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LEARNERS' CREATIVE MINDS AND HANDS DEVELOPMENT AS KEY IN SOLUTION-BASED SCIENCE EDUCATION FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract

A paradigm shift in science education is fast evolving because of the 21st-century demand for sustainable development in Nigeria. This is a kind of demand that emphasises creativity, critical thinking, and practical problem-solving. This paper examined: importance of integrating creative minds and creative hands into science education through a solution-based approach. The problem of the global creativity indices and Sustainable Development Goals (SDGs), mostly in quality education and innovation. Solution-based science education model for experiential learning, real-world experiences, problem solving and locally relevant application as skills to tackle pressing socio-economic and environmental problems. Some strategies like project-based learning, STEM/STEAM integration, makerspaces, and community science that could develop students' capacity to generate and implement innovative solutions. The paper also investigated the role of curriculum development, teacher retraining and infrastructural support in charging pedagogical shifts. Exhibitions that showcase schools and national programs that illustrate the potential of hands-on, inquiry-driven learning to foster resilience, civic responsibility and sustainable innovation. Creative skills in science education to nurture scientifically cultured citizens who may solve local and global problems. It concludes with policy and practice recommendations to provide sustenance to this educational transformation, stressing that developing learners' creative minds and hands is not only desirable but indispensable for attaining national progress and the SDGs. Therefore, science education

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must change from rote memorization to an active, learner-centred system that fosters novelty, sustainability, and inclusive development.

Keywords: Creative Minds, Creative Hands, Solution-Based Science Education, Sustainable Development

Introduction

The emerging global issues of the twenty-first century have made the science education environment necessitates a paradigm revolution from memorisation towards methods that could inspire creativity, problem-solving, and sustainability. In a developing country like Nigeria: sustainable development, cultivation of students' creative minds and hands is critical. Thus, fostering learners' capacity to come up with original answers to pressing problems is needed (Ayua et al., 2022; Ayua et al., 2023; Ayua et al., 2024). Nevertheless, the United Nations Industrial Development Organisation (UNIDO, 2016) confirms that Nigerian teachers and students lack creativity. In addition, Nigeria as a country was not ranked in the 2015 global creativity index for African countries. This suggests evidence of a country's underdevelopment (Mellander & King, 2015). This indicates that Nigeria has serious creative minds and hands problem which needs urgent attention in solution-based education towards achieving sustainable development in Nigeria.

Creative minds could be described as students' mental ability to imagine, create, and judgmentally analyse challenging issues. It entails divergent thinking, ideation, and the capacity to imagine original solutions to real-world problems (Ayua et al 2025; Terhemba & Ayua, 2025a). Meanwhile, creative hands represent the practical or psychomotor skills to apply or construct meaningful products and outcomes from abstract ideas (Terhemba & Ayua, 2025b; Terhemba & Ayua, 2025c Okebukola, 2018). Thus, it involves using tools, materials, and experimental procedures to realise innovation. That is to say, when creative thinking and practical skills are united in science education, students are better equipped for scientific inquiry, invention, and innovation. This may be to address local and global issues like climate change, energy scarcity, and health crises. United Nations, Educational, Scientific and Cultural Organisation (UNESCO, 2019) laments that students are not only passive consumers of knowledge but also active creators of solutions, therefore, solution-based science education is imperative in this era.

Solution-based science education is an instructional approach that underlines the application of scientific knowledge and practical skills to solve real-life problems. As an effective approach, solution-based education emphasizes arming young people with practical skills and knowledge to solve real-world problems, thereby reducing the likelihood of engaging in criminal behaviour (Eriba & Ayua, 2025; Hjalmarsson & Lochner, 2018). By providing solution-based education, Nigerian youths can develop critical thinking and problem-solving skills, enabling them to make informed decisions and contribute positively to society. It moves away from theoretical memorization to experiential and inquiry-driven learning. This pedagogical approach prioritizes science content that is vital and oriented towards identifying problems, designing experiments and advancing sustainable solutions (Ayua & Terhemba, 2025; Akinbobola & Olufemi, 2020). The teaching of science education in Nigeria, must go beyond conventional textbook delivery. The teaching of science education should be responsible for students' participation or hands-on activities for developing renewable energy prototypes, water purification systems, or low-cost medical devices and the like. This has to do with the unified efforts that require both cognitive creativity and practical skills for sustainable development in the ever-dynamic globe.

Sustainable development is the development that meets the current trend of an economic system. According to Eriba (2016) and Eriba (2023), sustainable development is the advancement that meets

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present needs without compromising the ability of future generations to meet theirs, encompassing environmental sustainability, economic development and social equity. The key way-out to this agenda is the quality solution-based science education; that is to say when learners are fully equipped with scientific knowledge and problem-solving skills to address challenges like environmental degradation, poor health infrastructure, and unemployment (Federal Ministry of Education, 2020). Nurturing learners for Sustainable Development Goals into science education, teachers have to foster scientific literacy while cultivating social responsibility and environmental consciousness. More emphasis on creative minds and hands in science further stimulates innovation to improve agriculture, health, and environmental conservation which are pillars of Nigeria's development. However, Ayua and Gamat (2018) observed that prevalent challenges including global economic crises, terrorism, and insecurity often lead to poor funding or disruption of government sustainable development plans, thereby impeding functional education. Consequently, the 21st century needs "education beyond certification": a sound, functional, result-oriented, and creativity-tailored approach that produces individuals with relevant knowledge, skills, and character to apply learning in solving real-life problems, rather than focusing on mere paper certification (Ayua, 2019).

There are unique socio-economic and environmental challenges faced by Nigeria including deforestation, pollution, urban waste, and inadequate health services. However, a solution-based science education system may empower young Nigerians to become agents of change in their communities. This may also require curriculum reforms, teacher retraining, laboratory infrastructure and digital tools to enable creativity and innovation (Umeh & Adeyemo, 2021). For instance, associations like Science, Technology, Engineering, and Mathematics (STEM) clubs, maker spaces, and entrepreneurship-based science projects can help learners apply their creative minds and hands toward problem-solving. These kinds of approaches support Nigeria's goal to achieve SDG 4 (quality education) and SDG 9 (industry, innovation, and infrastructure). The amalgamation of learners' creative minds and hands in science education is central to building a solution-oriented generation capable of addressing Nigeria's developmental encounters. Science education has to become a tool not just for knowledge acquisition only but for innovation and sustainability. A curriculum which advocates hands-on activities, problem solving, critical thinking and its relevance to local realities is imperative for sustainable national development.

Science education has a pivotal role in equipping individuals with knowledge, skills, and values necessary to address the current and the future challenges associated with sustainable development. It can foster scientific literacy, critical thinking, problem-solving abilities, and innovation which are tools for empowering economic growth, environmental conservation, and social equity (UNESCO, 2019). Many nations across the globe strive to meet Sustainable Development Goals (SDGs), Therefore, science education could serve as a strategic tool for empowering citizens, especially the youth, to become proactive agents of change (Okebukola, 2018).

The drive toward sustainable development in Nigeria, is to meet with the persistent challenges, including environmental degradation, high level of poverty and unemployment, weak health and poor education system and inadequate infrastructure. Additionally, the rapid population growth in Nigeria, coupled with unsustainable practices such as deforestation, poor waste management, and over-reliance on fossil fuels, threatens long-term development and ecological balance. These stand as shackles militating against the country's ability to meet national and international development targets. This shows that Nigeria is lagging behind amidst many countries in Africa and globally in achieving sustainable development. Sustainable Development Report 2023 confirms that Nigeria ranks 146 out of 166 countries on the global SDG Index, particularly with low performance in quality education (SDG 4), industry, innovation (SDG 9), and climate action (SDG 13) (Sachs et al., 2023). It is surprising that countries like Mauritius and Algeria in Africa

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perform better than Nigeria on key development indicators, reflecting more effective integration of sustainability principles into policy and education systems.

To reposition Nigeria for sustainable growth, a transformative education, skills and lifelong approach to science education is needed. This could be an approach that centres on developing learners' creative minds and hands. This implies that fostering cognitive creativity for ideation and innovation, as well as practical, hands-on abilities for implementing solutions for real-life problems is appropriate. Such a shift towards solution-based is because science education is essential to produce scientifically literate citizens who are capable of driving development through locally-sourced relevant materials for innovation leading to sustainable practices (Akinbobola & Olufemi, 2020). Therefore, empowering learners with creative minds-on and hands-on, problem-solving skills is not just desirable but it is crucial for sustainable development in Nigeria.

Creative Minds and Hands Development Role in Nigeria's Science Education

Creative minds and hands development refers to a deliberate cultivation of learners' capabilities to think imaginatively and act innovatively, that is to say, it is both cognitively and practically. Creative minds have to do with the imagination, critical thinking, and innovation to solve problems or create new ideas, while creative hands focus on the psychomotor aspect, using manual skills to design, construct and experiment with physical objects or systems (Akinbobola & Olufemi, 2020; Okebukola, 2018). This dual development ensures that science education learners are not just idea generators, but they can practically apply those ideas real-life through hands-on activities and manual dexterity.

Importance of Creativity, Critical Thinking, and Problem-Solving Skills in Science Education

Skills like Creativity, critical thinking and problem-solving are pertinent to science education due to the fact that they can help learners to approach the 21st century demand with flexibility and innovation. Science by its nature, it is inquiry-based, it is about asking questions, hypothesizing and finding solutions. This means that developing creativity could enable students to think outside the box or the conventional boundaries and suggest original ideas for problem solving. According to UNESCO (2019) critical thinking has to do with learners' ability to evaluate evidence, make sound judgment and refine their thinking processes.

It is certain that nurturing these skills into science education curricula could transform learners from being passive recipients of information to active participants in scientific knowledge construction. It may further develop resilience and adaptability for solving real-world scientific and environmental problems, especially in the context of sustainable development (Umeh & Adeyemo, 2021). Local problems like flooding, waste management, and inadequate energy supply are being faced by many communities in Nigeria. However, training science students to become creatively and critically engaged may be a functional and lasting solution for sustainability.

Hands-on Activities and Practical Skills as Support for Enhancing Learning Outcomes

It is certain that hands-on activities and practical skills development have become an integral part of strengthening theoretical scientific knowledge and improving learning outcomes. Activities like laboratory experiments, model building, fieldwork and design-based learning make abstract scientific concepts physical and applicable (Ogunleye, 2019). This means that they can promote learners' participation, motivation, and retention of knowledge. Practical participation can promote learners' thought to test hypotheses, observe real-life outcomes and develop technical skills for sustainability. Some examples like building a simple water filtration system in a classroom setting can help learners to understand environmental science, engineering principles and health implications in one unified practice. According to

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Adebayo and Akinyemi (2020); Ayua and Terhemba (2025) the goals of solution-based science education stand for what learners can apply and learn to solve real-world problems. It has become necessary in introducing solution-based, project-based learning, science clubs and local innovations to nurture a team of thinkers who can be equipped for the demands of a fast-evolving and sustainable conscious world.

Solution-Based Science Education and Sustainable Development in Nigeria

Learner-centred pedagogical approach for solution-based science education stresses the application of scientific knowledge, skills, and values to solve real-world problems. Akinbobola and Olufemi (2020) opine that solution-based science education moves beyond memorization of facts to encourage critical thinking, inquiry, innovation, and experimentation in addressing socio-economic and environmental issues. Learners are not passive recipients in this approach but active participants in generating scientific solutions to local and global challenges through collaborative and practical experiences.

The application of solution-based science education to sustainable development lies in its potential to foster informed decision-making, scientific reasoning and innovation. All of these are pertinent for addressing the three core pillars of sustainability: environmental protection, economic development and social equity as identified by Sachs et al. (2023). Through solution-based science education, students can be nurtured with creativity and critical thinking to apply scientific theories in sustainable agriculture, climate change mitigation, waste management, water conservation and renewable energy technologies. By aligning solution-based science education with the Sustainable Development Goals (SDGs), particularly SDG 4 (quality education), SDG 7 (clean energy) and SDG 13 (climate action), schools can nurture a generation of problem-solvers to confront Nigeria's development challenges.

Many educational programs and classroom practices illustrate the application of solution-based science education:

i. Eco-projects in schools: Students can design and make school gardens using organic waste for compost, learning both Biology and environmental sustainability.
ii. STEM innovation challenges: Associations like the Young Innovators Program (YIP) encourage students to create devices that solve local problems like water purification or solar-powered mobile chargers.
iii. Community-based science projects: Adebayo and Akinyemi (2020) suggests that Nigerian secondary school students can engage in water testing and environmental clean-up as part of their unified science curriculum. It may promote creative minds and hands-on learning and civic responsibility, participating and unifying more scientific understanding with action-based learning.

Sustainable Development in Nigeria: Challenges and Opportunities

There are a number of sustainable problems in Nigeria like environmental degradation because of deforestation and oil spillage, poor waste disposal, climate change vulnerability and high dependence on non-renewable energy sources, poor infrastructure, low investment in science and technology, poverty and a growing population that put pressure on available natural resources and public services. According to Sachs et al. (2023) the Sustainable Development Report 2023 shows that Nigeria was ranked 146 out of 166 countries on the SDG Index, with persistent underperformance in key areas like education quality, clean energy access and environmental sustainability. This suggests a pressing need for strategic intervention for sustainability in Nigeria.

Building Sustainability in Nigeria through Science Education

In spite of all these challenges, here are opportunities of science education to contribute to sustainable development in Nigeria:

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i. Sustainable topics like climate change, renewable energy and water conservation should be unified into the science curriculum to increase awareness and inspire physical action.
ii. Educators should be trained with skills for solution-based, inquiry-based and problem-solving instruction to improve science education outcomes.
iii. There should be collaboration between schools and industries for students to harness real-world experiences for science-driven solutions in agriculture, health and energy sectors. By doing so, science education can be a powerful tool for equipping young Nigerians with the skills required to advance sustainable development locally and globally.

Creative Minds and Hands Development through Solution-Based Science Education

The development of creative minds and hands through solution-based science education is crucial for equipping learners with both intellectual and practical skills needed for solving composite societal and environmental problems. This can promote innovation, critical thinking and capability in students to apply scientific knowledge and harness real-world problems, thereby advancing the goals of sustainable development.

Nurturing Creative Minds and Hands Development through Innovative Strategies

i. The Inquiry-Based Learning (IBL) can inspire learners to ask questions, explore phenomena, analyse data, and draw conclusions. This can promote cognitive creativity and critical thinking, which are key components for solving world problems. UNESCO (2019) confirms that when learners are engaged in authentic problem-solving processes, they begin to think and act like scientists and this kind of thoughts and actions create the way forward for sustainability.
ii. Moreso, Project-Based Learning (PBL) has to do with students participating collaboratively through projects that require both scientific reasoning and practical application. Akinbobola and Olufemi (2020) ascertain that these projects can frequently finish in prototypes or solutions to community issues, thereby merging “minds” (ideation) with “hands” (execution) for sustainability.
iii. The STEM and STEAM integration which stands for Science, Technology, Engineering, Arts, and Mathematics (STEAM) could encourage interdisciplinary learning. Umeh and Adeyemo (2021) posit that art and design thinking may promote creative expression, while science and engineering can foster problem-solving and practical skills.
iv. The Makerspaces and Innovation Labs stand to create innovation hubs where students can use tools like 3D printers, robotics kits, and recycled materials to design and test their ideas. Okebukola (2018) asserts that such environments may empower learners to experiment and build cognitive skills leading to creative hands.
v. They should be Curriculum Reform and Teacher Training on how to nurture creativity into science education. There is a need for the curricula to move beyond rigid content delivery to activity-based delivery. Adebayo and Akinyemi (2020) opine that teachers can be trained by government agencies and Non-Governmental Organisations (NGOs) like STAN (Science Teachers Association of Nigeria), UNICEF (United Nations International Children Emergency Fund) and UNESCO to use flexible, learner-centred instructional approaches that encourage exploration, experimentation, and collaboration.

Examples of Effective Practices and Interventions

i. Learners can be guided at all levels to design and construct simple solar cookers using locally available materials. According to Adebayo and Akinyemi (2020) hands-on science activity enhances understanding of renewable energy and heat transfer while promoting sustainable living.

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ii. Learners can be taught at all levels to construct simple water filtration systems using gravel, sand, charcoal, and cloth. Building problem-solving skills this activity can enhance understanding of water quality, health, and environmental science.
iii. Schools can engage learners in community-based environmental projects like cleaning and monitoring communities' waste disposal systems. They may investigate pollution sources, propose solutions, and design waste segregation tools integrating scientific knowledge with civic responsibility.
iv. Learners can be organized into partnership with local NGOs; the Young Innovators Challenge (YIC) could allow students to present science-based innovations that address local needs like low-cost irrigation systems or mobile medical kits. These platforms may validate student creativity and encourage scalable innovations for sustainability.

The development of learners' creative minds and hands through solution-oriented science instruction can equip learners with the relevant tools to become problem-solvers in their communities. This kind of approach may not only enrich science education but could also advance sustainable development by nurturing innovation, resilience, and technical competence.

Conclusion

The thought of developing learners' creative minds and hands is central to reaching a transformative education, skills, lifelong and solution-based science education system in Nigeria. Since Nigeria fights for environmental, social and economic challenges, nurturing students who can think innovatively and apply scientific knowledge practically can be more crucial than ever. Creativity, critical thinking, and hands-on problem-solving if utilized can equip learners not only to understand scientific concepts but also to design and implement solutions that address real-world problems, thereby contributing meaningfully to sustainable development. Tangible progress toward achieving the Sustainable Development Goals (SDGs), in Nigeria, especially in the areas of education, climate action and innovation, science education must be reformed to prioritize the integration of cognitive and practical skills. Teachers, curriculum planners, policymakers, and educational institutions must commit to creating learning environments that foster curiosity, innovation and experimentation. Therefore, all stakeholders in the education sector must work collaboratively to nurture learners' creative minds and hand development into science curricula at all levels. This could ensure that learners in Nigeria are not only informed but also empowered to drive sustainable development through scientific inquiry and innovation.

Recommendations

To effectively integrate and promote the development of students' creative minds and hands in science education for sustainable development in Nigeria, the following policies and practices are recommended for adoption:

1. Curriculum Reform and Integration

i. Curriculum reforms should be conducted at basic, secondary, and tertiary levels to include innovation-driven, problem-based, and hands-on learning components.
ii. The curriculum should contain Sustainable Development Goals (SDGs) and local environmental issues into classroom activities to ensure relevance and real-world application.
iii. The curriculum should incorporate interdisciplinary approaches: STEM and STEAM (Science, Technology, Engineering, Arts, and Mathematics) to promote creativity and technical skills simultaneously.

2. Teacher Training and Professional Development

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i. Governments and NGOs should organize Continuous Professional Development (CPD) programs focused on solution-based learning, inquiry-based learning, design thinking, project-based learning, and use of local materials for practical science.
ii. The government and NGOs should ensure by monitoring to train teachers to shift from traditional teacher-centred approaches to learner-centred pedagogies that might encourage learners' exploration, creativity, and experimentation.

3. Infrastructure and Resource Provision

i. Government and NGOs should invest in equipping science laboratories, makerspaces and innovation hubs in schools with affordable tools and locally sourced materials to support practical learning.
ii. Governments and NGOs should provide mobile science kits and digital labs for rural and underserved schools to ensure equity in creative hands-on learning experiences.

4. Incentivizing Innovation and Student Engagement

i. The government and NGOs establish science and innovation competitions at school, state, and national levels to encourage learners to apply scientific principles in solving community problems.
ii. The government should introduce rewards, scholarships, or mentorship programs for students who demonstrate exceptional creativity and practical ingenuity.

5. Partnerships and Collaboration

i. Teachers and learners should be encouraged to involve in Public-Private Partnerships (PPP) with industries, research institutes, NGOs, and local innovators to support schools with mentorship, resources, and real-world exposure.
ii. School authorities should collaborate with international organizations like UNESCO and UNICEF to support national associations aimed at fostering creativity and sustainability in education.

6. Policy Enforcement and Monitoring

i. Policy frameworks that are needed for creativity and problem-solving as core learning outcomes in science education should be adopted by The Federal and State Ministries of Education for clear instructions for sustainability in Nigeria.
ii. Monitoring and evaluation mechanisms should be set up by the government to track the implementation of these reforms and assess their impact on learner outcomes and community development.

By applying these recommendations they might not only enrich science education in Nigeria but also may prepare a generation of scientifically literate, innovative, and sustainability-conscious citizens who can address the nation's development challenges with their minds and hands.

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