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RESEARCH ARTICLE

PROMOTING SCIENCE SKILLS ACQUISITION FOR EMPOWERMENT AND SUSTAINABLE DEVELOPMENT

[1,*]Matthew Cyril and [2]Emmanuel I. Orji

[1]Department of Science and Vocational Education, Usmanu Danfodiyo University, Sokoto, Nigeria
[2]Department of Science Education, University of Nigeria, Nsukka, Nigeria

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Corresponding author:* **Matthew Cyril

ABSTRACT

This paper examined some of the major science skills and how their acquisition through skill-based approach to teaching and learning will promote empowerment and sustainable development. Nigeria is a member state of the United Nation (UN) and a signatory to many of the United Nation Development Programmmes (UNDP), among which are the Education For All (EFA), Millennium Development Goals (MDGs) and of recent, the 2030 Sustainable Development Goals (SDGs). All these programmes are in a way aimed at making the world a better place for the present and future generations through education. Central among their targets is knowledge, skills acquisition, empowerment and sustainable development as captured in the Target Areas of SDGs goal 4. Whereas the critical elements of National Economic Empowerment and Development Strategies (NEEDS) and the targets of the MDGs addresses basic science skills at lower level of education, the higher science skills also x-rayed in this study are at the heart of sustainable development. Hence, for empowerment and sustainable development to strive, it is recommended that science skills-based approach to science teaching should be incorporated in the teaching of science, and Science skills acquisition should be made to be an integral part of science instruction at all levels of learning.

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INTRODUCTION

Over the years, science education programs in Nigeria have raised more questions than answers. Pilot study report by Nigeria Education Research and Development Council (NERDC, 2008) has it that before now, the existing curricula in use in the Nigerian Primary and Secondary schools have been overloaded in such a way that it cannot induce in the learners the entrepreneurial skills needed to be self reliant nor responsive to the challenges posed by globalization. We were working on a system where curricula materials largely appear irrelevant to the needs and aspiration of both students and society (Dorayi, 2007). Many curricula in scientific and technological fields do not have much relevance to the needs of industries and other productive sectors of the economy. It is reported (Okebukola, 2005) that there is a widening gap between children's expectations of science classes and what they experience. In other words, there are some concerns that science teaching in schools is not producing the desired effect of ensuring a well rounded education, in terms of knowledge, skills, techniques and values needed to produce an individual who has been well educated and equipped with the spirit of enquiry, intellectual manipulative skills that will enable the learner generate jobs, create wealth and eradicate poverty. No doubt then that Nigeria Education Research and Development Council (NERDC) reviewed the primary and secondary school curricula for the attainment of the critical elements of National Economic Empowerment and Development Strategies (NEEDS) and the Millennium Development Goals (MDGs). These will among others, promote learning and life skills for young people as well as help them acquire basic knowledge and skills needed to meet contemporary societal needs. It was evident in the MDGs end point report 2015, that Nigeria has made appreciable progress in the attainment of the MDGs in the last 15 years, particularly in the area of Universal Primary Education (UPE), school enrollments, achieving gender parity in education, reducing the spread of HIV and AIDS, reduction in maternal death as well as reducing by halve the number of people leaving with hunger. However, with the adoption of the UNDP 2030 Sustainable Development Goals (SDGs) to completely finish the work of the MDGs, it is hoped that through Science Skills-Base Instruction (SSBI) and assessment of learning outcomes, higher science skills which are at the heart of sustainable development would be addressed and adequately acquired because effective teaching has been found to be at the heart of science education (Okebukola, 2002). At the United Nations Sustainable Development Submit of 25th September 2015, world leaders adopted the 2030 agenda for sustainable development, which include a set of seventeen Sustainable Development Goals (SDGs). The SDGs main objectives are to: end poverty, fight inequality and injustice and to tackle climate change by 2030, which Clark (2015) described as a path to an inclusive, sustainable and resilient development. The SDGs otherwise known as global goals were

build on the Millennium Development Goals (MDGs) to completely finish the work of the MDGs. One of the SDGs (Goal 4) provided by the United Nation Development Program (UNDP) is to ensure an inclusive and equitable quality education and promote life-long learning opportunities for all. This goal's specific targets (4.4 and 4.7), which forms the rudiments for this paper include among others:

i. By 2030, increase by X% the number of youth and adults who have relevant skills, including technological and vocational skills, for employment, decent jobs and entrepreneurship.
ii. By 2030, ensure all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable life-styles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of cultures contribution to sustainable development.

In both targets of the forth SDG, skills acquired through education future prominently as a key concept that could drive all other attainments reflected in the two targets, because the role of education has been identified as critical to its success (Obe, Johnson, Buckland, Brookes & White, 2004). In other words, it is through the acquisition of relevant skills that one could: be gainfully employed, have decent jobs and entrepreneurship, promote sustainable development and attain sustainable life-styles, etc. If the acquisition of relevant science skills can lead to meaningful sustainable development, then it is imperative to appraise all the available science skills for possible attainment of the targets of the fourth SDGs for meaningful science skills acquisition through Science Skills-Base Instruction and assessment of learning outcomes. Though effective teaching involves a conscious arrangement of resources in an effort to make science skills and content accessible to students, which in turn nurtures or changes the students' ability, knowledge and attitudes, SSBI enables students acquire science skills and apply them for sustainable life-style. Studies however, have also shown that effective assessments in science have profound positive impact on teaching and learning (Kirton, Hallam, Peffers, Robertson and Stobart, 2007). Assessment according to Morrison (2010) is an integral part of instruction, as it determines whether or not the goals of education are being met. It affects decisions about grades, placement, advancement, instructional needs, curriculum, and in some cases, funding. Skill has been described as the ability in carrying out a task (Ogbuanya, 2010). It is the ability to carry out a task with pre-determined results often within a given amount of time, energy, or both. Business dictionary (2017) describe skill as an ability and capacity required through deliberate, systematic and sustained effort to smoothly and adaptively carryout complex activities or job functions involving ideas (cognitive skills), things (technical skills), and/or people (interpersonal skills). It should be noted however, that skills are not just about work. They also serve essential social purposes.

…. Achieving a fair, more inclusive society depends on young people leaving school or college with the skills they need to work. Where they lack such skills, their exclusion is likely to be compounded during their lives.
Department of Education and Skills (2003) cited in Obe, et-al (2004), p. 3

Different science skills have been identified, classified or categorized by different scholars and programmes: Science Process Skills which are categorized into two (Basic and integrated) by the Elementary science programme of the American Association for the Advancement of Science (AAAS, 1967), Reasoning Skills and Critical thinking Skills by Valentino (2000), Acquisitive, Organizational, Creative, Manipulative and Communicative skills by Bybee, Powell and Trowbridge (2014). All these skills if properly acquired at various levels of learning can lead to meaningful sustainable development. World Commission on Environment and Development (WCED, 1987) suggests that development is sustainable where it meets the needs of the present without compromising the ability of future generations to meet their own needs. In other words, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are made consistent with the future as well as present needs. The International Union for Conservation of Nature (IUCN, 2017), sustainable development means adopting lifestyles and development paths that respect and work within nature's limits.

Science Process Skill: The history of science is in part the history of how scientists come to look at the world they study. Scientific experimentation and observation have come to be defined by the exercise of a process called the scientific method (Pollyn, 2009). The underlying skills and premises which govern the scientific method are referred to as science process skills. Science process skills are the tools that students use to investigate the world around them and to construct science concepts. Science process skills have also been described as mental and physical abilities and competencies which serve as tools needed for the effective study of science and technology as well as problem solving, individual and societal development (Nwosu and Okeke in Akinbobola and Afolabi, 2010). Jack (2013) describes the science process skills as cognitive and psychomotor skills employed in problem solving, and can be acquired and developed through training such as are involved in science practical activities. They are the aspects of science learning which are retained after cognitive knowledge has been forgotten. Science process skills therefore are a set of interrelated abilities by which adequate and reliable information about nature are acquired, understood and applied in solving problems. Process skills are the procedures adopted for performing tasks with high level of accuracy (Elijah 2006). Elementary Science Programme of the American Association for the Advancement of Science (AAAS, 1967), which focuses upon ways of developing basic skills in the process of science, classified the science process skills into two categories: Basic Science Process Skills and Integrated Science Process Skills (Akinbobola and Afolabi, 2010).

Basic science process skills: Basic Science Process skills (BSPS) are functional skills designed for primary school pupils, and are vital for science learning and concept formation at the primary and junior secondary schools (Akinbobola and Afolabi, 2010). They are viewed as central to elementary school science education and important enough to be taught in their own right. They are often combined with science content, enabling children to learn both science processes and content at the same time, in a seamless learning experience. The basic science process skills are useful in science and non-science situations.

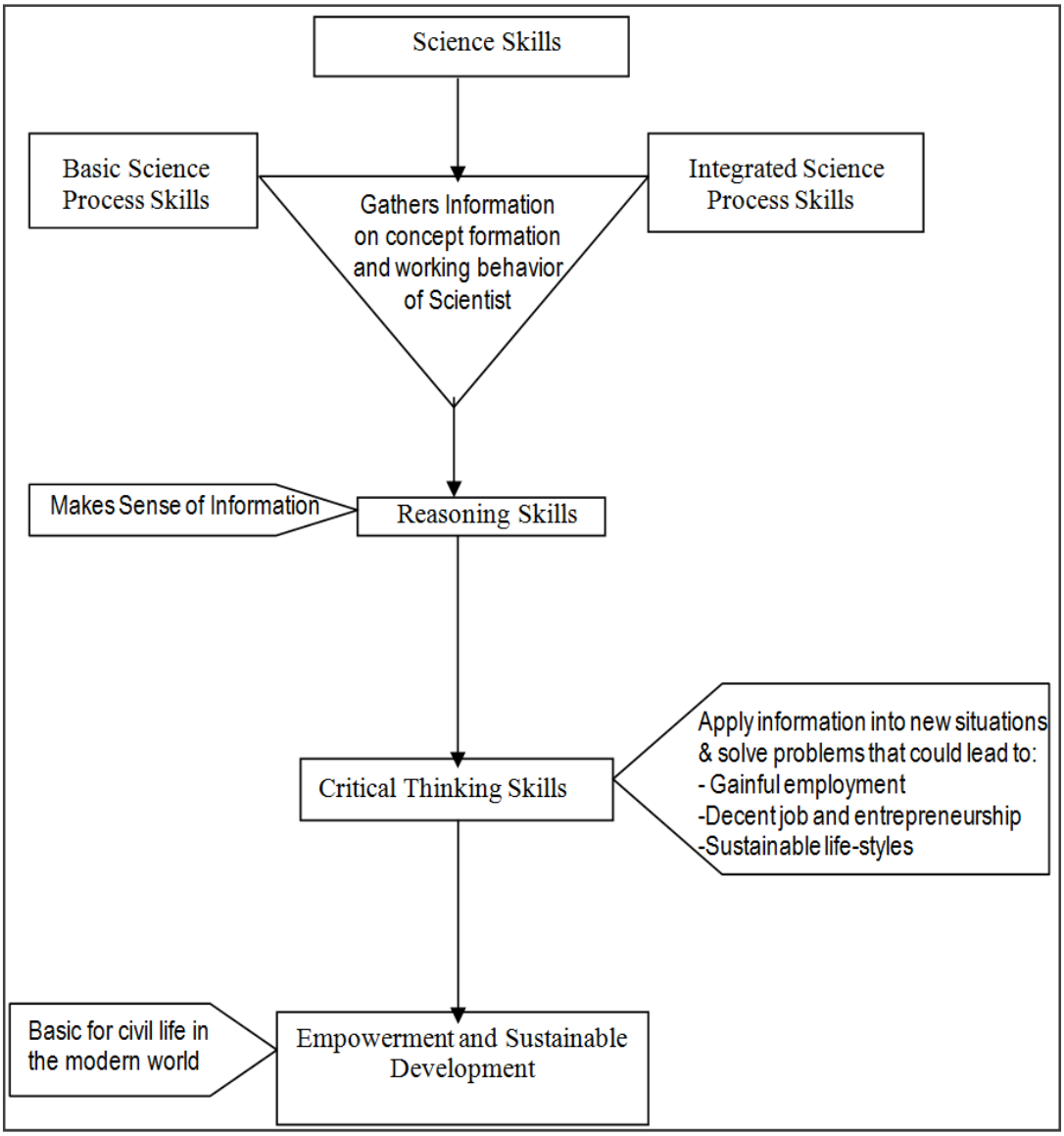

Figure 1. Science Skills Framework for Empowerment and Sustainable Development

Basic science process skills are seven of the thirteen science process skills meant for primary school pupils, namely: observing, classifying, measuring, communicating, inferring, predicting and number relationship. Opateye (2012) and Jinks (1997) provide the seven basic science process skills and their respective desired abilities as follows:

1.Observing skill
- Using their senses to notice specific features,
- Identify qualitative changes in conditions of the features observed and
- Identify similarities and differences in features.

2. Classifying
- Classify objects, specimens, organisms, etc. using observable properties,
- Grouping objects based on observable traits and
- Selecting traits that express the deeper essence of a system.

3. Measuring
- Using measurement to determine area, volume, length, time, temperature, etc,
- Determining quantity of items and
- Comparing some attributes of a system to a standard reference.

4. Communicating
- Using the skill to systematically report data or event and
- Ability to interpret and present information on observed charts, graphs, etc.

5. Predicting
- predicting the results for a proposed laboratory test or set up,
- Selecting predictions based on previously observed phenomenon,
- Providing rationale for the predictions and
- Using observation to predict future events/occurrences.

6. Inferring
- Formulating assumptions based on observations,
- Differentiating between observations and inferences,
- Using observations and inferences to identify testable questions and problems.

7. Number relationship
- Assessing the percentage of data,
- Sharing a given quantity based on ratio relationship,
- Determining the interaction of variables and
- Using analytical thought to dissect between cause and effect.

Table 1. Integrated science process skills

S/N	Skill	Description
1.	Identifying and controlling variables	Ability to identify variables that can affect an experimental outcome and manipulate independent variable.
2.	Defining operationally	Stating how to measure a variable in an experiment
3.	Formulating hypotheses	Stating the expected outcome of an experiment. Ability make intelligent guess.
4.	Collecting and Interpreting data	Organizing data and drawing conclusions from it.
5.	Experimenting	Being able to conduct an experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally defining those variables, designing a "fair" experiment, conducting the experiment, and interpreting the results of the experiment.
6.	Formulating models	Creating a mental or physical model of a process or event.

Table 2. Science reasoning skills

S/N	SKILL	DESCRIPTION
1.	Longing to know and understand	The desire to probe, find information and seek explanation
2.	Questioning of scientific assumptions	The tendency to hold open for further verification presented assumptions, encounters and ideas.
3.	Search for data and its meaning	The propensity to collect information and to analyze it in context.
4.	Demand for verification	The inclination to repeat and replicate findings and studies.
5.	Respect for logic	The inclination to move from assumption to testing and data collection to conclusions
6.	Consideration of premises	The tendency to put into context the reason for a particular point of view
7.	Consideration of consequences	The tendency to put into perspective the results of a particular point of view
8.	Respect for historical	The inclination to understand and learn from earlier ideas, studies and events.

Table 3. Critical thinking skills

S/N	SKILL	DESCRIPTION
1.	Analyzing	Studying something to indentify constituent elements or relationships among elements.
2.	Synthesizing	Using deductive reasoning to pull together key elements.
3.	Evaluating	Reviewing and responding critically to materials, procedures or ideas, and judging them by purposes, standards or other criteria.
4.	Applying	Using ideas, processes, or skills in new situations.
5.	Generating ideas	Expressing thoughts that reveal originality, speculation, imagination, a personal perspective, flexibility in thinking, invention or creativity.
6.	Expressing ideas	Presenting ideas clearly and in logical order while using language that is appropriate for the audience and occasion.
7.	Solving problems	Using critical thinking skills to find solutions.

Knowledge of basic science process skills would prepare the learner for the more complex skills. Here, students are introduced to information gathering and concept formation. Activities are characterized by curiosity and creativity; in which case, skills and abilities to develop new approaches and ways of thinking are encouraged. Also pupils develop ability to ask questions and seek answers to questions raised.

Integrated Science Process Skills: Integrated science process skills are the working behavior of scientist and technologists (Jack, 2013). The integrated science process skills include the following: making models, defining operationally, collecting and interpreting data, identifying and controlling variables, formulating hypotheses and experimenting.

This skill develops students' organizational ability in handling issues/events to a logically acceptable conclusion.

Science reasoning skills: Science Reasoning Skills help children make sense of information they gather by fostering an open mind, curiosity, logic and data-based approach to understanding the world (Valentino, 2000). These skills provided by Valentino (2000) have the following: At this stage, new ideas are generated, tested and applied into new perspectives adopting lifestyles and development paths that respect and work within nature's limits, which is basic for civil life in the modern world.

Critical thinking skills: Critical thinking skill requires students to apply information in new situations and in solving problems (Valentino, 2000). According to Ibe (2010), critical thinking involves the ability to identify a problem, raise questions about it, seek for information, analyze them and make inferences logically. Critical thinking skills enable pupils to be more critically minded, thereby expressing thoughts that

Science Skills-Based Instruction (SSBI): The achievement of the right to education requires that young people be given the opportunity necessary for the acquisition of the knowledge, skills, attitudes and values which are expected to enable them lead happy and productive lives as individuals and discharge their social duties for the betterment of life in the society. All these can be achieved if pupils are adequately exposed to science skills-based instruction at all levels of learning. In SSBI, the teacher begins by:

1. Carefully identifying and defining the science skills to be acquired in a given instruction or lesson. Implementing a skills-based approach to science instruction begins by carefully defining what you would like the students to be able to do (Valentino, 2000). This can be achieved by setting high expectations, facilitating skill practices and supporting all students so they can be successful. This will move students towards independence and how to think at high levels, solve problems and perform on various academic tasks with great success.
2. Focus the teaching of science skills not in isolation of the child's physical world or real world applications. Here the instructor becomes more like a coach leading a team. He introduces a skill, model it and ask students to practice. In so doing, students self confidence, independence, thinking skills collaboration and active learning are developed at the same time as knowledge is acquired. As students practice skills, they are discussing ideas and summarizing essential information, they are learning how to think critically, analyze ideas and solve sophisticated problems.
3. Conduct science skills-based assessments. In the classroom of science skills-based instruction, good amount of time should be dedicated to practices, assessing and reflecting on skills. Content analysis of educational objectives should reflect the six taxonomic levels of educational objectives in

the psychomotor domain. An example given by Nworgu (2015) are as follows:

a. Reflex movement: educators to pay attention to this movement for possible therapy.
b. Basic fundamental movement: this involves all of locomotive, non-locomotive and manipulative movements.
c. Perceptual abilities: involves the use of the senses.
d. Physical abilities: through constant practice develops ones physical abilities.
e. Skilled movement: requires a combination of physical abilities in creating things (creative ability).
f. Non – discursive communication: it is the combination of the 5 levels to arrive at a result.

Science Skills-Based instruction can be achieved if educational objectives are reviewed to reflect measures of Psychomotor ability in which knowledge and skills employed involves the physical manipulation of materials and equipment. Measurable objectives should be stated in words that are unambiguous in their applications, quantifiable in their measurability and precise in their meanings.

Suggestions: In view of the importance of skills acquisition in science as presented and its corresponding role in empowerment and sustainable development, the paper recommend as follows:

1. Teachers should make science skill-based instruction central to their science teaching by carefully identifying and defining the science skills to be acquired in a given instruction, in which knowledge and skills employed involves the physical manipulation of materials and equipment.
2. Students should be given a central position in science learning by focusing the teaching of science skills not in isolation of the child's physical world or real world applications. Also adequate time should be given to enable them independently manipulate the variables within the natural world and make meaning out of it.
3. In science skill-based instruction, teachers should often employ content of educational objectives in the psychomotor domain. This would address pupils ability to practice, assess and reflect on skills being acquired.

Conclusion

Science skill-based instruction is very important and central to skills acquisition in science. Teachers of science and science related disciplines should employ this instructional strategy in order to inculcate in pupils, the needed knowledge and skills for empowerment and sustainable development. As acquisition of professional qualification in science, equip an individual with skills to be self-employed.

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