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Creative Hands Development through Creative Exploration among Upper-Basic Intermediate Science Students with Varied Intellectual Abilities in Gboko, Benue State, Nigeria

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Abstract

This study investigated how creative exploration impacts the development of creative hands in upper-basic Intermediate Science students with diverse intellectual capabilities in Gboko, employing a quasi-experimental design with a pre-test/post-test and a non-equivalent control group. Two research questions and two hypotheses formed the basis of the investigation. The population of this study was 1,823 (995 male and 828 female) Upper-Basic III (UB3) students in 24 government grant-aided schools in Gboko Local Government, and a sample of 70 Upper-Basic III students, including 35 (17 male and 18 female) in the Experimental Group and 35 (13 male and 22 female) in the Control Group, was used for this study. A multi-stage sampling procedure was adopted for the study (stratified, purposive and simple random samplings inclusively). Creative Hand Design Test (CHDT) was validated by five experts, trial-tested, and test scores collected were computed using Pearson Product Moment Correlation (PPMC) statistics, which yielded a reliability coefficient of 0.997, and it was used for data collection. Mean and standard deviation were used to answer research questions, and Analysis of Covariance (ANCOVA) was used for the test of hypotheses. Findings revealed that there was a significant difference in the mean creative hands development scores of students taught Intermediate Science using Creative Exploration (CE) and those taught using Expository Teaching (ET) in favour of the Creative Exploration group. More so, there was no significant difference in the mean creative hands development among students with varied intellectual abilities taught Intermediate Science using Creative Exploration. The study recommends that science teachers should adopt Creative Exploration as a preferred instructional strategy in teaching Intermediate Science, as it enhances students' creative hands development more effectively than Expository Teaching.

Keywords: Creative Hands Development (CHD), Creative Exploration (CE), Intermediate Science (IS) and Varied Intellectual Abilities (VIA).

Introduction

Education is regarded as a dynamic process through which individuals acquire scientific knowledge, values, attitudes, and practical skills needed for meaningful participation and lifelong learning in a society. In the 21st century, science education has transformed beyond the traditional transmission of scientific knowledge to the advancement of innovation, creativity, and problem-solving abilities that prepare learners for real-life challenges (Ayua, 2019). That is why the need for a paradigm shift from non-constructivist to constructivist teaching strategies is imperative. In an effort to create a transformative education, skills and lifelong learning system, current educational systems emphasise learner-centred techniques that stimulate discovery, cooperation, and skill acquisition (Aytekin & Topçu, 2024). This repositioning is in line with worldwide educational reforms that support the development of competencies essential for sustainable development and societal

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advancement. Recent research has indicated that science education, which incorporates creativity and hands-on learning experiences, can enhance learners' engagement, adaptability, and innovative capability in school and beyond (Xu et al., 2024). Science is a methodical form of knowledge that deals with the understanding of natural events through observation, experimentation and rational reasoning. According to Puspita et al. (2025) science is very important to technical advancement, national growth, and the improvement of human living situations. Today, there is a shift in the focus of science education from training in the rote memorisation of knowledge to practical inquiry, innovation and creativity. This transformation is fundamental for supporting transformative education, skills and a lifelong learning system that prepares learners with the ability to overcome rising societal and environmental concerns. The focus on scientific creativity and inquiry-based activities can stimulate learners to think critically, produce creative ideas, and formulate practical solutions to scientific problems. Research has revealed that creative and inquiry-based science learning environments can promote students' creative thinking, problem-solving skills, and creative hands (Ayua et al., 2024; Samodra et al., 2026).

Science Education is an integral part of the teaching and learning of scientific concepts, processes, attitudes, and applications in formal and informal educational settings. Saefan et al. (2025) lament that it is designed to help learners acquire scientific literacy, process skills, and innovative capacities required for functioning effectively in a technologically driven society. The up-to-date focus of science education is on learner involvement, experimentation, and creativity, which may support transformative education, skills and a lifelong learning system. Through Intermediate Science education, learners are expected not only to understand scientific principles but also to apply them creatively in solving practical problems within their communities even if they discontinue formal education at the upper-basic level. Inquiry-based instruction, project-based learning, and exploratory learning approaches have been widely recommended for enhancing scientific creativity and active participation among Intermediate Science students with intellectual abilities. Studies have discovered that science education that encourages creative exploration can improve Intermediate Science students' originality, flexibility, and innovation skills for creative hands (Ayua & Jato, 2012; Ayua & Ode, 2015; Xu et al., 2024).

Intermediate Science (IS) is an amalgamated science subject that is offered at the upper-basic level of education to offer learners with foundational scientific knowledge and practical skills. At this stage, learners are exposed to basic concepts in Biology, Chemistry, Physics, and Earth Science in ways that inspire curiosity and prepare them for advanced science learning. Intermediate Science is expected to contribute meaningfully to transformative education, skills and lifelong learning systems by encouraging practical engagement, experimentation, and creative problem-solving among learners. However, the teaching of Intermediate Science in many schools still relies heavily on non-constructivist teaching methods that limit students' active involvement and creative expression. This situation often results in poor practical skills development and low curiosity in science learning. Scholars have argued that innovative instructional approaches such as simulation games, inquiry learning, and creative exploration are more effective in enhancing learning outcomes among learners with varying intellectual abilities (Adeyele, 2024). For this study, creative exploration was experimented with to determine if it could build deeper understanding and not just memorisation, develop problem-solving and adaptability, increase motivation and ownership, support diverse learners, and foster creativity and innovation.

Creative Exploration (CE) is a learner-centred teaching technique that requires students to actively explore ideas, alter materials, experiment with concepts and develop innovative solutions. According to Terhemba and Ayua (2024), Creative Exploration involves curiosity-based activities that stimulate imagination, innovation and critical thinking while learning. It can provide learners with opportunities to develop practical competencies, adaptive abilities and creative hands needed in present-day society. Its relevance in achieving a transforming education, skills, and lifelong learning system has grown more relevant. Creative exploration in science classrooms allows learners to build models, perform experiments, formulate hypotheses and engage in open-ended problem-solving activities that enhance creativity and ingenuity. Research has demonstrated that creative exploration has a great impact on students' scientific creativity, creative thinking, practical engagement and creative hands in science learning (Ayua & Jato, 2012; Ayua & Ode, 2015; Aytekin & Topçu, 2026; Terhemba & Ayua, 2024).

Creative Hands (CH) are the practical and manipulative skills demonstrated by learners when they design, construct, improvise or create new materials and solutions through active participation in learning activities. It underlines the psychomotor and creative sides of learning whereby learners translate ideas into concrete results. The development of creative

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hands is essential in promoting transformative education, skills and lifelong learning system because it could equip learners with vocational, entrepreneurial and innovative competences necessary for self-reliance and national development (Ayua et al., 2022; Ayua et al., 2023; Carbajal & Baranauskas, 2024). Creative hands development in science learning is the students' handling of scientific tools, making models and applying the theoretical ideas in a practical way. Educational experts have argued that hands-on and exploratory learning experiences could greatly boost learners' creative productivity and practical competence in science education among diverse intellectual ability pupils (Terhemba & Ayua, 2024).

Varied Intellectual Ability (VIA) refers to the differences in learners' cognitive capacities, reasoning skills, learning pace, and problem-solving potentials within a classroom setting. Learners are different in their intellectual functioning owing to the fact of individual differences in heredity, environment, motivation, and exposure to learning opportunities. Effective teaching approaches such as creative inquiry should accommodate learners with varying intellectual abilities to enable fair participation and achievement (Adeyele, 2024). This need is in line with the objective of the transformative education, skills and lifelong learning system, which aims at inclusive and adaptive learning opportunities for all learners. Students with varying intellectual abilities may respond differently to teaching approaches in science education, particularly those that involve creativity, inquiry and hands-on participation. Studies have shown that creative exploration, simulation games and interactive learning as innovative teaching approaches can help learners of varied intellectual levels to obtain meaningful learning results (Terhemba & Ayua, 2024). The intellectual capabilities include the operation, content, and product learners. Operation learners stress learning the processes and procedures necessary to complete a task and solve problems. Content learners are concerned with learning the content and understanding the subject matter. Product learners are focused on the tangible outputs of the learning process, i.e., producing or demonstrating something concrete. There are numerous sets of knowledge that exist; thus, there are varied intellectual talents, so pupils need to be checked in a classroom setting to carry out various kinds of activities.

The significance of this study lies in its potential contribution to improving the teaching and learning of Intermediate Science among upper-basic students in Gboko. The study is expected to provide empirical evidence on how Creative Exploration can enhance creative hands development among learners with varied intellectual abilities. The findings may help teachers adopt innovative instructional strategies that encourage practical engagement, creativity, and learner participation in science classrooms. Curriculum planners and educational administrators may also benefit from the study by integrating learner-centred and creativity-driven approaches into science curricula in line with transformative education, skills and lifelong learning systems. Moreso, the study may contribute to existing literature on Creative Exploration, scientific creativity, and practical skills development while serving as a reference for future researchers interested in creativity and science education. Evidence from recent studies supports the effectiveness of creative and inquiry-based instructional approaches in enhancing learners' creativity, innovation, and practical competence in science education (Puspita et al., 2025; Xu et al., 2024; Terhemba & Ayua, 2024).

The theoretical anchorage of the study is hinged on two theories: Piaget's (1957) Theory of Cognitive Development, which outlines how children construct mental models of the world through four different stages, each characterised by different ways of thinking and learning. These stages comprise the sensorimotor stage, preoperational, concrete operational and formal operational stages. However, the formal operational stage is more suitable to support creative exploration in this study because of the school age of Upper-Basic III students. Tailoring creative activities to individual intellectual abilities ensured that each student can explore and develop their creativity effectively. Piaget stresses the importance of active learning and exploration. Providing varied opportunities for hands-on activities allows students to participate in creative hands-on activities for transformative education, skills and lifelong learning amidst various intellectual ability students. Piaget highlights the natural curiosity of children. Fostering science in an environment where questions and exploration are encouraged could help students to develop creative hands regardless of varied intellectual abilities. Group activities and collaborative projects enable students to share ideas and learn from each other, promoting creativity and innovation while respecting diverse intellectual abilities.

Sternberg and Lubart's (1995) Investment Theory of Creativity 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. This theory highlights six resources that contribute to creativity: The ability to see problems in new ways and to move beyond

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conventional thinking; Sufficient understanding of a field to know where to invest creative efforts; Preference for thinking in novel ways and for challenging the status quo. Traits like willingness to take risks, tolerance for ambiguity, and perseverance. Intrinsic motivation, or a passion for the work itself, is crucial for sustained creative effort. Supportive environments that provide resources, encouragement, and recognition. Therefore, by valuing different styles of thinking, such as analytical, practical, and creative hands, the Investment Theory supports a variety of intellectual abilities and fosters an inclusive creative exploration environment for creativity. Encouraging students to take intellectual risks and explore unconventional ideas may help develop creative hands. This applies across intellectual abilities, allowing each student to contribute uniquely, and can provide a strong foundation for scientific knowledge at the basic education level, which may enable students to identify undervalued ideas with potential. This supports creative exploration by equipping students with the necessary background to innovate. Creating an environment that nurtures students' intrinsic motivation by allowing them to pursue their interests and passions enhances creativity across different intellectual abilities. Establishing a classroom environment that encourages experimentation, provides resources, and recognises creative efforts supports all students, regardless of their intellectual abilities. Encouraging traits like perseverance and risk-taking helps students develop resilience needed for creative exploration.

Empirical research has shown that creative and hands-on activities improve learners' creative hands development, creativity, manual dexterity and related cognitive capacities significantly at all levels of education. Kelly (2020) indicated that creative-hands development programs had a substantial impact on creative exploration among preschool children in New York, whereas Lee and Wang (2021) revealed that handicraft activities improved manual dexterity and creativity among preschool children in Canada. Likewise, Gomez and Harris (2022) found that artistic practice enhanced fine motor skills and creative expression in high school students in Australia. White and Green (2023) showed that visual arts education significantly improved creative hand skills in secondary school students in the United States. In the same vein, sculpture activities improved manual dexterity and creativity in high school students (Adams and Lee, 2020), craft activities significantly improved creativity and manual dexterity in young children in Australia (Martin and Roberts, 2022), and artistic workshops enhanced manual dexterity and creative thinking in middle school students in the United States (Davis and Thompson, 2021). These studies, though, established strong relationships between creative activities and the development of creative hands, but they focused largely on preschool, middle school, or high school learners outside Nigeria and did not specifically investigate the use of creative exploration in developing creative hands among Upper-Basic Intermediate Science students in Gboko, Benue State. Also, different instruments and approaches were employed in the studies instead of the Creative Hand Design Test (CHDT). This created a gap which the present study intends to fill by examining creative hands development through creative exploration among Intermediate Science students in Gboko, Benue State, Nigeria.

Empirical studies have consistently shown a positive relationship between practical and creative skill development and students' intellectual ability across different educational settings. Johnson and Nguyen (2021) found that fine motor skills significantly predicted intellectual ability among preschool children in the United States, while Carter and Davis (2022) reported that handwriting proficiency significantly correlated with higher intellectual ability among elementary school students in Canada. Similarly, Brown and Lee (2020) revealed that sculpture skills positively influenced intellectual ability among middle school students in Australia, whereas White and Robinson (2023) established that musical instrument proficiency enhanced intellectual ability among high school students in the United Kingdom. In the same vein, Green and Parker (2021) showed that carpentry skills positively predicted intellectual ability among vocational school students in the United States; Harris and Martinez (2022) found that pottery skills development improved intellectual ability among secondary school students in Canada. Turner and Baker (2020) reported that culinary skills development positively influenced intellectual ability among college students in Australia. Although these studies established strong links between practical skill acquisition and intellectual development, they mainly focused on fine motor, handwriting, sculpture, music, carpentry, pottery, and culinary skills without specifically addressing creative hands development through creative exploration in Intermediate Science among Upper-Basic students in Gboko, Benue State, Nigeria. Furthermore, most of the studies were conducted outside Nigeria, used different populations, instruments, and statistical techniques, thereby creating a gap that the current study seeks to fill by investigating creative hands development among Intermediate Science students with varied intellectual abilities using creative exploration and ANCOVA for hypothesis testing.

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Transformative education, skills and lifelong learning systems aim to prepare individuals to function effectively in a dynamic society through the acquisition of relevant knowledge, practical skills, and innovative capacities. Science education plays a vital role in achieving this goal by promoting national development, poverty reduction, environmental sustainability, and technological advancement (Terhemba, 2022). However, Nigeria continues to experience serious challenges in creativity development due to ineffective teaching methods that inadequately foster creative hands among learners with varied intellectual abilities. Reports by the United Nations Industrial Development Organisation (UNIDO, 2016) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2017) revealed low creativity indices and deficiencies in creative capacity among Nigerian teachers and students. Evidence from the Global Innovation Index (2023) and United Nations Development Programme (UNDP, 2023) indicates that nations with high creativity indices often achieve higher levels of development and progress. Despite the growing global emphasis on cultivating creativity for sustainable development, there remains limited research in Gboko on the effect of creative exploration in developing creative hands among Intermediate Science students with varied intellectual abilities.

This background necessitated this study with the following objectives:

1. Find out the difference in creative hands development of students taught Intermediate Science using Creative Exploration (CE) and those taught using Expository Teaching (ET).
2. Determine the difference in creative hands development among students with varied intellectual abilities (operation, content & product learners) taught Intermediate Science using Creative Exploration (CE).

The following research questions guided this study:

1. What is the mean difference in creative hands development of students taught Intermediate Science using Creative Exploration (CE) and those taught using Expository Teaching (ET)?
2. What is the mean difference in creative hands development among students with varied intellectual abilities (operation, content & product learners) taught Intermediate Science using Creative Exploration (CE)?

The following null hypotheses were formulated to guide the study at $p \leq 0.05$ α -level:

- H0₁** There is no significant difference in the mean creative hands development of students taught Intermediate Science using Creative Exploration (CE) and those taught using Expository Teaching (ET).
- H0₂** There is no significant difference in the mean creative hands' development among students with varied intellectual abilities (operation, content and product learners) taught Intermediate Science using Creative Exploration (CE).

Methodology

A pre-test post-test non-equivalent control group quasi-experimental research design was adopted for this study. This type of design, as recommended by Agogo and Achor (2019), is suitable for a study of this nature because it measures the participant's initial knowledge, attitudes, or behaviours, providing a baseline for comparison. The population of this study was 1,823 (995 male and 828 female) Upper-Basic III (UB3) students in 24 government grant-aided schools in Gboko Local Government, and a sample of 70 Upper-Basic III students, including 35 (17 male and 18 female) in the Experimental Group and 35 (13 male and 22 female) in the Control Group, was used for this study. A multi-stage sampling procedure was adopted for the study. Firstly, stratified sampling was used to categorise schools into single-sex and co-educational schools based on gender considerations. Secondly, purposive sampling was employed to select only co-educational schools located in urban areas due to their comparable features such as availability of electricity, pipe-borne water, good roads, and healthcare facilities. Thirdly, simple random sampling was used to select two intact classes from government grant-aided schools in the Gboko urban area.

The researcher adapted the Creative Hand Design Test (CHDT). It consisted of two sections: Section A contained students' biodata, and Section B included one activity: imitation of an electrical board extension. Each student was scored based on the steps of imitating the extension. There were 13 activities, each lasting for 2 minutes, with an opportunity to imitate correctly until an original workable extension was made. Each successful step was given 3 marks, after which the activities would be summed to a maximum of thirty-nine (39) marks. The key elements such as name, stages, scoring sheet and time of the Taxonomy of Creative Design ([TCD] Nilsson, 2011) were modified into CHDT to suit the age, environment and the Upper-Basic III class. CHDT was trial-tested on 22 students in a selected school that was not part of the proposed sample but had

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characteristics similar to the proposed sample to guard against priming. This is supported by Eriba and Iyekekpolor (2016) that students who are not part of the main study in the same town or even another town can be used as a sample for trial-test. The CHDT test scores were collected and computed using Pearson Product Moment Correlation (PPMC) statistic and yielded reliability coefficients of 0.997, and it was used for data collection.

The study had an experimental and a control group. Each group consisted of students with different intellectual abilities, including operation learners, content learners, and product learners. They were grouped using the Intellectual Ability Quiz (IAQ). The IAQ is a baseline diagnostic instrument developed by the researcher to classify students into operation, content, and product learners. It has Section A for students' bio-data and Section B containing seven items with options A, B, and C representing characteristics of the three intellectual ability types. Operation learners prefer hands-on and practical learning experiences, content learners focus on acquiring knowledge for its own sake, while product learners are achievement-oriented and value practical outcomes. Students were grouped based on the option they selected most frequently. A pre-test was given to all the groups before treatment. After pre-test administration, the experimental group was taught the concept of "Electrical Energy" using Creative Exploration (CE) lesson plans. Meanwhile, the control group was taught the same concept using Expository teaching (ET) lesson plans. This treatment lasted for six weeks before the post-test under standard examination conditions.

To control extraneous variables, the researcher used regular Basic Science teachers and trained research assistants to minimise the Hawthorne effect and teacher-related differences. Teachers with similar qualifications and experience were selected and provided with uniform lesson plans to ensure consistency in instructional delivery. Mean and Standard Deviation were used to answer the research questions. Meanwhile, Analysis of Covariance (ANCOVA) was used for test of hypotheses in order to control initial group differences arising from intact classes.

Results

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	St. D	Mean	SD	
Creative Exploration	35	20.86	5.74	36.91	3.41	16.05
Expository Teaching	35	22.29	4.71	30.89	4.40	8.60
Difference		1.43		6.02		7.45

Table 1 shows that students taught using Creative Exploration had a pre-test mean score of 20.86 with a standard deviation of 5.74, while their post-test mean score increased to 36.91 with a standard deviation of 3.41, resulting in a gain score of 16.05. Students taught using Expository Teaching had a pre-test mean score of 22.29 with a standard deviation of 4.71 and a post-test mean score of 30.89 with a standard deviation of 4.40, resulting in a gain score of 8.60. The Table 1 further reveals a post-test mean difference of 6.02 and a gain score difference of 7.45 in favour of the Creative Exploration group. This indicates that Creative Exploration was more effective in improving students' creative hands development in Intermediate Science than Expository Teaching.

Table 2: Mean and Standard Deviation of Creative-Hands Development (CHD) Based on Varied Intellectual Ability Students Taught Intermediate Science using Creative Exploration

Intellectual Ability	Sample (n)	Pre-CHD		Post-CHD		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Operation Learners	20	21.60	5.86	36.80	3.52	15.20
Content Learner	15	21.60	5.91	37.07	3.37	15.47
Product Learners	0	0	0	0	0	0

Table 2 reveals that operation learners had a pre-test mean score of 21.60 with a standard deviation of 5.86 and a post-test mean score of 36.80 with a standard deviation of 3.52, resulting in a mean gain of 15.20. Similarly, content learners recorded a pre-test mean score of 21.60 with a standard deviation of 5.91 and a post-test mean score of 37.07 with a standard deviation of 3.37, resulting in a slightly higher mean gain of 15.47. However, no data were recorded for product learners. The findings indicate that both operation and content learners improved considerably in creative hands development when taught Intermediate Science using Creative Exploration, with content learners showing a slightly higher mean gain than operation learners.

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

Source	Type III Sum of Squares	Df	Mean Square	F	ρ	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				

a. R Squared = .391 (Adjusted R Squared = .373)

b. Computed using alpha = .05

Table 3 presents the ANCOVA summary of students' creative hands development based on teaching method. The result shows that teaching method had a significant effect on students' creative hands development, $F(1, 67) = 38.437$, $p = .000$, since the p-value is less than the 0.05 level of significance. Therefore, the null hypothesis was rejected. This implies that there was a significant difference in the mean creative hands development scores of students taught using Creative Exploration and those taught using Expository Teaching in favour of the Creative Exploration group. The partial eta squared value of .365 further indicates that teaching method accounted for 36.5% of the variance in students' creative hands development, showing a substantial effect size.

Table 4: ANCOVA Summary of Students' Creative-Hands Development Based on Intellectual Ability

Source	Type III Sum of Squares	Df	Mean Square	F	ρ	Partial Eta Squared
Corrected Model	6.045 ^a	2	3.022	.249	.781	.015
Intercept	2870.937	1	2870.937	236.353	.000	.881
Pre-CHD	5.435	1	5.435	.447	.508	.014
Intellectual Ability	.610	1	.610	.050	.824	.002
Error	388.698	32	12.147			
Total	48088.000	35				
Corrected Total	394.743	34				

a. R Squared = .015 (Adjusted R Squared = -.046)

b. Computed using alpha = .05

Table 4 presents the ANCOVA summary of students' creative hands development based on intellectual ability. The result shows that intellectual ability had no significant effect on students' creative hands development, $F(1, 32) = 0.050$, $p = .824$, since the p-value is greater than the 0.05 level of significance. Therefore, the null hypothesis was not rejected. This implies that there is no significant difference in the creative hands' development of operation and content learners taught Intermediate Science using Creative Exploration. The partial eta squared value of .002 indicates a very negligible effect size, suggesting that intellectual ability contributed minimally to variations in students' creative hands development.

Discussion

The findings of this study, as presented in Table 3, revealed that there was a significant difference in the mean creative hands development scores of students taught Intermediate Science using Creative Exploration (CE) and those taught using

Expository Teaching (ET) in favour of the Creative Exploration group. This finding agrees with the studies of Kelly (2020), who found that creative hands development programmes significantly improved creative exploration among preschool children in New York. The finding is also in line with Lee and Wang (2021), who reported that handicraft activities significantly enhanced manual dexterity and creativity among preschool children in Canada. The result corroborates the study of Gomez and Harris (2022), which established that artistic practices improved fine motor skills and creative expression among high school students in Australia. The finding further supports the study of White and Green (2023), who revealed that visual arts education significantly improved creative hand skills among secondary school students in the United States. The findings are consistent with those of Adams and Lee (2020); Martin and Roberts (2022); and Davis and Thompson (2021), who all reported that sculpture activities, craft activities, and artistic workshops, respectively, enhanced creativity, manual dexterity, and creative thinking among learners. The agreement between these empirical studies and the present study may be attributed to the fact that creative and hands-on instructional approaches actively engage learners in practical activities, experimentation, manipulation of materials, and problem-solving processes that stimulate creativity and psychomotor skill development. The significant result obtained in this study therefore confirms that Creative Exploration is an effective instructional strategy for enhancing creative hands development among Intermediate Science students.

The result presented in Table 4 shows that there was no significant difference in the mean creative hands development among students with varied intellectual abilities taught Intermediate Science using Creative Exploration. This finding implies that intellectual ability did not significantly influence students' creative hands development when exposed to Creative Exploration. This result is not in agreement with earlier empirical studies that established significant relationships between practical skill development and intellectual ability. For instance, Johnson and Nguyen (2021) reported that fine motor skills significantly predicted intellectual ability among preschool children, while Carter and Davis (2022) found a significant correlation between handwriting proficiency and intellectual ability among elementary school students. Brown and Lee (2020); White and Robinson (2023) established significant positive relationships between sculpture, musical proficiency, and intellectual ability, respectively, while Green and Parker (2021); Harris and Martinez (2022); Turner and Baker (2020) also reported significant effects of carpentry, pottery, and culinary skills on intellectual ability across different educational levels. The disparity between these findings and the present study may be attributed to contextual differences, as the previous studies focused on specific skill-based activities in foreign settings and used different analytical approaches, whereas the present study focused on creative exploration within Intermediate Science classrooms in Gboko, Nigeria.

Conclusion

Based on the findings of the study, it was concluded that Creative Exploration (CE) is an effective instructional strategy for enhancing students' creative hands development in Intermediate Science. The results showed that students taught using Creative Exploration achieved significantly higher creative hands development scores than those taught using Expository Teaching. However, while Creative Exploration developed students' creative hands, the findings also revealed that intellectual ability (operation and content learners) did not significantly influence creative hands development, indicating that the strategy was beneficial to students regardless of their intellectual ability classification. Therefore, Creative Exploration is a more effective and inclusive teaching approach for improving practical creativity and skill development among Upper-Basic Intermediate Science students.

Recommendations

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

1. Science teachers should adopt Creative Exploration as a preferred instructional strategy in teaching Intermediate Science, as it enhances students' creative hands development more effectively than Expository Teaching.
2. Teachers should provide more hands-on, exploratory, and activity-based learning opportunities to enable students to actively engage in learning processes that develop creativity and practical skills.
3. Curriculum planners should integrate Creative Exploration strategies into the Intermediate Science curriculum to promote creativity, innovation, and skill acquisition among learners.
4. Since intellectual ability did not significantly affect creative-hands development, teachers should apply Creative Exploration uniformly across all learners, ensuring that students of different intellectual abilities are given equal opportunities to participate and develop practical skills.

5. Schools and educational stakeholders should organise regular training and workshops for Basic Science teachers on how to effectively implement Creative Exploration strategies in classroom instruction.

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