actor.
	EDG 4	Some academic departments encourage students to work in teams and pitch business ideas.
	EDG 5	Not all departments teach students on entrepreneurship. However, lecturers can be taught so they can teach students.
	EDG 6	Professionals on LinkedIn in can be invited to talk to students.
Innovation Development Enablement	IDE 1	School challenges with prizes attached to them encourages students to think out-side-the-box.
	IDE 2	Credit should be given to organisations that encourage students to develop new ideas and work together as a team as it is not enough for everyone to develop their own ideas individually.

	IDE 3	Some students have generated ideas due to their collaboration and affiliation with certain organisations.
	IDE 4	University community creates a good people network for business owners, which can help generate new ideas.
	IDE 5	WhatsApp is the best means of sharing information and ideas on campus using various closed groups.
Circular Plastic Economy Growth	CPEG 1	More business ideas on SDGs and the sustainability of the environment should be developed to help the community.

Table 8: *Focus Group Insights from University Student Innovators*

Insights from Focus Group		
University Support for Innovation Development in Plastic Waste Management	SID 1	Incorporation into innovation challenge on circular plastic economy was facilitated by universities providing a platform for it to be anchored.
	SID 2	Supervisors encouraged students' participation based on past/current related projects.
	SID 3	Research on agricultural waste was easily applied in converting plastic waste to something useful.
	SID 4	Supervisors provided help or guidance during the process.
	SID 5	Information on opportunity to be part of innovation was received in university by other students, class groups, department information, etc which triggered interest in plastic waste.
Idea Generation Platform at University for Plastic Waste Management	IGP 1	Had idea based on concern but needed a platform to present idea.
	IGP 2	Previous experience in participation in school competitions in universities had built capacity to innovate, however further support is needed.
	IGP 3	Would not have developed an innovative idea to innovate on plastic waste management without competition at university.
	IGP 4	Already working on research for plastic waste conversion to nano materials, with a second option to utilize agricultural waste.
	IGP 5	University challenge helped in channelling resources to something more valuable and useful.
Source of Awareness and	SAI 1	University project on micro plastics in Africa based on concern of it being ignored.

Interest on Plastic Waste Management	SAI 2	News on flooding and personal experiences with flooding during raining season. This sparked an interest to want to do something about the environmental issues.
	SAI 3	Seeing information on the internet on flooding caused by climate change created desire to think out-side-the-box for biodegradable plastics.

The second order themes were then narrowed down further into six broader themes – entrepreneurship, desire generation, innovation development enablement, circular plastic economy growth, university support for innovation development, idea generation platform and source of awareness. The key emerging ideas were mapped to three main elements – sensitisation and awareness, encouragement and capacity building. These results shaped the initial thinking around the theory formulation.

As part of the iterative process, the codes and categorisation were later modified based on groupings and emerging trends in the discussions. As shown in Figure 4, Figure 4 the categories were reshaped to reflect awareness, inspiration, idea generation, encouragement and capacity building as critical determinant factors of students' participation in the circular plastic economy (CPE) with soft power being the main selective category that pulls them all together.

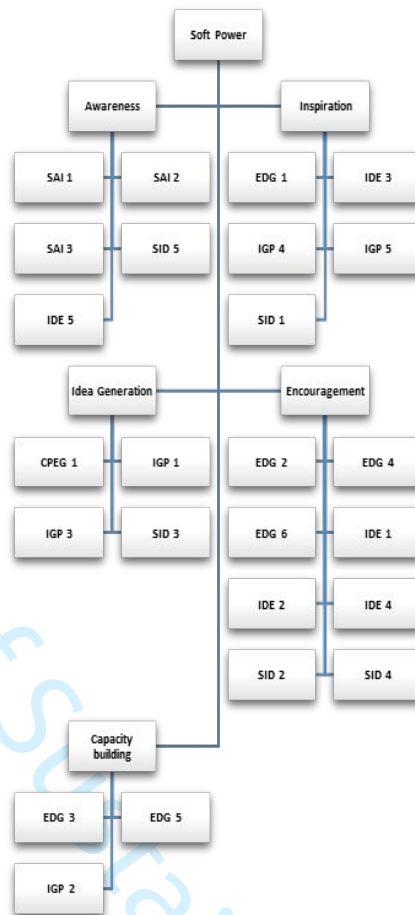


Figure 4: *Reflective Thematic Analysis of Focus Group Discussions*

The process has established some evidence that Nigerian university students are more likely to participate in the CPE through a high prominence of soft power principles and the enabling environment which supports epistemic agency. Features that support practical evidence and use soft power by increasing awareness, inspiration, idea generation, encouragement and capacity building. The results show encouragement as being the most significantly cited and impactful determinant. Encouragement stimulates agency and enables learners to use their capabilities and capacity productively. This is facilitated rather than enforced.

5 DISCUSSION AND IMPLICATIONS

The project concentrated on interrogating capacity building for the circular economy in Nigeria with a specific focus on the role of higher education institutions in developing skills for the circular plastic economy through effective pedagogic innovation (Nanath and Ajit Kumar, 2021). It first positions the circular plastic economy as a sustainable solution to the plastic

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3 waste challenge. The findings suggest that the association between tackling plastic waste,
4 education and collaboration with industrial solutions is well established. The significant role
5 of HEI's in building capacity of Nigerian university students through the application of the
6 Belgrade Charter as a framework to expand awareness, build knowledge, promote attitudes,
7 skills, evaluation ability and participation in the circular plastic economy is examined. Through
8 an iterative process, the study proposes an archetype for CPE education in Nigerian HE
9 ecosystem.

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12 The study findings indicate that in order to ensure CPE is integrated into the broad socio-
13 political framework, in countries in the global south which perceive their responsivity to the
14 climate crisis as historically less significant, HEIs would need to play a critical role in leading
15 pioneering frameworks and strategies for championing engagement in practical environmental
16 challenges (Bertossi and Marangon, 2022). The Belgrade Charter presents a broad, critical
17 framework and regulations that would facilitate the transformation for integrating pedagogies
18 that have a good chance of leading to transformative learning (Adefila et al., 2023).

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21 The data from Nigerian university students demonstrates that epistemic agency facilitated by
22 scaffolded awareness and knowledge building and the Belgrade framework which helped in
23 guiding the variables that influence their participation in the CPE, are principal policy
24 instruments. It found the factors as being significant at $p < 0.1$ each, in the influence of the
25 participation of students of Nigerian HEIs in environmental education and circular plastic
26 economy, amongst others. The positive relationship between "awareness" and "knowledge"
27 and the CPE, established the role of Nigerian universities, with a control for age, gender and
28 geographic location, as a way of incubating foot soldiers to drive for change. This shows that
29 students are not ambivalent or dismissive of the challenges of the climate crisis and are
30 prepared to support collaborative action. Furthermore, the study shows that there is a latent
31 perception of the role of all as planetary citizens in the fight against climate change.

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34 The study also posits the premise that the HEIs have a role to play through the Nigerian
35 National Universities Commission (NUC) in facilitating participation of students collaborating
36 with other stakeholders. Policy instruments that ensure learning environments and resources
37 support a critical inquiry of CPE, including scientific evidence of the role of humans in
38 environmental degradation and our shared planetary citizenship and responsibility to tackle
39 climate change are critical. The infrastructure and processes that promote knowledge building
40 in collaboration with key stakeholders via activities and strategies such as enlightenment
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3 campaigns, workshops and seminars, scaffolded curricula development, teachers' professional
4 development, amongst others is equally important as attitudes and skills can be influenced by
5 participation and critical engagement. Although, attitudes are more of a behavioural condition,
6 it has a significant and direct impact on the CPE, as increase in participation correlate with an
7 uptick in positive attitudes. Therefore, although challenging, mechanisms would need to be
8 developed based on social and psychological theories to influence attitudes (Olufemi, 2012).
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14 The findings might be difficult to implement due to the lack of political will and poor process
15 management with respect to enacting top-down policies and championing incentives. Though
16 economic and sociocultural incentives driven by the Ministry of Education can stimulate a
17 comprehensive and integrated structure for HEIs generally, these may not be aligned to local
18 peculiarities. A phased approach, starting with awareness creation and a nuanced appreciation
19 of institutional needs and designs for supporting pedagogic innovation and infrastructure for
20 collaboration with stakeholders might be the most pragmatic solution.
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27 The findings contribute to a growing body of evidence for Nigerian university students'
28 participation in the CPE using soft power tools and techniques, through awareness, inspiration,
29 idea generation, encouragement and capacity building (Babalola and Olawuyi, 2021). The
30 research develops a thick and significant emphasis for encouraging initiatives that value
31 epistemic agency, personal motivation and stimulating an enabling environment (Etuk, 2015).
32 This implies that even though awareness programmes, ideation workshops, capacity building
33 regulations and policies are put in place, university students would most likely participate and
34 become foot soldiers of the CPE when they are encouraged by attraction rather than coercion.
35 Therefore, more resources should be channelled towards communications and behaviours that
36 give students the confidence to innovate and participate in the CPE. Furthermore, collaboration
37 with industry (Piekarski et al., 2019) is essential to inspire participation in the CPE.
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The dataset in this study is not representative and relatively small. A longitudinal study which
tracks students through the full university education experience and includes touchpoint
evaluation of the crucial entrepreneurial training in the classroom and in placements would be
useful. The team plans to revisit the universities engaged with this project in the next three
years. Though it may not be possible to access the same sample, it is envisaged that continued
evaluation and monitoring of the entrepreneurial education policy enactments at the coalface
can be done to explore how increased funding and strategic alignment is supporting learners
develop skills and self-efficacy. Purposive sampling was used in this study to collate data as

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3 the research on pedagogic innovation in entrepreneurial education in the Nigerian HE
4 ecosystem is not well known. This study was not able to capture a generative sample as a result
5 of the limitations. A broader overview of policy formulation, implementation and enactment is
6 urgently required, focus on good policy and implementation through evaluation and monitoring
7 should be prioritised as well. This requires continuous funding, committed support from
8 regulators and increasing awareness and communication, in the education ecosystem, of the
9 importance of pedagogic evaluation research and links to effectiveness with respect to
10 transformative learning.
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21 6 Conclusion

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23 The main aim of the study was to complement the considerable body of literature available on
24 the circular plastic economy by providing additional information on the plastic challenge while
25 positioning the circular economy as a viable solution. The study examined the roles HEI's may
26 play in environmental education with a particular slant on the circular plastic economy as
27 established in the Belgrade Charter as a framework for building the capacity of Nigerian
28 university students. The study found that though knowledge of the circular economy as a
29 sustainable and viable approach to plastic waste management is well established; the HEIs
30 would need to play a critical role in decontextualising pioneering frameworks, such as the
31 Belgrade Charter, to ensure locally relevant pedagogic innovation through epistemic agency is
32 realised. Encouraging participation by students through attraction rather than coercion is a more
33 valuable tool for stimulating engagement at many relevant levels.
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43 The study only focused on four well established universities therefore, the findings only
44 provide a preliminary foundation for evaluating generalisability to other Nigerian universities.
45 The study also presents opportunities for further research with greater sample size, control for
46 universities, amongst other features of implementing environmental and entrepreneurial
47 education policies. Action research projects on the CPE shows there is a positive reaction based
48 on participation, there is a need to unpack the elements that support engagement on the one
49 hand as well as implementation and effective outcomes downstream.
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Appendix 1

I. *Survey questions*

1. Gender [Male/Female]
2. Age ([18-24]; [25-34]; [35-44]; [45-54]; [55-64]; [65-74]; [75 and over])
3. Location (State and(or) LGA)
4. What qualification are you studying for? [Undergraduate, Masters, PhD, Primary, Secondary, Other]
5. What is your employment Status (Part-time work, Full-time work, Self Employed/run a business, Others(specify:.....))
6. Field of study [Engineering, Agriculture Arts, Humanities, Medicine, Sciences, Computer Science, Other (specify)]
7. Name of University [Unilag, PAULESI, ABU, OAU, UNN, other (Specify)]
8. Are you currently running a business? (Y/N)
9. Have you ever been part of a business that contributes to the circular plastic economy? [yes, no]
10. How do you rate your knowledge about the circular plastic economy? (No knowledge, little knowledge, moderate knowledge, very good knowledge, excellent knowledge)
11. What is your level of awareness of the link between plastic pollution and climate change? (No awareness, little awareness, moderate awareness, high awareness, excellent awareness)
12. How concerned are you about the impact of plastic waste on the environment? [Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned]
13. How will you rate the plastic-waste problem in your community [not all severe, slightly severe, moderately severe, highly severe, extremely severe]
14. Have you taken any action to manage plastic waste in your environment? Y/N If yes, please list the actions
15. How effective are the waste collection and management systems used in the country? [ineffective, moderately effective, fairly effective, very effective, effective]
16. Are you aware of any regulations in your immediate environment to improve plastic waste management? [Yes, No] if yes, state the policies you are aware of?
17. How confident are you that regulations on plastic waste will be enforced? [Not at all confident, slightly unconfident, moderately confident, highly confident, extremely confident]
18. Have you been involved in an initiative to reduce, reuse or recycle plastic waste? (Y/N)
19. Which of these digital technologies are you aware of? e.g. Artificial intelligence - Yes/No, Blockchain - Yes/No, Robotics -Yes/No, GIS - Yes/No, e.tc.

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20. How do you rate your ability to generate financial value (e.g. income/profit) from a circular plastic product? (None, low, moderate, high, excellent)
 21. How do you rate your ability to generate financial value (e.g. income/profit) from a circular plastic service? (None, low, moderate, high, excellent)
 22. I want to start a business that contributes to the circular plastic economy. [strongly disagree, disagree, neither disagree nor agree, agree, strongly agree,]
 23. I want to work with a business that contributes to the circular plastic economy [strongly disagree, disagree, neither disagree nor agree, agree, strongly agree,]

II. *Focus group discussion questions*

- A. Introductions
- B. What is the university doing to help student acquiring entrepreneurial skills? Follow up to appraise responses on circular plastic economy
- C. What is the university doing to help student be innovators? Follow up to appraise responses on circular plastic economy
- D. What other things have helped you in your entrepreneurial and innovation journey? Follow up to appraise responses on circular plastic economy
- E. What can the university do to enhance student skills for innovation and entrepreneurship?

Appendix 2 – Descriptive Statistics for Likert Scale Statements

Frequencies

	Gender	How do you rate your knowledge about the circular plastic economy?	What is your level of awareness of the link between plastic pollution and climate change?	How concerned are you about the impact of plastic waste on the environment?	How will you rate the plastic-waste problem in your community?
N	Valid	151	151	151	151
	Missing	0	0	0	0

Statistics

	How would you rate your knowledge/understanding on 3D printing?	To what extent do you think 3D printing is useful for managing plastic wastes?	To what extent do you think 3D printing technology is easy to use?	How do you rate your ability to prepare a business plan?	How do you rate your ability to generate financial value (e.g. income/profit) from a circular plastic product?
N	Valid	151	151	151	151
	Missing	0	0	0	0

Statistics

	How do you rate your ability to generate financial value (e.g. income/profit) from a circular plastic service?	How do you rate your ability to generate business solutions that address societal problems?	How do you rate your user engagement skills?	How do you rate your ability to market your products/services?	How do you rate your ability to build a team for your business venture ?
N	Valid	151	151	151	151
	Missing	0	0	0	0

Statistics

	How do you rate your ability to lead a team	How do you rate your book-keeping	After my studies, I would	I prefer to work for a business	I want to start a business that contributes to
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		in your business venture?	(managing cash inflow and outflow) skills?	like to start my own business	than start my own	the circular plastic economy.
N	Valid	151	151	151	151	151
	Missing	0	0	0	0	0

Statistics

I want to work
with a business
that contributes
to the circular
plastic
economy.

N	Valid	151
	Missing	0

Frequency Table

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	48	31.8	31.8	31.8
	Male	103	68.2	68.2	100.0
	Total	151	100.0	100.0	

How do you rate your knowledge about the circular plastic economy?

		Frequency	Percent	Valid Percent
Valid	Excellent knowledge	2	1.3	1.3
	Very good knowledge	15	9.9	9.9
	Moderate knowledge	58	38.4	38.4
	Little knowledge	58	38.4	38.4
	No knowledge	18	11.9	11.9
	Total	151	100.0	100.0

What is your level of awareness of the link between plastic pollution and climate change?

		Frequency	Percent	Valid Percent
Valid	Excellent awareness	11	7.3	7.3
	High awareness	37	24.5	24.5
	Moderate awareness	60	39.7	39.7
	Little awareness	39	25.8	25.8

	No awareness	4	2.6	2.6
	Total	151	100.0	100.0

How concerned are you about the impact of plastic waste on the environment?

		Frequency	Percent	Valid Percent
Valid	Extremely concerned	52	34.4	34.4
	Very concerned	77	51.0	51.0
	Moderately concerned	20	13.2	13.2
	Slightly concerned	2	1.3	1.3
	Total	151	100.0	100.0

How will you rate the plastic-waste problem in your community?

		Frequency	Percent	Valid Percent
Valid	Extremely severe	29	19.2	19.2
	Highly severe	73	48.3	48.3
	Moderately severe	36	23.8	23.8
	Slightly severe	10	6.6	6.6
	Not all severe	3	2.0	2.0
	Total	151	100.0	100.0

How would you rate your knowledge/understanding on 3D printing?

		Frequency	Percent	Valid Percent
Valid	Excellent	5	3.3	3.3
	Good	35	23.2	23.2
	Neutral	59	39.1	39.1
	Poor	47	31.1	31.1
	Never heard of it	5	3.3	3.3
	Total	151	100.0	100.0

To what extent do you think 3D printing is useful for managing plastic wastes?

		Frequency	Percent	Valid Percent
Valid	Very useful	30	19.9	19.9
	Useful	56	37.1	37.1
	Moderately useful	32	21.2	21.2
	A little useful	28	18.5	18.5
	Not useful at all	5	3.3	3.3
	Total	151	100.0	100.0

To what extent do you think 3D printing technology is easy to use?

		Frequency	Percent	Valid Percent
Valid	Very easy	8	5.3	5.3
	Easy	41	27.2	27.2
	Difficult	17	11.3	11.3
	Moderately difficult	81	53.6	53.6
	Very difficult	4	2.6	2.6
	Total	151	100.0	100.0

How do you rate your ability to prepare a business plan?

		Frequency	Percent	Valid Percent
Valid	Excellent	17	11.3	11.3
	High	34	22.5	22.5
	Moderate	81	53.6	53.6
	Low	18	11.9	11.9
	None	1	.7	.7
	Total	151	100.0	100.0

How do you rate your ability to generate financial value (e.g. income/profit) from a circular plastic product?

		Frequency	Percent	Valid Percent
Valid	Excellent	17	11.3	11.3
	High	36	23.8	23.8
	Moderate	75	49.7	49.7
	Low	20	13.2	13.2
	None,	3	2.0	2.0
	Total	151	100.0	100.0

How do you rate your ability to generate financial value (e.g. income/profit) from a circular plastic service?

		Frequency	Percent	Valid Percent
Valid	Excellent	18	11.9	11.9
	High	35	23.2	23.2
	Moderate	78	51.7	51.7
	Low	17	11.3	11.3
	None	3	2.0	2.0
	Total	151	100.0	100.0

How do you rate your ability to generate business solutions that address societal problems?

		Frequency	Percent	Valid Percent
Valid	Excellent	24	15.9	15.9
	High	58	38.4	38.4
	Moderate	60	39.7	39.7
	Low	8	5.3	5.3
	None	1	.7	.7
	Total	151	100.0	100.0

How do you rate your user engagement skills?

		Frequency	Percent	Valid Percent
Valid	Excellent	21	13.9	13.9
	High	70	46.4	46.4
	Moderate	53	35.1	35.1
	Low	7	4.6	4.6
	Total	151	100.0	100.0

How do you rate your ability to market your products/services?

		Frequency	Percent	Valid Percent
Valid	Excellent	26	17.2	17.2
	High	47	31.1	31.1
	Moderate	67	44.4	44.4
	Low	11	7.3	7.3
	Total	151	100.0	100.0

How do you rate your ability to build a team for your business venture ?

		Frequency	Percent	Valid Percent
Valid	Excellent	24	15.9	15.9
	High	63	41.7	41.7
	Moderate	59	39.1	39.1
	Low	5	3.3	3.3
	Total	151	100.0	100.0

How do you rate your ability to lead a team in your business venture?

		Frequency	Percent	Valid Percent
Valid	Excellent	32	21.2	21.2

	High	63	41.7	41.7
	Moderate	52	34.4	34.4
	Low	4	2.6	2.6
	Total	151	100.0	100.0

How do you rate your book-keeping (managing cash inflow and outflow) skills?

		Frequency	Percent	Valid Percent
Valid	Excellent	39	25.8	25.8
	High	46	30.5	30.5
	Moderate	50	33.1	33.1
	Low	14	9.3	9.3
	None	2	1.3	1.3
	Total	151	100.0	100.0

After my studies, I would like to start my own business

		Frequency	Percent	Valid Percent
Valid	Strongly agree	77	51.0	51.0
	Agree,	50	33.1	33.1
	Neither disagree nor agree	22	14.6	14.6
	Disagree	2	1.3	1.3
	Total	151	100.0	100.0

I prefer to work for a business than start my own

		Frequency	Percent	Valid Percent
Valid	Strongly agree	6	4.0	4.0
	Agree,	14	9.3	9.3
	Neither disagree nor agree	62	41.1	41.1
	Disagree	45	29.8	29.8
	Strongly disagree,	24	15.9	15.9
	Total	151	100.0	100.0

I want to start a business that contributes to the circular plastic economy.

		Frequency	Percent	Valid Percent
Valid	Strongly agree	46	30.5	30.5
	Agree,	82	54.3	54.3
	Neither disagree nor agree	16	10.6	10.6
	Disagree	7	4.6	4.6
	Total	151	100.0	100.0

I want to work with a business that contributes to the circular plastic economy.

		Frequency	Percent	Valid Percent
Valid	Strongly agree	48	31.8	31.8
	Agree,	85	56.3	56.3
	Neither disagree nor agree	12	7.9	7.9
	Disagree	5	3.3	3.3
	Strongly disagree,	1	.7	.7
	Total	151	100.0	100.0