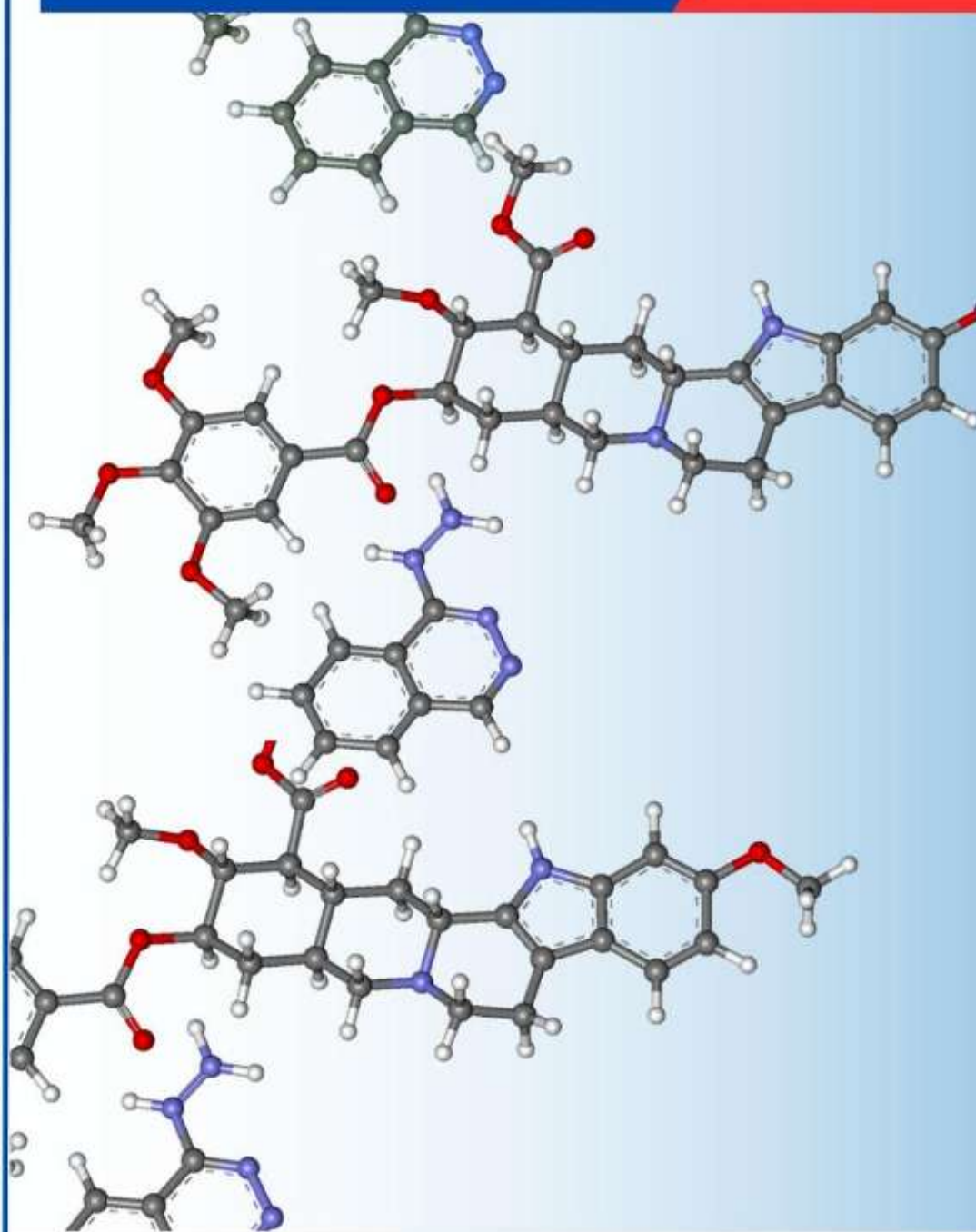




# STEMJAS

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## **EDITORIAL**

STEM Journal of Anambra STAN (STEMJAS) is a publication of **Science Teachers Association of Nigeria, Anambra State Chapter**. STEMJAS is developed to disseminate information on Science, Technology, Engineering and Mathematics (STEM) Education to teachers, teacher-trainers, researchers and other interested persons. Articles that are of relevance to STEM education are published in this journal. We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Ebele C. Okigbo  
**Editor-in-Chief**

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## PROMOTING CREATIVITY AND CRITICAL THINKING; A WAY FORWARD FOR SECONDARY SCHOOL STUDENTS' SKILLS DEVELOPMENT

Okoye, Nestor E.<sup>1</sup>; Anaeke, Grace U.<sup>2</sup>

<sup>1</sup>Department Of Physics Education; <sup>2</sup>Department Of Physical and Health Education  
Federal College of Education Technical, Umuze, Anambra State  
<sup>1</sup>nestor.okoye@fctumunze.edu.ng; <sup>2</sup>grace.anaekwe@fctumunze.edu.ng  
08143027669; 08149252405

### Abstract

The paper discussed the promotion of creativity and critical thinking in secondary school students for achieving skills development. Skills are developed through critical thinking and creativity. Critical thinking is a kind of thinking in which a person asks questions, analyses, interprets, and evaluates what he or she hears, says, reads or writes. Creativity has been described as a skill used to produce something which no specific rules can be applied. Creativity is related to innovation which is a process of both generating and applying creative ideas in some specific context. According to this paper some of the scientific skills include observing, inferring classifying, measuring, communicating and problems solving, to mention but a few. Some strategies/ approaches for promoting creativity and critical thinking for skills development such as using student –centered approaches in teaching and learning, designing and presenting students with activities that have multiple solutions, connecting students to real-world problems among others were discussed. Furthermore, special roles which a science teacher must play to ensure effective development of critical and creative thinking for skill development were x-rayed. Way forward for ensuring skill development is enhanced in secondary school students science curricular were also stated.

**Keywords:** Creativity, Critical Thinking, Skills, Science Teacher

### Introduction:

Education, from the early civilization to modern times has been the driving force behind every developmental activity. It is a veritable tool/instrument for achieving national development (Yekini, 2013).

Creativity and critical thinking are at the heart of skills development. The stance of National Policy on education is clear on this –development of Nigerian youths into sound and effective citizens through acquisition of appropriate skills. Countries which have made great progress in reducing poverty in recent decades are those which have combined effective and equitable investment in ensuring that conscious efforts are made in schools and classroom activities to foster creativity and critical thinking.



Creativity and critical thinking enable people to use and extend their capabilities, develop skills, improve their livelihood and increase earning potentials. The processes by which science and technology can affect such changes are complex. It must involve a meaningful learning process which develops not only literacy and numeracy but also life skills and capacity to think and to reflect. To ensure that the objective of skill acquisition is achieved, the school curriculum was diversified to cater for the differences in talents, opportunities and future roles (NPE, 2004). In Anambra State, for example, the maxim has been one student two skills. Skills according to the Oxford Dictionary of current English, 9<sup>th</sup> Edition, is the ability to do something well. Experience shows that individuals are not equally talented nor are people gifted in the same aspect of life since there are diversity of gifts by the same spirit. Therefore there is need to nurture these gifts into productive ventures.

In Nigeria, the level of skill acquisition among students is very low (Okoye and Okeke, 2014), (Mullis, Martin, Foy, Kelly and Fishbein, 2020). Strategies to improve skill levels through science education have not yielded the desired result. Therefore, it is imperative that science education be shifted toward a broader perspective of twenty- first century skills especially critical thinking (CT) development. It seems that the main purpose of science education has become CT skills development among students so that they can effectively handle every sphere of life.

Critical thinking is defined as an intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and or evaluating information gathered from, or generated by observation, experience, reflection, reasoning or communication, as a guide to belief and action. It is a kind of thinking in which a person asks questions, analyses, interprets, evaluates and makes a value judgment about what he or she hears, says, reads or writes. To this end, science education should be aimed at producing rational thinkers (Okoye, 2016).

To become a critical thinker is important in every sphere of life like information, politics and economics. This is because the 21<sup>st</sup> century has come with knowledge explosion, hence there is need for critical evaluation of the information (Jaber and Hammer, 2016). No wonder the national curriculum for science subjects (Physics, Chemistry, and Biology) all focus on rational thinking independent thinking, reasoning, critical thinking and creativity which are significant to produce skills among learners.

Related to critical thinking in spurring skill development is creativity The concept of creativity cannot be explained in only one single authoritative definition. Hence, there are several views of creativity giving rise to varying definitions. According to Okoye (2015), “creativity is inventing, experimenting, growing, taking, risks, breaking rules, making mistakes and having fun”. No wonder creativity has been described as skills used to produce that which no specific rules can be applied.

Feldman, Papalia and Olds (2001) said creativity is ability to think in new light, produce something never seen before or discern problems others fail to recognize. Fleximize (2015) sees creativity as a form of expression, a way of solving problems or the way of creation of new ideas.

Creativity is related to innovation. Innovation is the process of both generating and applying creative ideas in some specific context. Creative ideas are necessary steps to innovation process while innovation is the consequence of creativity. By and large, the researchers see creativity as an imagination, an idea and the ability to perceive the world in new ways with a view to finding hidden patterns, making connections between seemingly unrelated phenomena and generating solution to a problem. It is a process or the act of conceiving something original or unusual or thinking something new.

Behaviors typically descriptive of creativity include:

- Bringing about something entirely new
- Inventing an existing object with new properties
- Imagining possibilities that were not conceived before now
- Performing or observing something in a manner different from what was possible or normal previously. Creative thinking is result oriented; it is the thinking that has the power of reproducing new results out of the existing one; it is the intelligent imagination that seeks for a solution over an issue.

Creativity is assessed in terms of the attributes or characteristics by which a creative person is known. Most of them are more amenable to observational techniques than to tests. Courage, curiosity, independence of judgment, initiative, vision and willingness to take risks were among the attributes identified. Okoye (2015) believed that a creative students in whatever field of study exhibits the attributes of fluency, flexibility, originality, and sensitivity. Others are perseverance, elaboration, redefinition, intellectual honesty and divergent thinking among others. While critical thinking collects, collates and analyzes data, creativity synthesizes, fashions and produces the data into usable and valuable form. However, critical and creative thinking helps students to manipulate information and idea, in such a way that their meaning will be transformed, which results in production of new idea far better than the original. The ideas and information manipulated through these means allow students discover new meanings and understandings. Creativity and innovation are two great engine that drive scientific and technological breakthrough.

The school prepares students for life after school. How he is able to adapt to this life depends on the skills he acquires while in school. As a result, Hick (2015) considers the inculcation of creativity in school as being very important.

The nature of experiences to which students are exposed in school determine whether or not their creative abilities will be developed. Thus school experiences can mar or promote creativity.

Creativity is killed in school because of the fact that teaching and examination of children encourage memorization of facts. Learners are most often passive participants in the teaching-learning process. Divergent thinking is not seriously encouraged in school most of the times.

In the school, a child who is capable of memorizing and regurgitating information passively received in class, obtains a high grade. A child who presented information outside the fact that was taught in the class may obtain a lower grade. This tends to discourage a creative thinkers.



### Skills in Science Education

Skill according to Bellingham (2007), is a well-developed capability of any kind. It could be intellectual or physical capabilities. This simply means that skill is the ability to do something well, or acquired in the cause of learning science.

In Science education, skill primarily refers to science process skills which are the abilities that are used by scientists to investigate the world. In Nigerian science education, skills are defined as the practical, cognitive, and entrepreneurial abilities which students require to understand the natural world, participate in scientific enquiry, and contribute to national development.

#### Key Skills:

Science process skills like observing, classifying, inferring, measuring, communicating, predicting, defining operational, predicting, controlling variables, formulating hypothesis, experimenting, interpreting data, formulating models e.t.c as well as practical skills for lab work and innovation, problem-solving, critical thinking, and the entrepreneurial skills necessary for job creation. Below is the description of these skills:

- **Observing:** Using the senses to gather information or events
- **Inferring:** Making an education guess about an object or event based on previously gathered data or information
- **Classifying:** Grouping or ordering objects or events into categories based on properties or criteria
- **Measuring:** Using both standard and non-standard measures and estimates to describe the dimensions of an object or event
- **Communicating:** Using words or graphic symbols to describe an actions, object or event.
- **Predicting:** Stating the outcome of a future event based on a pattern of evidence.
- **Defining operational:** Stating how to measure a variable in an experiment.
- **Controlling variables:** Being able to identify that which can affect an experimental outcome, keeping most constant while manipulating only the independent variable.
- **Formulating hypothesis:** Stating the expected outcome of an experiment.
- **Experimenting:** Being able to conduct an experiment, including asking of appropriate questions, stating hypothesis, identifying and controlling variables, designing a 'fair' experiment, conducting the experiment.
- **Interpreting data:** Organizing data and drawing conclusion from it.
- **Formulating models:** Creating a mental or physical model of a process or event.
- **Problem solving:** Application of knowledge in order to find solutions to challenges.
- **Critical thinking:** Analyzing information and forming reasoned judgment.
- **Innovation and creativity:** Developing new ideas and approaches about a problem.
- **Entrepreneurial skills:** Ability to create products and services, and start businesses.

The question now is: when is skill said to be learned? According to Ivowi (2008) a skill is usually accepted to have been acquired if it is demonstrated correctly at least every two out of three occasions when demand is made. This two-third rule is just for a start. Far more demand is made in later stages of skills development. By implication a skill has been learned when it is readily

transferred to new situations. Science skill is developed when it enables the individual to acquire and process information and solve problems even when the information base changes.

The issue now is: how far has science education in Nigeria been able to impart such skills? Research findings suggest that the learning of scientific skills by students has not reached the expected levels (Ayuso, Lopez and Ruiz, 2022). This was collaborated by Okoye and Ogundeji (2022) who stated that of a particular concern among employers was the total lack of practical skill among science and technology graduates.

The process by which science education can affect such skills development is complex. It must involve a meaningful learning process as well as adopting strategies for effective science teaching and learning.

### **Strategies for promoting creativity and critical thinking for skills development**

The following strategies are vital for promoting creativity and critical thinking for skills development:

- **Use of student-centered approaches:** Employing methods such as project based learning and inquiry –based learning which are student-centered give students more agency in their work. These methods allow students to choose problems, develop their own solutions and have ownership of their learning. According to Tadesse (2020), employing student- centered approach creates a classroom environment that supports active learning.
- **Designing activities with multiple solutions:** Problems with a single correct answer which do not encourage students to think divergently and develop novel solutions should be avoided. Instead activities which lead to problems with multiple solutions should be designed. According to Clifford (2013) acknowledging the process of getting a solution to a problem means paying attention to the steps a student takes- such as the strategies they try, the persistence they show or the creative ideas they test out rather than simply praising the final outcome. It can be easily observed that when students see that adults notice how they think, adapt and iterate, they grow more willing to explore new ideas and creative solutions.
- **Encouraging questioning and hypothesis generation:** Prompting students to ask questions about phenomena and to wonder about the world helps them to think critically. This helps them to create mental images and develop hypotheses.
- **Integration of digital tools:** Certain tools like the PhET that provides free, interactive and research-based simulations for teaching and learning science and mathematics should be employed in teaching. This helps students to develop analytical and critical thinking skills through interactive learning experiences. Maria, Teresa, Beymar and Jhon (2025) posit that through play, art, literature and other creative activities students can develop their imagination, critical thinking, adaptability, and problem solving skills.
- **Promoting collaboration:** Opportunities for students to work together, share ideas, and build on each other's perspective should be created. Sharing ideas enables a student to evaluate his own ideas as well as helping him to see various perspective of a problem. (Okoye, 2015). This helps students to develop their thinking through activities like discussion, and debates.



- **Shifting the teacher's role:** The teacher should move from being a sole instructor to a facilitator who guides students' exploration. They should ask questions and create a space for students to learn mistakes.
- **Connection to real-world problems:** Students should be actively involved in solving practical problems to apply their scientific knowledge in meaningful ways.

### The teacher's special role

Despite the fact that certain learning skill may be developed to some extent without formal instruction, systematic teaching could have a significant impact on their cultivation. Hence, the most important resources in the science classroom is the science teacher/ educator. Developing skills in science education depends to a large extent on the instructional technique adopted by the science teacher, (Cheung, 2018). Research studies have indicated that teaching science through inquiry-based methods lead to the development of improved laboratory procedures, interpreting data, oral communication, critical thinking and creativity. Inquiry-based pedagogy engages students in the investigative nature of science through exploration of the natural or material world. These explorations lead students to ask questions, make discoveries, seek explanations and test their findings as they look for answers and develop new understanding.

Similar to the inquiry method is the hands-on-activity method which provides great opportunities for students to be active to participate and practice what has been taught. It helps in fostering skills such as observing, measuring, and classifying.

Moreover, when students engage in hand-on-activities, they remember the material better, feel a sense of accomplishment when the task is completed, and are able to transfer that experience to other learning situations.

It is hoped therefore that teachers should as a matter of necessity adopt the use of inquiry based and hands-on-activity methods of teaching which will help students acquire scientific and technical skills, make them creative and producers of wealth. Teacher should make students to be engaging in divergent thinking by encouraging them to ask questions in the class and if possible challenge the views of teachers. They should be encouraged to think and find alternative answers to a problem when solving problem in the class.

Independent thought is important for creativity hence students should be encouraged not to be afraid to oppose the views of the majority, but hold his view firmly in any discussion.

The idea of asking students to pay money in place of handwork or project should be discouraged by teachers and banned in schools also the practice of allowing students to buy already-made materials from the market or commissioning experts to construct project works for students when they are assigned project to do should be discouraged.

In addition, the teacher can apply other contemporary techniques/teaching strategies which may include:

- i. The application of developmentalist and constructivist learning theories in science teaching and learning.
- ii. Use of E-learning strategies and computer-based information searching method.



### **Other roles expected of the science teacher to ensure skills are developed include:**

- Improvisation: Improvised materials should be used to make teaching and learning more meaningful where real objects are not available. By improvising materials and asking students to improvise makes both the teacher and the students think critically and creative.
- Organizing visit to factories and workshops periodically (excursion): Through excursion students come face to face with many materials from workshops and factories.
- Motivating students to read science textbooks as well as bringing in science-related magazines, newspapers, journals, computer programs, movies etc. to the class and discussing them with the students. Through these means, students critical and creative thinking will be enhanced and skills developed.
- Being dedicated and committed to his duty as a science teacher: Some science teachers do not have positive attitude to science education so that students can imitate and model after them. Most of the science teachers lack the zeal and dedication to motivate students to achieve greatness in STME pursuits. Some are after their salary without giving any consideration on how to improve on the quality of their teaching output for skills development, if teachers are dedicated they can even rise above the constraining circumstances of paucity of material resources and government apathy.

### **Conclusion**

The importance of sound and competent scientific skills required by individuals (students) to cope with the complexities of the 21<sup>st</sup> century education cannot be over-emphasized.

As it is, there is a link between well-developed scientific skills and production practices which in turn leads to economic growth. There is need to engage students actively on inquiry and hands-on-activity methods of teaching to help them acquire scientific skills, make them think critically and creative, and producers of wealth. This way, creative individuals will emerge to salvage Nigeria from the present scavenger's economy which came to be as a result of little or no inventions. To this end the action of all stakeholders especially the science teachers must be felt if we are to produce scientific literate citizens with true mastery of competency skills, improved critical and creative thinking skills. The secondary schools should as a matter of necessity come up with the responsibility of producing creative individuals. This can only be achieved if conscious efforts are made in school and classroom to foster creativity. The time for action is now! A stitch in time, they say, saves nine.

### **The way forward**

The following suggestion are hereby made to ensure students develop critical and creative thinking for skills development:

- Practical oriented science should be introduced in primary schools to enable pupils embrace science early in life.
- Seminars and workshops should be organized on creativity and critical thinking to educate teachers on what creative skills entail and how to foster and promote them in the classroom.



- Science curriculum should be revised periodically to ensure adequate provision for critical and creative thinking contents are made at all levels of education.
- Science teachers who excel in their work especially that of encouraging students to be creative and acquire scientific skills should be rewarded by honouring them with local government, state or national awards.
- Students should be encouraged to join clubs and societies in schools that give them the opportunity for exhibiting creativity such as the science club, debating society and JETS (Junior Engineering and Technology Society). They have to be actively involved in the activities of the clubs as being a mere member should not be enough.

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