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Developing Creative-Hands Among Varied Cognitive Style Upper-Basic 3 Students in Basic Science Using Creative Exploration in Gboko

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Abstract
Development of creative-hands among varied cognitive style upper-basic III students in basic science using creative exploration in Gboko was studied using quasi-experimental research design (pre-test post-test non-equivalent control group). Two research questions and two hypotheses guided the study. A sample size of 70 (39 males and 31 females) students was drawn out of a population of 1 823 (995 males and 828 female) upper-basic III science students using a multi-stage sampling from 24 government grant-aided schools was used for the study. The Creative Hand Design Test (CHDT) which was used for data collection was validated by five experts. It was trial-tested by a test retest; test scores obtained were computed by Pearson Product Moment Correlation (PPMC) which yielded a reliability value of 0.997. Mean and standard deviation were used to answer research questions and Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 α-level. The results show a significant difference in the students' creative-hands development when taught Basic Science using creative exploration and the students taught using expository teaching with mean gain of 16.05 for CE, $F(1,67) = 38.437$; $\rho = 0.000 < 0.05$. The result also shows no significant difference in the students' creative-hands development based on different cognitive styles as students were taught using creative exploration $F(1, 31) = 0.066$; $\rho = 0.936 > 0.05$. The study recommends, among others, that creative exploration be used for teaching science at basic schools.

Keywords: Development of Creative-Hands, Varied Cognitive Style, Upper-Basic III Students, Basic Science, Creative Exploration

Introduction

Education is an instrument for human capital investment leading to societal building. Therefore, it is supposed to make an individual to be functionally fit for meaningful and lasting living in a society. Education is integral for inculcating knowledge, wisdom, understanding, attitude, interest and all kinds of skills for a man to be functionally fit in the ever-changing globe. This might be a reason why Policy documents on education in many nations, for instance: Australia, Canada, United Kingdom, China, Singapore, United States of America including Nigeria have contained self-determining and activity-based curriculum which provides hands-on-activities to students' learning of science for lasting functional education. A self-determining curriculum that can allow students to explore their environment creatively, gain creative knowledge that can be beneficial to both themselves and the society is needed (Manalu et al., 2022; Pantiwati, et al., 2023). According to Wiyanti and Hadi (2023) there are no restrictions in such curriculum delivery and the unlimited opportunity given to children to explore, may stimulate students with varied cognitive styles to develop creative-hands.

Education is an integral part of societal building. It is expected to be aimed towards the complete progress of human nature and fundamental freedom (Agogo, 2018). The Federal Republic of Nigeria (FRN, 2013) has affirmed that, teaching should be tilted or geared towards purposeful skills acquisition for sustainable development and self-reliance. However, Agogo and Otor (2019) has observed that education has not attained its full function and this could be why in the 21st century, so many things need to change, including methods of teaching, methods of assessment of learning, resources for teaching as well as approaches to learning science. It is noted that today we are also living in an age of transition from an economy and culture, where survival is driven by natural

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resources to a new and emerging economy that mandate this change (Terhemba, 2022). From the forgoing Ayua (2018) has opined that the ideal curriculum for such an era is the one which saves pace with the modern changes and challenges in the culture of a people with an opinion of addressing them in order to make the society a healthier home to live in. Ayua (2019) adds that an effective science teaching method aims to achieve curriculum objectives that reflect the needs and aspirations of learners, their communities, and the broader global society. Such teaching methods should be student centred, activity based, explorative and creative in nature, be rich in harnessing scientific knowledge for skills needed to drive economic growth, development and stability for survival in the 21st century. Education is actually a bedrock, health and growth of a nation. It is supposed to develop students with creativity aiming at achieving human rights for all, by eradicating poverty, protecting the planet and ensuring prosperity in a changing world. However, Ayua and Agbidye (2020) confirmed that the gap between policy and practice is occasioned by poor teaching methods resulting in unemployment which could be likened to underdevelopment, due to lack of creative-hands in Basic Science.

Basic Science serves as a foundational component of the 9-year Basic Science and Technology curriculum implemented at the basic education levels in Nigeria. According to Danjuma (2015), it involves approaches that present scientific concepts and principles in a unified manner, minimizing premature distinctions between scientific disciplines. Ayua and Eriba (2023) describe it as the introductory phase of science education, intended to lay the groundwork for further learning at post-basic and tertiary levels. The National Policy on Education (FRN, 2013) underscores the importance of basic education and outlines goals that support science teaching, including fostering scientific creativity, promoting wealth creation, enhancing educational progress, encouraging independent thinking, and equipping learners for self-reliant employment. However, Ayua and Eriba (2023) argue that these objectives cannot be realized through teaching methods that fail to engage students both practically and intellectually. Sagiru (2015) further observes that Basic Science is currently not delivered in a manner that cultivates students' creative abilities essential for personal and national scientific advancement. Science is the creative endeavour of a human mind giving rise to creative-hands if integrated meaningfully in the classroom with teaching methods that are minds-on and hands-on. To understand the natural world, scientists through science education sought to discover new problems, think of multiple choices to approach problems, come up with hypotheses, acquire the ability to collect relevant data, analyse and interpret it critically, and formulate new theoretical insights. (Peng, 2019). Scientific process requires creative exploration such as the application to explore, observe, identify evidence, create explanations, investigate, evaluate and further investigate. Scientists through science education use creative exploration of scientific discoveries often emerge through analogy. For example, the wave theory of light was inspired by similarities between light and sound, while the concept of Earth as a giant magnet arose from observed commonalities between the planet and magnetic materials. (Peng, 2019). Science teachers through science education can develop novel and valuable designs which agree to the description of creative exploration for developing creative-hands that can harness science leading to ending poverty, hunger in all forms everywhere, encouraging productivity, economic growth, sustainability and stability. It is therefore, unquestionable that the development of creative-hands may be useful in science for achieving lasting functional education when students are taught using creative exploration.

Creative Exploration (CE) is an instructional approach that encourages students to investigate, discover, and learn through open-ended, curiosity-driven, and self-directed activities. It promotes the development of creative thinking, critical reasoning, and problem-solving abilities. Rooted in the constructivist view of learning, CE emphasizes that knowledge is built through interactions among learners and with the resources available in their environment. Milne et al. (2016) assert that children possess a natural curiosity and engage in exploration as a means of understanding their world. Such exploration plays a vital role in their learning and in nurturing creativity and practical skills. Providing opportunities and support for children to think independently, ask questions, make predictions, experiment, seek explanations, and draw conclusions is fundamental to Basic Science education. This process, often referred to as 'children’s science,' arises organically as learners strive to make sense of the world around them (Milne et al., 2016). Creative exploration is constructivist and self-paced, with students at the centre of learning in nature that uses self-directed, experiential learning in relationship-driven environments (Archie, 2019). It emphasizes process over product, promoting experimentation and rehearsal. The importance of experiential and interdisciplinary education is the belief that students learn best by immersing themselves into their natural world where they are free to inquire, explore, and reflect (Valarie, 2023). According to Arce and Ferguson (2013), this approach is grounded in principles that grant students autonomy over the direction of their learning. It emphasizes experiential learning through sensory engagement, touching, moving, listening, and observing. It also recognizes the importance of students forming relationships with peers and interacting with objects in their environment, which they must be free to explore. Furthermore, it upholds the belief that students

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should have unlimited opportunities and diverse means of self-expression. At its core, this approach views young learners as capable individuals, and aims to nurture their education through active, student-centred experiences. In this approach, there is a belief that students of different cognitive styles may have their rights to develop their creative-hands potential (Biermeier, 2015). This approach is related to Bruner's (1960) theory of discovery learning which posits that students learn best through active exploration and problem-solving, which enables them to construct new ideas based on their existing knowledge.

Creative-hands refers to skilful manual work, especially in art, crafts or design. It also means people who are skilled at making things with their hands. As a representation of creativity, the hand plays a vital role in one’s culture, predominantly in art and music. Windebank (2020) and Bhattacharya (2023) see creative-hands as the ability or skill to produce things branded by originality of thought. This implies that, it is skilful display of one’s inventive or innovative imagination. Creative-hands showcase creativity, which contains a multifaceted interplay between spontaneous and controlled thinking, the capability to both spontaneously brainstorm novel ideas and consciously evaluate them to regulate whether they will truly work (Beatty, 2018). This implies that the ability of varied cognitive style students to physically create beautiful, innovation and functional objects through skilled handiwork defines creative-hands. Creative-hands is supported by Sternberg and Lubart's (1995) investment theory of creativity which posits that creativity involves buying low and selling high in the world of ideas, meaning that creative individuals invest in ideas that are initially undervalued but have potential for innovation.

Cognitive style refers to an individual’s distinctive way of processing information from the environment, which manifests through differences in perception, analysis, organization, categorization, and continuous evaluation of information (Grebenev et al., 2014). These variations form the basis of specific cognitive appraisal patterns and serve as a valuable foundation for implementing differentiated learning strategies and tailoring instructional methods. Essentially, cognitive style reflects how students interpret environmental stimuli and the thinking patterns they employ to construct their understanding of the world. Gaining insight into the diverse cognitive styles of learners offers an opportunity to explore individual learning differences more deeply. Such understanding can inform the practices of teachers, counsellors, and other educational professionals, enabling them to better support students’ creative development and learning experiences (Lewin, 2019). Students exhibit different cognitive styles, each with distinct characteristics. For instance, memory learners rely on previously acquired knowledge to integrate new information. Perceptive learners differ in how they respond to visual, auditory, or tactile cues in their environment. Meanwhile, analytical learners prefer a methodical, logical approach, processing information in a step-by-step sequence. Cognitive styles are different from students’ intellectual abilities, but they may affect personality progress and how people learn and apply information (Lewin, 2019). The primary difference between cognitive styles and intellectual abilities lies in their focus. Cognitive styles are about the preferences in processing information, while intellectual abilities are about the capacity and performance in cognitive tasks. For instance, a person may have high intellectual abilities in language, indicated by their proficiency in vocabulary and grammar. However, their cognitive style might be more visual, meaning they prefer using images and spatial relationships to understand and remember information (Sternberg & Zhang, 2021).

The aim of meaningful and functional education is to inculcate knowledge, wisdom, understanding and all kinds of skills to an individual to fit meaningfully into the ever-dynamic society. This submits that creative science teaching which is an aspect of education is the wealth and health of every nation, and in deed the key to attaining human right for all by eliminating poverty, shielding the planet and guaranteeing success and prosperity across the ever-dynamic globe. However, there exist a yawning gap in creativity (creative-hands inclusively) (Jobberman, 2021) as a result of poor creativity teaching methods, despite the urgent need for creative-hands as a tool for innovation and national prosperity. United Nations Industrial Development Organization (UNIDO, 2016) confirmed that Nigerian teachers and students are deficient in creativity. Likewise, Mellander and King (2015) on global creativity index (GCI) and related indices for some selected African countries showed that Nigeria was not ranked in the 2015 global creativity index for African countries. This implies that Nigeria has serious creativity problem which needs urgent attention. Globally, there has been an increased need for focus on cultivating the creative capital of citizens for sustainable growth (United Nations Education, Scientific and Cultural Organisation - UNESCO, 2017 & World Economic Forum, 2015). This is due to the global link between creativity and prosperity of nations. Global Innovation Index (2023) and United Nations Development Programme (UNDP, 2023) confirms that high development indices of countries are dependent on their corresponding high creativity indices. This is why nations pursue goals that will improve the livelihood of their citizens. The poor creativity index in Nigeria linked with poor creative teaching methods, resulting to low development of creative-hands

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couple with the fact that, no study regarding development of creative-hands among varied cognitive style upper-basic III students in basic science using creative exploration in Gboko.

Aim and Objectives of the Study

The aim of the study was to investigate development of creative-hands among varied cognitive style upper-basic III students in basic science using creative exploration in Gboko. Scientifically, the study sought to:

1. Find out the difference in creative-hands development of students taught Basic Science using Creative Exploration (CE) and those taught using Expository Teaching (ET).
2. Establish the difference in creative-hands development among students with different cognitive styles taught Basic Science using Creative Exploration (CE).

Research Questions

The following research questions guided this study:

1. What is the mean difference in the creative-hands development of students taught Basic Science using Creative Exploration (CE) and those taught using Expository Teaching (ET)?
2. What is the mean difference in the creative-hands development among students with varied cognitive styles (memory, perceptive and analytical learners) taught Basic Science using Creative Exploration (CE)?

Hypotheses

The following null hypotheses were formulated and tested at $p \leq 0.05$ α-level:

1. There is no significant difference in the mean creative-hands development of students taught Basic Science using Creative Exploration (CE) and those taught using Expository Teaching (ET).
2. There is no significant difference in the mean creative-hands development among students with varied cognitive styles (memory, perceptive and analytical learners) taught Basic Science using Creative Exploration (CE).

Material and Methods

A quasi-experimental research design (pre-test post-test non-equivalent control group) was employed to study the development of creative-hands among varied cognitive style upper-basic III students in basic science using creative exploration in Gboko. The study aimed to develop students' ability to harness their environment for making novel and unique production of electrical extension boards with their hands for creativity investment. A multistage sampling procedure was used to draw a sample size of 70 (17 males with 18 females in the experiment and 13 males with 22 females in the control group) Upper-Basic III science students in two schools. The sample was drawn from a population of 1 823 (995 males and 828 females) students in 24 Government Grant-Aided schools in Gboko Local Government. Firstly, the schools were stratified into two (single and coeducational Basic Science schools). Secondly, purposive sampling was used to purposively select only the co-educational Basic Science schools in the urban areas only because of diverse students' population, real-world demographics and socioeconomic conditions and due to the distinct comparable features between urban and rural areas such as the availability of basic amenities like; electricity, pipe born water, good roads and hospitals. Thirdly, to ensure bias-free, objectivity, honesty, and assignment of subjects into groups, the four schools were randomly selected and was given creativity equivalence-test using the creative hand design test in standard intact classes of teacher-students ratio not more than 1:35 as specified in the National Policy on Education (2013). After which two upper-basic schools that had equivalence creative hand design test scores were assigned into groups (A= Experimental Group and B = Control Group) by "raffle draw." That is, since the two schools had creative hand design test's equivalence, the researcher wrote letter A = Experimental and letter B = Control on two pieces of paper, folded them properly and dropped them in a bucket. The school that drew letter A was assigned into experimental group and the school that drew B was assigned into control group.

The Creative Hand Design Test (CHDT) was adapted and employed as the primary instrument for data collection. The CHDT consists of two sections: Section A gathers students' bio-data, while Section B contains a single hands-on activity involving the imitation of an electrical extension board. Each student was evaluated based on the sequential steps taken to replicate the extension board. The task includes 13 defined steps, each allotted two minutes, giving students multiple opportunities to complete the process correctly until a functional and investment-ready extension board is produced. Each successfully completed step was awarded 3 marks. That is, the scores were based on continuum from 0 to 3 representing a range of values: 0 = absence, 1 = low trial, 2 =

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moderate trial, 3 = advanced workable level. After which the summed scores in the 13 steps for each if scored 3, is summed to a total possible score of 39 marks. To ensure the instrument's validity, the CHDT underwent expert review by five professionals: a Professor of Science Education with a specialization in Physics, an Associate Professor of Mathematics Education, both from the Department of Science and Mathematics Education, an Associate Professor of Electrical/Electronic Technology from the Department of Vocational and Technology Education, a Senior Lecturer in Tests and Measurement from the Department of Educational Foundations, and a Basic Science teacher with over 10 years of classroom experience from Benue State Technical College, affiliated with Benue State University, Makurdi, Nigeria. These experts reviewed the instrument in light of the research topic, objectives, questions, and hypotheses. They provided valuable suggestions for enhancing the face and content validity of the instrument, all of which were implemented. A trial test of the CHDT was conducted with 22 Upper Basic III students from a school in Gboko that was not included in the main study sample. The reliability of the instrument was established using the test-retest method, yielding a Pearson’s Product-Moment Correlation coefficient of 0.99, indicating a high level of stability.

Following the validation of the research instrument, four research assistants were trained to ensure uniformity in the implementation of the study. After the training, a pre-test was administered to both the experimental and control groups. Subsequently, both groups received instruction on the Basic Science concept of “electrical energy.” The experimental group was taught using the Creative Exploration (CE) strategy, while the control group received instruction through the Expository Teaching (ET) method. The instructional treatment spanned a duration of six weeks, aimed at fostering creative hand skills among Upper Basic III students, enabling them to leverage their environment for creativity-driven investment. To maintain internal validity, extraneous variables such as the Hawthorne effect, teacher variability, initial group differences, pre-test sensitization, and instructional setup effects were adequately controlled. Data analysis was conducted using mean and standard deviation to answer the research questions. The research hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 level of significance. ANCOVA was selected due to its appropriateness in adjusting for initial group differences and handling multiple independent variables. Specifically, it facilitated the comparison of group means between the two teaching strategies (CE and ET), while statistically controlling for prior levels of creative-minds development. This choice was further justified by the nature of the data, which was measured on an interval scale and demonstrated normal distribution (Emaikwu, 2013).

Results

Research Questions One: What is the mean score difference in the Creative-Hands Development (CHD) of students taught Basic Science using Creative Exploration (CE) and those taught using Expository Teaching (ET)?

Table 1: Mean and Standard Deviation of Students’ Creative-Hands Development (CHD) based on Teaching Method

Method	Sample (n)	Pre-CHD		Post-CHD		Gain	Mean Gain Difference
		Mean	St. D	Mean	SD		
Creative Exploration	35	20.86	5.74	36.91	3.41	16.05	7.45
Expository Teaching	35	22.29	4.71	30.89	4.40	8.60	

Table 1 indicated that students taught Basic Science using CE had mean gain scores of 16.05 while those taught using ET had a mean gain score of 8.40. Thus, there was a mean gain difference of 7.45 in favour of students taught Basic Science using Creative Exploration (CE). This showed that students taught using CE developed creative-hands more as compared to those taught using ET. Also, SD for CE at post-CHD was lower than for ET, showing that CE scores clustered closer to their means more than for ET.

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Research Questions Two: What is the mean difference in the creative-hands development among students with different cognitive styles taught Basic Science using Creative Exploration (CE)?

Table 2: Mean and Standard Deviation of Creative-Hands Development (CHD) of Students by Cognitive Styles

Cognitive Style	Sample (n)	Pre-CHD		Post- CHD		Mean Gain	Mean Gain Difference
		$\bar{x}$	SD	$\bar{x}$	SD		
Memory Learners	11	18.73	6.28	37.00	3.49	18.27	
Perceptive Learner	11	23.27	4.92	37.00	3.49	13.73	$0.42 \leq 4.54$
Analytical Learners	13	22.62	5.56	36.77	3.54	14.15	

The results presented in Table 2 indicate that memory learners taught Basic Science through Creative Exploration (CE) recorded a post-CHDT mean score of 37.00 with a standard deviation of 3.49, compared to a pre-CHDT mean score of 18.73 and a standard deviation of 6.28. Similarly, perceptive learners had a pre-CHDT mean score of 23.27 (SD = 4.92) and a post-CHDT mean score of 37.00 (SD = 3.49), while analytical learners recorded a pre-CHDT mean score of 22.62 (SD = 5.56) and a post-CHDT mean score of 36.77 (SD = 3.54). These results reflect mean gain scores of 18.27 for memory learners, 13.73 for perceptive learners, and 14.15 for analytical learners. As further revealed in Table 6, the mean gain differences among the cognitive styles ranged from 0.42 to 4.54, with the highest gains observed among memory learners. This suggests that memory learners benefited most from the Creative Exploration strategy, demonstrating greater development in creative-hand skills compared to their perceptive and analytical counterparts when taught Basic Science using CE.

Hypotheses One: There is no significant difference in the mean creative-hands development scores of students taught Basic Science using Creative Exploration (CE) and those taught using Expository Teaching (ET).

Table 3: ANCOVA Summary of Students' Creative-Hands Development Based on Teaching Method

Source	Type III Sum of Squares	Df	Mean Square	F	P	Partial Eta Squared
Corrected Model	660.498[a]	2	330.249	21.486	.000	.391
Intercept	5039.553	1	5039.553	327.879	.000	.830
Pre-CHD	24.484	1	24.484	1.593	.211	.023
Teaching Method	**590.789**	**1**	**590.789**	**38.437**	**.000**	**.365**
Error	1029.802	67	15.370			
Total	82135.000	70				
Corrected Total	1690.300	69				

The ANCOVA summary presented in Table 3 reveals a statistically significant difference between the two instructional groups, with $F(1, 67) = 38.437$ and $p = 0.000$, which is less than the alpha level of 0.05. Based on this result, the null hypothesis is rejected, indicating that the method of instruction had a significant effect on students' creative-hands development in Basic Science. Specifically, students taught using the Creative Exploration (CE) strategy outperformed those taught through Expository Teaching (ET) in terms of creative-hand skills. The partial eta squared value of 0.365 reflects a large effect size, suggesting that approximately 36.5% of the variance in creative-hand scores is attributable to the difference in instructional strategies. This underscores a strong positive association between the Creative Exploration strategy and the development of students' creative-hand skills in Basic Science.

Hypotheses Two: There is no significant difference in the mean creative-hands development among students with different cognitive styles taught Basic Science using Creative Exploration (CE).

Table 4: ANCOVA Summary of Students' Creative-hands Development Based on Cognitive Style

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Source	Type III Sum of Squares	Df	Mean Square	F	ρ	Partial Eta Squared
Corrected Model	7.084[a]	3	2.361	.189	.903	.018
Intercept	2528.796	1	2528.796	202.221	.000	.867
Pre-CHD	6.649	1	6.649	.532	.471	.017
Cognitive Style	**1.649**	**2**	**.825**	**.066**	**.936**	**.004**
Error	387.658	31	12.505			
Total	48088.000	35				
Corrected Total	394.743	34				

The ANCOVA summary in Table 4 shows $F(1, 31) = 0.066$ with a p-value of 0.936, which is greater than the alpha level of 0.05. This indicates that the result is not statistically significant, and thus, the null hypothesis is retained. Consequently, there is no significant difference in the development of creative-hand mean scores among students with different cognitive styles who were taught Basic Science using the Creative Exploration (CE) strategy. This finding suggests that CE is equally effective across various cognitive styles, and it does not produce learning disparities based on students' cognitive preferences. The partial eta squared value of 0.004, representing a very small effect size, further supports this conclusion. It implies that only 0.4% of the variance in creative-hand scores is associated with differences in cognitive styles, confirming the uniform effectiveness of CE in promoting creative-hand development among students, regardless of their cognitive style.

Discussion

This study was about development of creative-hands among varied cognitive style upper-basic III students in basic science using creative exploration in Gboko. The findings of the study are discussed as follows: Regarding students' creative-hands development, there was a significant difference in the development of creative-hands between students taught Basic Science using Creative Exploration (CE) and those taught using Expository Teaching (ET). Students taught using CE develop more creative-hands as compared to students taught using ET. The finding of this study is not odd because students who were taught Basic Science were involved in discovering, perceiving, evidence, generating descriptions, investigating, carrying out further investigations and making connections with instructional materials. They took ownership of the class and developed creative-hands as they were fully motivated to learn meaningfully; they produced Extension Boards (EB) for creativity investment. However, such opportunities were not in the ET where students were fed by the teacher in directing instructions, lecturing, presenting information and focusing on transmission of knowledge only.

This result supports results of a study by Kelly (2020) which showed a significant increase in creative exploration scores post-programme with a significant correlation between creative-hands development and creative exploration subscales. The study also agrees with results of Lee and Wang's (2021) study that handicraft activities significantly enhanced both manual dexterity and creativity in preschool children, with strong positive correlations between the two variables. The study's result also supports concurs with Gomez and Harris's (2022) findings that regular engagement in artistic activities led to significant improvements in fine motor skills and creative expression. The study also agrees with findings by White and Green (2023) that visual arts education significantly improved creative hand skills, with higher dexterity scores. Moreover, this result agrees with that of Adams and Lee (2020) that sculpture activities were found to significantly improve both manual dexterity and creativity, with higher scores for students who regularly engaged in sculpturing. Additionally, the result of the study verifies findings by Martin and Roberts (2022) that craft activities significantly improved manual dexterity and creativity in young children, with positive feedback from teachers on children's skill development. Similarly, the result is in line with Davis and Thompson's (2021) findings that artistic workshops significantly enhanced manual dexterity. Creative exploration is effective in fostering creative-hands of Basic science schools in Gboko.

Regarding students' creative-hands development based on gender, it was found that no significant difference exists in the creative-hands development between male and female students taught basic science using creative exploration. this explains that creative exploration is gender friendly. The finding is at variance with the findings of Foster and Campbell (2020) whose study revealed significant gender differences in creative hand skills, with females excelling in fine motor tasks. Similarly, the finding disagrees with Lopez and Martin (2021) who found that females showed higher proficiency in detailed and intricate handicraft tasks, while males exhibited better performance in larger, more robust projects. The finding is inconsistent with Nguyen and Turner's (2022) findings that females demonstrated higher manual dexterity in tasks requiring precision. The finding is at variance with White and Harris's (2023) results that female outperformed males in fine motor tasks. Moreover, the finding

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disagrees with Smith & Brown's (2021) results that female student had higher scores in tasks requiring detailed and delicate hand movements. The result also disagrees with Martin and Roberts (2022) as well as Davis and Thompson's (2021) position found that female generally scored higher in tasks requiring fine motor skills and girls showed higher proficiency in detailed handicraft tasks disagrees with the current study. Why the previous studies showing gender differences could be methodological differences, cultural influences, theoretical perspectives and maybe statistical analysis.

The findings established that Creative Exploration (CE) provides a way out in developing students' creative-hands in Basic Science among Basic Schools in Nigeria. CE is an approach that makes teaching and learning of Basic Science more accessible and engaging for all students, regardless of varied cognitive styles. It is therefore, a good alternative in the teaching and learning of Basic Science at Basic education level. Moreover, the usage of the Expository Teaching in teaching and learning Basic Science should be discouraged. Because the adoption of Creative Exploration is appropriate for the teaching and learning of Basic Science and its inclusion in the curriculum will support the holistic students' development of creative-hands without cognitive styles disparity for creativity investment in Basic Schools, thus, achieving the objectives of basic education and science education in Nigeria.

Recommendations

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

i. Basic science teachers should use creative exploration to ensure effective teaching and learning of Basic science to enhance the development of students' creative-hands in Basic Science.
ii. Workshops should be organized by professional bodies such as Science Teachers Association of Nigeria (STAN) and National Teachers Institute (NTI) to sensitize Basic science teachers and other educators on the use of creative exploration to develop creative-hands among Basic science school students for creativity investment.
iii. Ministry of education should encourage the use of creative exploration among Basic science teachers in the classroom by funding seminars, workshops, conferences and refresher courses for teachers to ensure meaningful, functional and lasting teaching and learning science to enhance the development of students' creative-hands in Basic Science.
iv. Curriculum designers should encourage and promote creative exploration programme to supports holistic student development of creative-hand.

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