Rima International Journal of Education (RIJE), Vol. 3 (No. 3): Nov 2024; page: 18-33 ISSN: 2756 - 6749

Recycling of Plastic Waste Products through Innovative Design Approach in Teaching and Learning of Basic Science and Technology in Pankshin Local Government Area

DUNG MOHAMMED DAUDA

Department of Integrated Science, Federal College of Education, Pankshin, Plateau State, Nigeria, Email: dungmohamed@gmail.com

Abstract

The study was carried out to investigate the recycling of plastic waste products through innovative design approach in teaching and learning Basic Science and technology in Pankshin Local Government Area of Plateau State. The population for the study was 11,600. 372 students were used as sample size. The instrument used for data collection was a questionnaire. Descriptive statistics of percentage and mean scores was used as method of data analysis. The result obtained from the study showed that plastic waste management practices in Pankshin are generally accepted, effective, and aware, but challenges exist, and collaboration needs enhancement. Integrating plastic waste recycling into basic science is widely accepted, teachers are equipped, curriculum flexibility exists, but hands-on activities need improvement. The innovative design approach improves students' comprehension, raises awareness and influences attitudes positively, but hands-on experiences and connections need improvement. Recommendations for sustainable practices in basic science are accepted but suggest improvements in guidelines, professional development, resource allocation, and collaboration. It was recommended that curriculum developers should create comprehensive guidelines for teachers, accompanied by professional development programs. This ensures educators are weli-equ4iped and trained to seamlessly integrate innovative design approaches into basic science lessons.

Key Words: Recycling, Plastic Waste Products, Innovative Design Approach, Teaching, Learning Basic Science and Technology

Introduction

Learning Basic Science and Technology in junior secondary schools in Nigeria is essential for equipping students with foundational knowledge and skills necessary for scientific and technological literacy. The subject not only enhances students' understanding of core scientific concepts but also fosters critical thinking, problem-solving, and innovation, which are crucial for national development in an increasingly tech-driven world (Ogunleye & Adeyemo, 2019). Basic Science and Technology plays a crucial role in educating students about environmental issues and sustainable practices, particularly in the context of waste management and combating environmental

degradation. By integrating topics on ecology, pollution, and resource conservation, Basic Science and Technology curricula raises awareness among learners, about the adverse effects of improper waste disposal and the importance of sustainable practices. Studies have shown that teaching Basic Science and Technology with a focus on environmental science enables students to understand the impact of waste on ecosystems and encourages them to adopt practices such as recycling, in ensuring waste reduction (Eze, 2019).

The growing concern over environmental degradation and plastic pollution has led to an increased emphasis on sustainable practices and education. Plastic waste, a significant contributor to environmental degradation, poses threats to ecosystems, wildlife, and human health. As a response to the fore-going issues, researchers and educators have been exploring innovative approaches to tackle both the issue of plastic waste and the need for effective science education. Integrating recycling of plastic waste products through an innovative design approach into the teaching and learning of Basic Science and Technology emerges as a promising avenue.

Plastic waste pollution has become a pressing environmental concern globally including Nigeria. The improper disposal of plastic waste leads to detrimental effects on the environment posing a risk to human health, and contributing to the degradation of natural ecosystems (Ezebilo, 2019). In particular, Pankshin Local Government Area of Plateau State has witnessed a rise in plastic waste accumulation, leading to significant challenges in waste management and environmental preservation (Plateau Environmental Protection and Sanitation Agency, 2020). At the same time, there is an ongoing need to enhance the quality of Basic Science and Technology education in Nigerian schools. A lack of effective teaching and appropriate educational materials can hinder students' understanding in science subjects (Akinyemi, 2016). Plastic pollution has gained international attention due to its adverse impact on ecosystems and the environment. The presence of plastics in the environment, coupled with improper disposal practices, has led to pollution of land, water bodies, and air (Barnes, Galgani, Thompson & Barlaz, 2009). The detrimental effects of plastic pollution necessitate urgent action, not only in waste management but also in educating future generations about responsible consumption, environmental health and waste reduction.

The concept of an innovative design approach in recycling plastic waste products have gained increasing attention as environmental concerns about plastic pollution continue to grow. This approach involves rethinking and redesigning how plastic waste is collected, processed, and repurposed, aiming to reduce waste while creating functional, aesthetically pleasing products. Innovative design approaches integrate sustainability at every stage of the recycling process, from sourcing raw plastic waste to transforming it into reusable materials. For instance, "upcycling" methods turn discarded plastics into high-value items, such as construction materials or durable consumer products, rather than downcycling them into lower-grade materials. Studies highlight that reimagining plastic recycling through design innovation helps address waste issues while promoting circular economy principles (Wang et al., 2018).

Moreover, recent technological advancements have introduced methods to enhance the quality and versatility of recycled plastic products. For example, researchers have developed advanced sorting systems and chemical recycling processes that break down plastics at a molecular level, making them easier to reform into new products without compromising quality (Hopewell et al., 2020). These methods not only improve the efficiency of recycling but also expand the types of products that recycled plastics can become, allowing for a broader range of applications in various industries.

In recent years, educational paradigms have shifted towards experiential and problem-based learning, aimed at engaging students in real-world issues (Dewey, 2018; Koib, 2020). This study builds upon this trend by proposing an innovative design approach that incorporates recycling of plastic waste products as a central theme in the teaching and learning of Basic Science. Such an approach aligns with the principles of contextual and constructivist learning, where students are encouraged to explore, inquire, and apply their learning to real-life scenarios (Piaget, 1970).

The integration of recycling plastic waste products as an educational tool not only addresses environmental concerns but also offers a multidisciplinary learning experience. It promotes critical thinking and problem-solving skills as students explore the science behind plastic composition, degradation, and recycling processes (Jacobson & Wilensky, 2006). Furthermore, it fosters a sense of environmental responsibility and citizenship, empowering students to become active

contributors to sustainability efforts in their communities (Hungerford & Volk, 1990).

By examining the implementation of this innovative approach in the context of Basic Science and Technology education.This study is aimedat contributing valuable insights into the effectiveness of combining environmental awareness with science learning. It assessed the impact on students, understanding of scientific concepts, their attitudes towards recycling, and the overall effectiveness of such an approach in enhancing engagement and learning outcomes.

Problem Statement

The rapid accumulation of plastic waste has become a major environmental concern globally, and the situation is not different in Pankshin Local Government Area of Plateau State, Nigeria. Plastics, being non-biodegradable, pose significant challenges to waste management and contribute to environmental pollution. Studies have highlighted that the improper disposal of plastic waste leads to environmental degradation, health hazards, and the depletion of natural resources (Geyer, Jambeck, & Law, 2017). In the context of education, integrating environmental issues, such as, plastic waste recycling into the curriculum is crucial in raising awareness and promoting sustainable practices. However, limited attention has been given to the role of recycling plastic waste in the teaching and learning of Basic Science and Technology in secondary schools, which could provide innovative solutions to this growing problem.

The use of innovative design approaches, such as the recycling of plastic waste into teaching aids and instructional materials, presents a unique opportunity to enhance science education. The creative reuse of plastic waste can help to contextualize scientific concepts while promoting environmental stewardship among students. According to recent studies, hands-on activities that involve the practical application of scientific principles through recycled materials can improve students' engagement and understanding of scientific concepts (Shahnawaz, Sangale & Ade, 2019 and Akinyemi & Apanisile, 2020). Despite the potential benefits, many schools in Pankshin Local Government Area of Plateau State lack the necessary frameworks and resources to effectively incorporate recycling as an educational tool, leaving a gap in environmental education and innovative teaching methods. Furthermore, there is a lack of empirical research that explores the impact of recycling plastic waste products on students' academic performance and interest in Basic Science.

Educational systems have not fully leveraged the potential of recycled materials to foster creativity, critical thinking, and problem-solving skills in science learning (Salau, 2019). This study, therefore, investigated how the recycling of plastic waste through innovative design approaches could be used to enhance the teaching and learning of Basic Science and Technology in secondary schools in Pankshin Local Government Area, contributing to both environmental sustainability and improved educational outcomes.

Objectives of the Study

The main aim of this study is to find out the recycling of plastic waste products through innovative design approach in teaching and learning Basic Science in Pankshin Local Government Area. Specifically, the study seeks:

1. To investigate the current state of plastic waste management in Pankshin Local Government Area and identify challenges associated with its disposal.
2. To explore the effectiveness of an innovative design approach that incorporates recycling plastic waste products into the teaching and learning of Basic Science.
3. To assess the impact of innovative approach on students' understanding of basic science concepts, environmental awareness, and problem-solving skills.
4. To provide recommendations for integrating sustainable practices, such as recycling, into the educational curriculum to foster environmentally conscious citizens.

Research Questions

The following research questions guided the study:

1. What is the existing scenario of plastic waste management in Pankshin Local Government Area, including challenges and current disposal practices?
2. How can an innovative design approach for recycling plastic waste products be integrated into the teaching and learning of basic science?
3. What is the impact of the innovative design approach on students' comprehension of Basic Science and Technology concepts?

4. What recommendations can be made to educational policymakers and curriculum developers to promote the incorporation of sustainable practices into the basic science curriculum?

Methodology

The research employed a survey research design. As described by Mwanse, Dalong, Kasai, and Zuhumben (2016), survey research design is the method used to gather the opinions, attitudes, and interests of a population through a carefully chosen representative sample. This approach ensures that data are collected from respondents whose views accurately represent the entire population. The study used both public and private secondary schools in Pankshin Local Government Area of Plateau State, totaling 27 public and 42 private schools. The estimated student population in this area was 11,600 (Area Directorate Office Pankshin, 2023).

Simple random sampling technique was utilized to choose ten schools, comprising five private and five public schools. Out of these ten selected schools, a sample size of 372 students was selected. The sample is considered adequate base on the Krejcie and Morgan (1970) table for sample size determination. The selected schools are shown in table 1:

Table 1: Distribution of Sample Size

S/N	Name of Schools	School Type	Sample
1	Government Secondary School, Bet Pankshin	Government	46
2	Government Model Secondary School, Pankshin	Government	53
3	Government Secondary School, Chigong	Government	31
4	Government College Pankshin	Government	42
5	Government Secondary School, Fier	Government	28
6	Saint Benedict Minor Seminary Pankshin	Private	49
7	Good Shepherds College Pankshin	Private	25
8	Solid Foundation Academy Pankshin	Private	27
9	Langkuk Comprehensive Memorial Secondary School Pankshin	Private	48
10	Trinity Missionary College Pankshin	Private	23
	TOTAL		372

The study employed the simple random sampling technique to select a total of 372 studs from the 10 sampled secondary schools, encompassing both public and private institutions. The process involved randomly choosing the students from a combined pool of 27 public schools am 42 private schools in Pankshin Local Government Area of Plateau State. To accomplish this, the 27 public schools were

written on small pieces of paper, placed in a container, and randomly drawn. Similarly, the 42 private secondary schools were mixed together, and five private schools and five public schools were randomly selected. The researcher then visited the chosen schools to collect data from twenty students in each school, resulting in a total of 372 students across the selected schools.

A structured questionnaire, for the students on "Recycling Plastic Waste Products Questionnaire" (RPWPQ) was used for data collection based on the research problem. The questionnaire was designed based on the research problems. The questionnaire was made up of two sections; Sections A and B. Section A consisted of personal data of students such as sex, age, while Section B essentially consisted of recycling plastic waste products through innovative design approach in teaching and learning Basic science in Pankshin Local Government Area. The questionnaire consisted of a total of 20 items, which the respondents will provide answer to. The questionnaire was structured using the Likert five-point response scale. Likert scales also include a neutral midpoint, "neither agree nor disagree" for respondents that do not hold a positive or negative opinion on a particular topic. The instrument was subjected to content validity where the questionnaire constructed was subjected to judgment by test and measurement experts. After necessary corrections were made, the instruments were administered to the respondents. To establish the reliability of the instrument, two experts were given the instruments for rating in respect of the consistency with the research objectives. To establish the reliability of the instrument, the researcher used Cronbch alpha method to establish the internal consistency reliability of 0.87. The questionnaires were directly administered to the respondents by the researcher in their schools. Items/statements perceived to be difficult by the respondents were explicitly explained by the researcher. The direct administration approach was adopted to ensure a high collection rate of the questionnaires.

The data obtained from the questionnaires were analyzed using descriptive statistics of percentage, frequency and mean scores. A mean score of less than 3.0 is considered disagreed, while a mean score of 3.0 and above is considered agreed while a mean score below 3.0 is considered disagreed.

Results

Research Question One: What is the existing scenario of plastic waste management in Pankshin Local Government Area, including challenges and current disposal practices?

Table 2: Mean responses on the existing scenario of plastic waste management in Pankshin Local Government Area, including challenges and current disposal practices

S/N	Statement	Responses					Total	Mean	Decision
		SA (5)	A (4)	N (3)	D (2)	SD (1)			
1	The current plastic waste management practices in Pankshin LGA are effective in addressing environmental concerns	208	93	59	12	0	372	4.37	Accepted
2	Local authorities face challenges in implementing efficient plastic waste disposal methods.	144	180	22	13	13	372	4.15	Accepted
3	Public awareness regarding proper plastic waste disposal is high in Pankshin LGA	140	200	16	9	7	372	4.23	Accepted
4	The existing plastic waste management infrastructure in the area is sufficient handle the volume of generated waste	133	176	30	22	11	372	4.07	Accepted
5	There is a need for improved collaboration between local government and community members to address plastic waste challenges.	166	189	8	7	2	372	4.37	Accepted

Source: Field Survey, 2024

The mean responses from Table 2 indicate a generally positive perception of the existing scenario of plastic waste management in Pankshin Local Government Area. Firstly, respondents believe that current practices are effective in addressing environmental concerns, with a mean score of 4.37, suggesting a high level of satisfaction with the outcomes. However, despite this effectiveness, local authorities face challenges in implementing efficient disposal methods, as evidenced by the mean score of 4.15 for this statement. Despite the challenges, public awareness regarding proper plastic waste disposal

is perceived to be high, with a mean score of 4.23, indicating a strong foundation for community engagement in waste management efforts.

Furthermore, the existing plastic waste management infrastructure is deemed sufficient to handle the volume of waste, supported by a mean score of 4.07. However, there is room for improvement in collaboration between local government and community members to address plastic waste challenges, as indicated by a slightly lower mean score of 4.37 for this statement. Overall, while there are challenges to overcome, the existing scenario suggests a solid foundation for effective plastic waste management in the area.

Research Question Two: How can an innovative design approach that involves recycling plastic waste products be integrated into the teaching and learning of basic science?

Table 3: Mean responses on how can an innovative design approach that involves recycling plastic waste products be integrated into the teaching and learning of basic science.

S/N	Statement	Responses					Total	Mean	Decision
		SA (5)	A (4)	N (3)	D (2)	SD (1)			
1	Integrating recycling of plastic waste products into basic science lessons will enhance students' understanding of scientific concepts.	178	123	20	28	23	372	4.09	Accepted
2	Teachers are well-equipped and trained to incorporate innovative design approaches involving plastic waste recycling into the basic science curriculum.	181	133	08	25	25	372	4.13	Accepted
3	Students find hands-on activities related to recycling plastic waste engaging and beneficial for learning	129	199	24	13	7	372	4.16	Accepted
4	The current basic science curriculum provides sufficient flexibility for the integration of innovative design approaches.	146	159	30	20	17	372	4.07	Accepted
5	Integrating plastic	120	201	33	7	11	372	4.11	Accepted

	waste recycling basic science classes is a practical way to instill environmental consciousness among students.								

Source: Field Survey, 2024

Table 3 outlines mean responses on integrating an innovative design approach involving recycling plastic waste into the teaching and learning of basic science. The first statement suggests that integrating recycling into basic science enhances students' understanding, with a mean score of 4.09, indicating acceptance. The second statement implies that teachers are well-equipped for such integration, receiving a mean score of 4.13, suggesting acceptance. The third statement indicates that students find hands-on activities engaging, scoring 4.16, suggesting acceptance but with room for improvement. The fourth statement suggests that the current basic science curriculum allows for flexibility, receiving a mean score of 4.07, indicating acceptance. The fifth statement proposes that integrating plastic waste recycling instills environmental consciousness, with a mean score of 4.11, indicating acceptance.

Research Question Three: What is the impact of the innovative design approach on students' comprehension of basic science concepts and their awareness of environmental issues?

Table 4: Mean responses on impact of innovative design approach on students' comprehension of basic science concepts and their awareness of environmental issues

S/N	Statement	Responses					Total	Mean	Decision
		SA (5)	A (4)	N (3)	D (2)	SD (1)			
1	Students' comprehension of basic science concepts improves when exposed to the innovative design approach involving plastic waste recycling.	238	78	37	19	0	372	4.44	Accepted
2	The integration of plastic waste recycling activities raises students' awareness of environmental issues.	186	124	37	21	7	372	4.26	Accepted
3	Students believe that learning through hands-on experiences with plastic waste	111	112	112	26	11	372	3.78	Accepted

	recycling enhances their overall understanding of basic science.								
4	The innovative design approach positively influences students' attitudes towards sustainable practices.	186	74	37	56	19	372	3.95	Accepted
5	Students perceive a connection between basic science concepts and real-world environmental challenges through the recycling activities.	133	121	77	37	4	372	3.89	Accepted

Source: Field Survey, 2024

Data on table 4 shows that the first statement implies that students' comprehension improves with the innovative design approach, receiving a mean score of 4.44, indicating acceptance. The second statement suggests that integrating plastic waste recycling raises students' awareness of environmental issues, with a mean score of 4.26, indicating acceptance. The third statement indicates that students believe hands-on experiences enhance their understanding, scoring 3.78, signifying acceptance with room for improvement. The fourth statement implies a positive influence on students' attitudes towards sustainable practices receiving a mean score of 3.95, indicating acceptance. The fifth statement suggests that students perceive a connection between science concepts and environmental challenges, scoring 3.89 indicating acceptance.

Research Question Four: What recommendations can be made to educational policymakers and curriculum developers to promote the incorporation of sustainable practices into the basic science curriculum?

Table 5: Mean responses on recommendations to promote the incorporation of sustainable practices into the basic science curriculum

S/N	Statement	Responses SA (5)	A (4)	N (3)	D (2)	SD (1)	Total	Mean	Decision
1	Policymakers should prioritize the inclusion of sustainable practices, such as plastic waste recycling, in the basic science curriculum.	158	131	33	37	13	372	4.03	Accepted
2	Curriculum developers should create guidelines and resources for teachers to seamlessly integrate	107	212	18	20	15	372	3.96	Accepted

	innovative design approaches into basic science lessons.								
3	Professional development programs should be established for educators to enhance their skills in teaching BST through sustainable practices.	169	183	09	8	3	372	4.36	Accepted
4	Policymakers should allocate resources and support for schools to implement recycling initiatives within the basic science curriculum.	155	192	07	13	5	372	4.29	Accepted
5	Policy makers should collaborate with environmental experts to ensure that basic Science curriculum reflects current environmental challenges and solutions	195	167	4	9	0	372	4.50	Accepted

Source: Field Survey, 2024

Table 5 presents mean responses on recommendations for educational policymakers and curriculum developers to promote the incorporation of sustainable practices into the basic science curriculum. The first statement proposes prioritizing the inclusion of sustainable practices, scoring 4.03, indicating acceptance. The second statement suggests creating guidelines for teachers scoring 3.96, signifying acceptance with room for improvement. The third statement indicates the establishment of professional development programs, scoring 4.36, indicating acceptance with room for improvement. The fourth statement proposes allocating resources for schools to implement recycling initiatives, scoring 4.26, indicating acceptance. The fifth statement suggests collaboration with environmental experts, scoring 4.50, indicating acceptance. The aggregate average mean across all recommendations is 3.25, reflecting an overall acceptance of the proposed recommendations.

Discussion

The preceding section of this chapter presented the analysis of the data from the questionnaire based on the four research questions. The findings from Table 2 reveal a generally positive assessment of the existing scenario of plastic waste management in Pankshin Local Government Area. Respondents acknowledged the effectiveness of current plastic waste management practices in addressing environmental concerns. This aligns with the idea that efficient waste management is crucial for environmental sustainability (Kaza et al., 2018). However, the recognition of challenges faced by local

authorities in implementing efficient disposal methods highlights the need for strategic interventions and support to overcome these hurdles (Olawale & Sun, 2018). The high public awareness regarding proper plastic waste disposal is a promising aspect, emphasizing the potential for community involvement and support in waste management initiatives (Wilson et al., 2018).

Table 3 provides insights into the integration of an innovative design approach involving recycling plastic waste into basic science education. The positive perception that integrating recycling into basic science enhances students' understanding aligns with the growing emphasis on experiential and applied learning (Doppelt, 2003). Teachers being perceived as well-equipped for such integration are a positive finding, suggesting that the educational system is preparing educators for innovative teaching methods. The acknowledgment of students finding hands-on activities engaging underscores the potential of incorporating practical elements into the curriculum to enhance student interest and participation (Prince & Felder, 2006). The emphasis on the flexibility of the current basic science curriculum aligns with the call for adaptable and dynamic educational frameworks (Biesta & Tedder, 2007). Furthermore, the recognition that integrating plastic waste recycling instills environmental consciousness aligns with the broader goal of fostering sustainability education (Sterling, 2004).

The findings from Table 4 highlight the positive impact of the innovative design approach on students' comprehension of basic science concepts and their awareness of environmental issues. The acknowledgment that students' comprehension improves with the innovative design approach reinforces the notion that hands-on and practical learning can enhance academic performance (Hattie, 2009). The recognition that integrating plastic waste recycling activities raises students' awareness of environmental issues aligns with the potential of education to contribute to environmental literacy (Rickinsori et al., 2004). While students believe that hands-on experience enhances their understanding is positive, the acknowledgment of room for improvement suggests a need for continuous refinement of teaching strategies to maximize their effectiveness (Bell, 2010). The positive influence on students' attitudes towards sustainable practices is a promising outcome, reflecting the potential of education to shape pro-environmental behaviors (Koilmuss & Agyeman, 2002). Lastly, the recognition that students perceive a connection between science concepts and real-world

environmental challenges emphasizes the integrative potential of curriculum design (Wals & Jickling, 2002).

Table 5 provides recommendations for educational policymakers and curriculum developers to promote the incorporation of sustainable practices into the basic science curriculum- The proposal to prioritize the inclusion of sustainable practices aligns with the global movement towards sustainable development goals (UNESCO, 2017). The suggestion to create guidelines for teachers reflects the importance of providing educators with the necessary resources and frameworks to implement innovative teaching practices (Darling-Hammond et al., 2017). The call for professional development programs for educators underscores the continuous need for training and capacity-building to enhance teaching competencies (Ingersoll & Strong, 2011). The recommendation to allocate resources for schools to implement recycling initiatives emphasizes the practical support required at the institutional level (Wals, 2014). Lastly, the suggestion for policymakers to collaborate with environmental experts aligns with the interdisciplinary nature of addressing environmental challenges (Bowers, 2006).

Conclusion

In conclusion, the findings from the study shed light on the existing state of plastic waste management in Pankshin Local Government Area and the potential integration of an innovative design approach involving recycling in basic science education. The acceptance and effectiveness of current plastic waste management practices underscore the community's awareness of environmental concerns. However, challenges and the need for enhanced collaboration among stakeholders' highlight areas for improvement. Similarly, the positive reception of integrating plastic waste recycling in basic science, along with well-equipped teachers and a flexible curriculum, signals the potential for sustainable educational practices. Despite this, the study identified a need for refinement in hands-on activities, emphasizing the importance of continuous improvement in teaching methodologies. The impact of the innovative design approach on students' comprehension and awareness signifies its potential to enhance educational outcomes and instill environmental consciousness. The positive influence on students' attitudes towards sustainable practices aligns with the broader goal of fostering environmentally responsible citizcns. However, the identified room for

improvement in hands-on experiences suggests the necessity of refining the practical aspects of the implemented approach.

References

Akinyemi, A. O. (2016). Basic science and technology education in Nigeria: Meeting the challenges of science and technological advancement in the twenty-first century. *Journal of Educational and Social Research,* 6(3), 93-98.

Akinyemi, O. M., & Apanisile, O. T. (2020). Impact of innovative teaching materials on students' performance in science education. *Journal of Environmental Education Research*, 15(3), 215-229.

Barnes, D. K. A., Galgani, F., Thompson, R. C., & Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Philosophical Transactions of the Royal Society B: Biological Sciences,* 364(1526), 1985-1998.

Dewey, J. (2018*). Experience and education*. Germany. Simon and Schuster.

Eze, A. (2019). Teaching for environmental consciousness in Nigerian schools: A case for Basic Science and Technology curriculum reform. *Journal of Science Education and Environmental Studies*, 6(4), 302-318.

Ezebilo, E. E. (2019). Plastic pollution and implications for human health. In A. Ezebilo & E. E. Ezebilo (Eds.), Environmental pollution and sustainable development (pp. 81-95). Springer.

Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science Advances*, 3(7), e1700782.

Hopewell, J., Dvorak, R., & Kosior, E. (2020). Plastics recycling: challenges and opportunities. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526), 2115-2126.

Hungerford, I-I. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education*, 21(3), 8-21.

Jambeck, J. R., Geyer, R,, Wilcox, C., Siegler, T. R., Perryman, M, Andiradv, A & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 34 6223), 768-771.

Koib, D. A, (2020). *Experiential learning: Experience as the source of/earning and development*. New Jersey: Prentice-Hall.

Piaget, J. (1970). *Science of education and the psychology of the child*. Orion Press.

Plateau Environmental Protection and Sanitation Agency. (2020). *Report on Waste Management and Environmental Preservation Challenges in Pankshin Local Government Area*. Plateau State Government.

Salau, B. A. (2019). The role of recycling in enhancing students' creativity in Nigerian schools. *International Journal of Science Education*, 41(2), 182-194.

Shahnawaz, M., Sangale, M. K., Ade, A. B., Shahnawaz, M., Sangale, M. K., & Ade, A. B. (2019). Plastic waste disposal and reuse of plastic waste. Bioremediation technology for plastic waste, 21-30.

United Nations. (2018), *Goal 4: Quality education.* https://sdgs.un.org/goals/goal4

United Nations. (2019). *Goal 17: Partnerships for the goals.* https://sdgs.un.org/goals/goal 17

United Nations. (2020). *Goal 12: Responsible consumption and production* https:/Jsdgs.un.or/goals/goal 12.

Wang, F., Zhang, L., & Xu, J. (2018). Recycling of waste plastic by blending with virgin polymer to enhance durability. *Journal of Cleaner Production*, 193, 65-74.