

THE CONTRIBUTIONS OF SCIENCE PROCESS SKILLS ON WASTE-TO-WEALTH SKILL ACQUISITION OF PRIMARY SCHOOL PUPILS IN OYO TOWN

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Abstract

Improper waste management poses a global threat, negatively impacting public health and creating unsightly environments. While governments are making efforts, a truly significant impact requires a collective responsibility. It is crucial to instil a sense of ownership in everyone, starting with comprehensive education for school children and extending to those who currently disregard waste issues. Embracing the "waste-to-wealth" concept offers an inclusive approach, engaging individuals from households to the broader community. This study, therefore, determined the contributions of science process skills and gender on waste-to-wealth skill acquisition in Oyo Central Senatorial District. A pre-test post-test control quasi-experimental design was adopted. Two hundred primary school pupils were purposively selected from eight schools in Afijio and Oyo West Local Government Areas. A self-designed instrument of Pupils' Performance on Waste-to-Wealth Project Rating Scale (PPWWPRS), which has a reliability index of 0.80, Cronbach's alpha, was used to collect data from 200 primary school pupils. Data were organized and analysed using frequency count, percentage, mean, and analysis of covariance. The findings revealed that science process skills contributed to high performance in waste-to-wealth skill acquisition of primary school pupils. Gender has no significant contribution to science process skills on waste-to-wealth skill acquisition ($F(1; 172) = 3.15; p > 0.05; \text{Partial } \eta^2 = 0.02$). It was therefore recommended that the primary school curriculum needs to place a stronger emphasis on science process skills (SPS) and provide pupils with more opportunities for practical application. Primary school teachers should be encouraged to adopt a hands-on approach to teaching. This will empower them to develop and implement practical activities, ultimately fostering critical thinking and creativity in their pupils.

Keywords: Science Process Skills; Gender; Waste-to-Wealth; Primary School Pupils; Skill Acquisition

Introduction

The shift in global climate patterns stands as a primary environmental hurdle for the modern world. This arises as a result of overexploitation of resources, pollution, and waste mismanagement, which continue to pose a threat to human health and the environment. The indiscriminate disposal of waste (plastics, nylon, papers, animal dungs, faeces, leaves, unused wood, metal scraps, PET bottles, and others) makes the environment unattractive at a glance. It is also unhealthy to the well-being of both human, terrestrial, aquatic animals, and plants. A persistent challenge in developing nations is the inadequate coverage of solid waste collection relative to generation rates (Olamide *et. al.*, 2024). Consequently, uncollected waste accumulates in public spaces, leading to road obstruction and drain blockage. This is a typical situation in most Nigerian cities, where roadsides have turned into a dumping ground despite the efforts of the government to make the roads free of any obstruction. Waste management is categorized as a local problem, but it has a global and greater effect (Maalouf

&Agamuthu, 2023). It was reported by the World Bank (2018) that rapid urbanisation, an increase in population, and economic development are the major causes of an increase in waste generation in most developing countries.

Waste is the unwanted and unused parts of a material that are discarded into dumping sites. The effective processing of waste streams for subsequent resource application is of significant importance in the pursuit of environmental sustainability and the development of a circular economy (Tanveer *et. al.*, 2022). According to Ameer (2021), waste management involves waste prevention, reuse, and recycling wherever possible to avoid environmental hazards. Quality education with an appropriate teaching and learning approach is the only instrument that can be used to create awareness on how to transform most of the waste into valuable materials. This method of transforming waste to functional materials is referred to as waste-to-wealth, which has to be universal and make it an inclusive idea. Both adults and young people need to participate in the waste-to-wealth idea so as to achieve the sustainability of the environment. Ignorance and lack of quality education bring waste mismanagement. Mulak *et al.* (2024) affirmed that involving young people in waste-to-wealth is about nurturing environmentally responsible citizens, fostering creativity and problem-solving skills, introducing basic economic concepts, and encouraging community engagement. Involving school pupils in waste management is an excellent idea; this is referred to as inclusive waste management. Sulistyawati *et. al.* (2020) highlight the critical importance of instilling responsible waste management habits in young children as a significant long-term investment.

The use of appropriate methods and approaches in teaching is a pathway to quality education for sustainable development. Introducing a waste-to-wealth initiative as a means of managing waste in the environment involves creativity, critical thinking, and problem-solving skills. Waste-to-wealth is seen as a means of creating environmental awareness and a sense of responsibility among school pupils (Mulak *et. al.*, 2024). The science process skills approach is an action exhibited when exploring the environment. This approach promotes critical thinking, creativity, problem-solving, and well-informed citizens. Science process skills is a pedagogical approach that stresses the methods of learning, incorporating student engagement and imaginative thinking to facilitate the acquisition of knowledge, abilities, ethics, and perspectives relevant to everyday situations (Depari &Hasrudin, 2019). Science process skills enhance hands-on learning among students. The development of science process skills and the provision of entrepreneurship education hold significant importance for societies pursuing a pathway towards self-reliance and sustainability (Akinbobola& Bada, 2022). Waste-to-wealth initiative through the science process skill approach is another important means of achieving sustainable development.

Dilek (2023) stated that science process skills enhance the effectiveness of learning and the acquisition of scientific attitudes. Science process skills encompass the cognitive and intellectual abilities used in science learning for understanding and problem-solving (Nwubaet. *al.*, 2022). In some studies, it was posited that science process skills are not meant for use during science class teaching only (Hill, 2023). They are skills for both individual and societal development. Science process skills are learner-centered because the learner makes use of the senses during the teaching and learning process. Practical activities that involve science process skills make it easy for learners to develop the 21st-century skills (Tzobasa& Njoku, 2021; Apeadidoet. *al.*, 2024). Science process skills are divided into two: the fundamental, which are general for every individual and are called basic science process skills, and the integrated science process skills, which are displayed in secondary and tertiary institution sciences (Ugwuanyi & Nwafor, 2021; Chinda & Achigbe, 2024). The core science process skills of observing, communicating, measuring, and classifying are fundamental tools utilised in many scientific disciplines. This study focuses on the contributions of three basic science process skills to the waste-to-wealth project among primary school pupils. The justification for selecting these three skills (observing, classifying, and measuring) was that they are concrete skills. In contrast, others are abstract and may be challenging for primary school pupils to demonstrate.

This research examines the relationship between scientific process skills and gender in the context of a waste-to-wealth project among primary school students. Gender is a significant aspect influencing education, as noted by several experts. There are varied opinions on how gender influences students' performance in the acquisition of knowledge and skills. Research conducted by researchers such as Okoye and Osuafor (2021), Pius

and Okoli (2021), Ibe & Nwosu (2017), and Anchor et al. (2018) indicated that male students showed superior science process skills, but other studies revealed that females exhibited enhanced science process abilities (Mbonu-Adigwe *et al.*, 2019; Okafor, 2020). Statistical analyses usually indicate that gender does not significantly influence the development of science process skills among students. Studies conducted by Ekon and Eni (2015); Irungu *et al.* (2019); Ihejiamazu *et al.* (2020) and Okoye and Osuafor (2021) jointly demonstrated that gender did not significantly influence students' development of science process abilities. Zuba (2022) indicated that the interaction of gender and instructional styles did not significantly affect the development of science process abilities among students. This indicates that student gender did not substantially affect the efficacy of the teaching approaches. The absence of interaction corroborates the conclusions of Ibe and Nwosu (2017); Mbonu-Adigwe *et al.* (2021), Pius and Okoli (2021), all of whom noted no synergistic effect of gender and instructional methods on the learning of science process skills in science education. Okoye and Osuafor (2021) have differing views regarding the substantial interaction between gender and instructional methods on the development of science process skills. Fisher *et al.* (2020) emphasised the ongoing under-representation of women in Science, Technology, Engineering, and Mathematics (STEM) disciplines as a significant obstacle to tackling Africa's developmental challenges. This necessitates the organisation of inclusive activities, the utilisation of suitable instructional techniques and materials, and the demonstration of expertise in implementing gender-responsive policies (Mhewa *et al.*, 2020; Lee, 2021; Ekine *et al.*, 2023).

Theoretically, this study is grounded in the works of Lev Vygotsky's Social Constructivism Theory, which posits that children build knowledge through social interaction and active engagement. This framework is relevant because developing science process skills (observing, classifying, and measuring) requires pupils to use their senses and cognitive tools to solve problems. By interacting with waste materials, learners do not merely receive information; they actively develop the critical thinking and creativity needed to transform discarded items into valuable resources. This theory supports the study's findings that a learner-centred, hands-on approach is more effective than conventional teaching for acquiring 21st-century skills and fostering environmental responsibility.

The indiscriminate disposal of waste in Nigerian cities creates significant environmental and health challenges despite the enormous efforts from the government. Waste management is an important issue throughout the world. People's ability to convert waste into valuable resources through waste-to-wealth ideas has not been given proper attention, especially in the education sector. There are many studies on science process skills, gender, and waste management in institutions of learning, but much has not been done on science process skills and waste-to-wealth among primary school pupils as a way of achieving sustainable development.

The main objectives of the study are to:

1. Determine the main effect of treatment (observing, classifying, measuring, and conventional method) on primary school performance on waste-to-wealth skill acquisition.
2. Examine the main effect of gender on the performance of pupils in waste-to-wealth skill acquisition
3. Investigate the interaction effect of treatment and gender on primary school pupils' performance in waste-to-wealth skill acquisition.

Hypotheses

The following hypotheses were tested at the 0.05 level of significance:

H01: There is no significant main effect of treatment (observing, classifying, measuring, and conventional) on pupils' performance in waste-to-wealth skill acquisition.

H02: There is no significant main effect of gender on the pupils' performance in waste-to-wealth skill acquisition.

H03: There is no significant interaction effect of treatment and gender on the pupils' performance in waste-to-wealth skill acquisition.

Methodology

This study is a 4 x 2 factorial matrix of a pretest-posttest control group quasi-experimental design. Science process skills approach (observing, classifying, and measuring skills and conventional method being the control group) was crossed with gender (male and female) in primary school pupils of Afijio and Oyo West Local Government of Oyo Central Senatorial District of Oyo State. The multi-stage sampling technique was employed to select participants for this study. At first, purposive sampling was employed to choose two local government areas (Afijio and Oyo West) from the eleven local government areas within the Oyo Central Senatorial District. Subsequently, four schools were purposively chosen from each of the two LGAs based on the criteria of geographical distance, co-educational status, and public designation. Making a total of eight public primary schools' participants. In each LGA, the four chosen schools were randomly allocated into four treatment groups (Experimental Group I, Experimental Group II, Experimental Group III, and the Control Group) by a balloting process. A purposive sampling strategy was employed to select an entire Primary III class from each of the eight schools. Primary III was chosen because it represents the mid-level of elementary education in Nigeria. With a target of 25 pupils per class, the final sample consisted of 200 Primary III pupils from the Oyo Central Senatorial District. Data was collected using a self-designed instrument titled "Pupils' Performance on Waste-to-Wealth Project Rating Scale" (PPWWPRS). This instrument contained the characteristics of the project, such as beauty, value, market value, and completion with finishing touches. The instrument was rated on a 5-point Likert scale, which was (1=poor, 2=Fair, 3=good, 4=Very Good, 5=Excellent). The instrument measured the performance of pupils on waste-to-wealth skill acquisition. Early childhood education experts validated the instrument, and corrections were made. The instrument was taken to a school in the Atiba Local Government, which was not part of the study, for field testing. The reliability index of the instrument was calculated and yielded a 0.80 Cronbach's alpha. The researcher prepared instructional guides for the experimental and control groups.

The participants were subjected to the use of waste to produce valuable resources before the introduction of the treatment, and this was referred to as the pre-intervention phase. The projects produced were collected for rating, using the research instrument of PPWWPRS, and the performance of the pupils was taken as a pre-test. The researcher, class teachers, with the help of research assistants, used the treatment on the participants at the intervention phase, which lasted for six weeks. At the end of the intervention phase, pupils were allowed to convert waste to valuable resources, and these projects were rated with the instrument. The results of the pupils were regarded as posttest performance. The data collected were analysed through the use of frequency counts, percentage, mean, and F-test statistical tools, and analysis of covariance was used to test the hypotheses at a 0.05 level of significance.

Results

Hypothesis 1: There is no significant main effect of treatment (observing, classifying, measuring and conventional) on pupils' performance in waste-to-wealth project.

Table 1: Summary of 4X2X2 Analysis of Covariance on Waste-to-Wealth Performance

Tests of Between-Subjects Effects

Dependent Variable: Post Performance

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared	Eta Squared
Corrected Model	9842.105 ^a	16	615.132	5.092	.000	.321	
Intercept	17804.815	1	17804.815	147.389	.000	.461	
PrePerfm	35.566	1	35.566	.294	.588	.002	
Treatment	4509.141	3	1503.047	12.442	.000	.178	
Gender	380.873	1	380.873	3.153	.078	.018	
treatment * gender	355.426	3	118.475	.981	.403	.017	
Error	20777.810	172	120.801				
Total	808737.000	189					
Corrected Total	30619.915	188					

a. R Squared = .321 (Adjusted R Squared = .258)

Table 1 shows that there is a significant main effect of treatment on the waste-to-wealth performance of the pupils ($F_{(3;172)} = 12.44$; $p < 0.05$; Partial $\eta^2 = 0.18$). Therefore, the null hypothesis 1 is rejected. To know the source of the magnitude of performance across the group, estimated marginal means of the ANCOVA is presented in Table 2.

Table 2: Estimated Marginal Means on Waste-to-Wealth Performance

Variable	Categories	Mean	Std. Error
Intercept (Grand mean)	Pre-performance	20.582	-
	Post Performance	64.171	0.890
Treatment	Expt. I	67.714 ^a	1.818
	Expt. II	62.396 ^a	1.856
	Expt. III	70.257 ^a	1.684
	Control	56.315 ^a	1.774
Gender	Male	62.588 ^a	1.182
	Female	65.754 ^a	1.332

Table 2 reveals that pupils in Experimental Group III, who were exposed to measuring as the leading skills, had the highest waste-to-wealth performance mean score (70.26); followed by those in Experimental Group I, who were exposed to Observing as the leading skills (67.71); followed by those in Experimental Group II, who were exposed to classifying as the leading skills (62.40). Pupils exposed to conventional group had the lowest performance mean score (56.32). To know the source of the significant effect, Scheffe's post hoc pairwise comparison was performed and Table 3 presents the summary.

Table 3: Summary of Scheffe's Post Hoc Pairwise Comparison of Performance

	Mean score	EXP I	EXP II	EXP III	Control
EXP I	67.714 ^a		*		*
EXP II	62.396 ^a	*		*	*
EXP III	70.257 ^a		*		*
Control	56.315 ^a	*	*	*	

Note: * implies significant difference at 0.05 level

Table 3 shows that the significant effect reported in Table 4.2 was as a result of significant difference between:

1. Experimental I and Experimental II
2. Experimental I and Control
3. Experimental II and Experimental III
4. Experimental II and Control
5. Experimental III and Control

However, there is no significant difference between Experimental I and Experimental III in their waste-to-wealth performance.

Therefore, it can be inferred that measuring leading skill (Experimental group III) is the best to improve pupils' performance in waste-to-wealth, followed by observing leading skill (Experimental group I), followed by

classifying leading skill (Experimental group II), while the conventional method is the lowest in improving waste-to-wealth performance among pupils.

Hypothesis 2: There is no significant main effect of gender on the pupils' performance in waste-to-wealth skill acquisition.

Table 1 shows that there is no significant main effect of gender on pupils' performance in waste-to-wealth when exposed to scientific skills ($F(1;172) = 3.15; p > 0.05; \text{Partial } \eta^2 = 0.02$). Therefore, hypothesis 2 is not rejected. Though Table 2, the estimated marginal means table, reveals that females had a higher waste-to-wealth performance mean score (65.75) than males (62.59), the difference between the two mean scores (3.17) is not significant.

Hypothesis 3: There is no significant interaction effect of treatment and gender on the pupils' performance in waste-to-wealth skill acquisition.

Table 1 shows that there is no significant interaction effect of treatment and gender on the waste-to-wealth performance of the pupils ($F(3;172) = 0.98; p > 0.05; \text{Partial } \eta^2 = 0.02$). Therefore, hypothesis 4 is not rejected.

Discussion of Findings

The results of the study show that the science process skills approach has a positive effect on the experimental groups when compared with the control group. This dictates that science process skills make the participants in experimental groups develop critical thinking, creativity, and problem-solving skills needed to transform waste into valuable resources. This result is in line with the findings of (Tzobasa & Njoku, 2021; Apeadido *et al.*, 2024) who posited that hands-on activities involved in science process skills make it easy for learners to develop the 21st-century skills, which allowed for better performance in the waste-to-wealth project performance. This implies that active engagement and hands-on experiences are important for effective learning and the acquisition of skills. This finding provides theoretical support for incorporating environmental education into early childhood curricula.

The findings also revealed that gender does not affect the performance in waste-to-wealth projects through the use of science process skills. This aligns with the studies of Ekon and Eni (2015); Irungu *et al.* (2019); Ihejiamazu *et al.* (2020) and Okoye and Osuafor (2021), whose results collectively indicated that gender was not a significant factor in students' acquisition of science process skills. The last finding indicates that the treatment's effect on performance does not differ significantly between boys and girls (and vice versa). This suggests that the treatment effect is independent of the pupils' gender, and conversely, the gender effect is independent of the treatment group. Furthermore, this implies that when the same interventions are applied to both male and female pupils concurrently, their projects are evaluated using the same PPWWPRS rating scale. In line with the results of Ibe & Nwosu (2017), Mbonu-Adigwe *et al.* (2021); (Pius & Okoli, 2021), and this study found no evidence of a combined effect of gender and instructional approaches on the acquisition of science process skills among science students.

Conclusion

This study demonstrates that the integration of Science Process Skills (SPS), specifically observing, classifying, and measuring, significantly enhances the ability of primary school pupils to engage in waste-to-wealth activities. The empirical evidence indicates that pupils taught through these practical scientific methods outperformed those taught using conventional instructional styles. By utilising their senses and cognitive tools to interact with waste materials, learners successfully developed the critical thinking and creativity necessary to transform discarded items into valuable resources. Furthermore, the study confirms that these gains in skill acquisition are gender-neutral, as both male and female pupils achieved similar levels of performance when provided with the same hands-on opportunities. Ultimately, the science process skills approach serves as an effective pedagogical bridge between classroom learning and practical environmental sustainability. Teaching science through hands-on activities (like observing and measuring) helps children learn how to turn trash into

valuable items. This method works equally well for both boys and girls. By using this practical approach, schools can help students develop creative thinking and a sense of responsibility for the environment.

Recommendations

Based on the outcomes of the findings, the following recommendations were made:

1. The primary school curriculum needs to place a stronger emphasis on science process skills (SPS) and provide pupils with more opportunities for practical application. This exposure is crucial for developing their critical thinking, creativity, and problem-solving capacities.
2. Primary school teachers should be encouraged to adopt a hands-on approach to teaching. This will empower them to develop and implement practical activities, ultimately fostering critical thinking and creativity in their students.
3. To build the capacity of Basic Science and Technology teachers, school administrators are advised to organise training programmes centred on child-centred, activity-based teaching approaches and the waste-to-wealth concept, ultimately fostering pupils' comprehension of science process skills.

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