CHEMISTRY TEACHERS' UNDERSTANDING OF SCIENCE PROCESS SKILLS IN RELATION TO SCIENCE PROCESS SKILLS ASSESSMENT IN CHEMISTRY LEARNING: A PERSPECTIVE FROM KASHIM COLLEGE OF EDUCATION MAIDUGURI. BORNO STATE.NIGERIA

M.Y AMUDA, A YAHAYA AND BABAGANA. A
Department of Chemistry Kashim Ibrahim College of Education P.M.B 1469 Maiduguri

Abstract

Teachers play an important role for teaching science process skills through planning and arranging learning activities and teaching how to reach scientific information's. Considering that teachers are the main source in educating individuals, there is a need for current and prospective teachers to acquire science process skills and ways of teaching it to students in a science classroom. Scientific process skills (SPS) are fundamental scientific methods to achieve desired knowledge which are useful in problem solving in our immediate environment. Qualitative case study was adopted in this study that consisted of all the eight chemistry teachers teaching in chemistry department of Kashim Ibrahim College of Education, Maiduguri as population. A semi structured questionnaire procedure was used to collect data. The result of the study revealed that teachers' conceptual understanding of SPS is weak cutting across all the teachers in the department. They were oriented on the few assessment procedures such as those used in setting up equipment, data collection, safety and observing color but weak in opinion and ideas assessment indicators about SPS. These affects the accuracy and appropriateness of the teacher's selection of SPS assessment in chemistry learning. Therefore we recommend that the need for teachers to be professionals as one's professional knowledge which is informed by one's professional background, experience and perceptions can be seen from teachers' behaviors. Involve students in the laboratory works in order to raise the science process skills. Develop teaching strategies used in teaching within the laboratory premises for better and appropriate assessment of the

students learning ability. Use of integrated teaching approaches in a single lesson can create more opportunities for inculcation and acquisition of SPS in the classroom.

Keywords: *Science process skills, Teachers' understanding, Assessment, Chemistry learning and Chemistry Laboratory.*

Introduction:

The study of science involves learning both processes as well as content. While science process skills represent possible problem solving mechanisms involved in any cognitive process, the use of logical thinking abilities that enables us to develop scientific knowledge .All teachers want their students to learn, how to think and science process skills (SPS) are essentially the basis of analytical thinking to get information, think on the problem and formulate results. The main aim of education is to modify the behavior of child according to the needs and expectation of the society. Acquiring SPS is considered as "learning how to learn" because children learn how to learn by thinking critically and using information's creatively and they continue to learn when making discriminating observations, organizing, and analyzing facts and concepts, giving reasons for particular outcomes, evaluating and interpreting results, drawing justifiable conclusions and predicting what will happen if anything were to be changed (Martin et al, 2001).

The desire to enhance acquisition of SPS through the use of effective instructional strategies has directed a lot of attention to understanding of how learners learn. The rapid advancement of science and technology and increasing need for scientists and technologists have made it all the more important to provide science based education in the schools. Vigorous methods for the cultivation and promotion of science should be adopted. Science has now become a compulsory subject in the school curriculum because of its multifarious value to the individual as well as the society. The shift from the teacher-centered activity based method which encourages and develops in the child the spirit of inquiry; an attempt to make students full aware as well as understand the ways scientists work and also the equipping and preparing students for their possible careers in science and technology led to the development of science process skills.

The National Policy on Education (FME, 2004) stated that the aim of education is to inculcate in the child, the spirit of inquiry and creativity through the exploration of nature. Through the implementation of SPS, students are engaged into authentic science teaching that stimulates their curiosity. In other word, efficient science teaching can be done by implementing process skills in a simultaneous way.(Aydin,2013). SPS are teachable and it can be facilitated to the students using laboratory activities that are intended to build and strengthen their comprehension of the concepts of Chemistry.

Akinbobola, and Ado (2007). It is worth noting that for science teaching to be meaningful and relevant, it must adequately reflect the nature of science. It must not only be process-oriented, but it should also emphasize the products of science. Science process skills (SPS) have been described as mental and physical abilities and competences which serve as tools needed for the effective study of science and technology as well as problem solving, individual and societal development.

Science as a process as well as a product:

According to Fitzpatrick (1960) "Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it.'' According the Schlesinger (2000) "Science is a process of the human intellect. It is a way of thinking, a way of doing, a method of discovering new relationships in the physical and biological universe." These definitions emphasize three basic principles of the nature of Science. Science is an accumulated and systematized body of knowledge, the scientific method of enquiry and the scientific attitude. The first point indicates the product of Science, while the second and third point indicates the process of Science. In other words, Science is both a product and process. Products are the outcome of process. Systematic observations and experimentation leads to the formulation of theories and generalization's. The science process skills such as observation, classification, communication, measurement, prediction and inference and so on can be translated into immediate behavior by the child as he attempts to understand the phenomena of science encountered in his environment. Students should observe measure, classify, use numbers, see

relationship, make hypothesis, devise experiments, interpret evidence, draw conclusions and verify the findings. It refers that, systematic way of knowing science. As part of the study of science, students have to develop the capacity to deal with the problems in his day to day life. It can be achieved only through his constant involvement with the process of science.

Therefore a process oriented approach to science teaching and learning can serve the causes of science education. Science process skills enable student how to think scientifically by applying problem solving techniques to science lessons, while all lessons should incorporate process skills in discovering science concepts, teaching science process skills starting at primary level will specifically help students retain science lessons longer.

The process of doing 'Science' is the science process skills that scientists use in the process of doing science. The Science Process Skills forms the foundations for scientific method. Science is both thought and action. Thought is nothing but the ideas, conception, and beliefs about the natural phenomena on wherein the action is methods and the process includes certain set of skills and abilities such as observation, measurement, communication, testing hypothesis, design experiment, changing variable etc. These skills are commonly called scientific method. These skills are the foundation for formulation of theories, generalization, principle, and laws. It encourages the spirit of inquiry through laboratory experiments. Menon (1986) stated that the processes of scientific inquiry represent the spirit of science as an activity and its essence that it distinguishes science from other discipline. Hands-on minds-on experiments and activities provide rich learning experiences for the students to acquire science process skills. These are chiefly mental skills, but also associated with physical skills.

Inquiry-based activities have been advocated to be employed in science classrooms at all educational levels of education to foster acquisition of SPS. Science process skills are beneficial in that students can realize by participating in inquiry in the science laboratory. Science process skills are inseparable in practice from the conceptual understanding that is involved in learning and applying science. Classroom studies on scientific reasoning have centered on the basic science process skills (BSPS) and integrated science process skills (ISPS) over several decades; many researchers have focused their attention on these skills (Germann &Aram, 1996a; Harlen, 1999; Brotherton & Preece,

1995). Basic science process skills (BSPS): observing, classifying, measuring, communicating, inferring and predicting. These skills provide the intellectual groundwork in scientific inquiry, such as the ability to order and describe natural objects and events. The ability to use BSPS is attributed to the ability to perform empirical inductive reasoning or Piagetian concrete operational reasoning (Beaumont-Walters & Soyibo; Germann & Aram, 1996a; Eilam, 2002). While the ISPS; identifying and defining variables, collecting and transforming data, constructing tables of data and graphs, describing relationships between variables, interpreting data, manipulating materials, and recording data, formulating hypotheses, designing investigations, drawing conclusions and generalizing asidentified by the American Association for Advancement of science (AAAS) which did the pioneer work on the identification of activities that constitute science process skills (Kazeni, 2005). The identified seventeen activities that constitute SPS according to AAAS are classified into two categories based on operational differences and the intellectual demands as:Basic science process skills (BSPS) and integrated science process skills (ISPS). The BSPS forms the foundation upon which other higher order skills (ISPS)are developed. The ISPS are the terminal skills for solving problems or doingScience experiments. The ability to carry out ISPS is attributed to hypothetic-deductive reasoning (Piaget's formal operational reasoning; Beaumont-Walters, & Soyibo; Germann & Aram, 1996a; Huppert, Lomask & Lazarowitz, 2002). If students are not exposed to these two categories of skills in a systematic, logical and chronological manner they run the risk of learning the skill through simple rote-learning and memorization and they will in turn face difficulties in mastering and developing the skill of a higher level.

Literature

Acquiring SPS is considered as "learning how to learning" because children learn how to learn by thinking critically and using information, creativity, and they continue to learn when making discriminating observation, organizing, and analyzing facts or concepts, giving reasons for particular outcomes, evaluating and interpreting results, drawing justifiable conclusions and predicting what will happen if anything were to be changed (Martin et al, (2001).Considering that teachers are the main source of in evaluating individuals, it is inevitable

that there is a need for prospective teachers to acquire SPS and ways of teaching it to students in a science class. One's professional background, experience and perceptions can be seen from the teachers' behaviors. It is also possible that the form of assessment affects how science is been taught and interpreting
Process skills assessment by teachers should be in context, not in isolation, which allow for a more integrated and authentic assessment of the content areas. Process skills shall be incorporated into test questions that are designed to address content within the context of Nigeria education policies. Both content and process student expectations shall be reported in test questions that measures a content student expectations in areas such as skill inusing scientific method, approach to discover facts and concept,practical work performance, active involvement of students, utilizing laboratory equipment,visiting industries, accustomed to problem solving etc. All these are manifested in areas such as: ability to analyze mathematical relationships, to connect, record, and communicate ideas, create and use representations to organize, record and communicate ideas, including symbols, diagrams, graphs and language as appropriateso that students can attain a greater depth of understanding of complex content.

Alternatives, Authentic and Performance Assessment: What are they?

Authentic Assessment: This is a form of assessment in which students are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills. Other definitions are:

- According to Wiggins (1993), authentic assessment means "engaging in worthwhile tasks and problem-solving activities that demand students' use of acquired/requisite knowledge effectively and creatively". Such tasks are either replicas of or analogous to the kinds of problems faced by adult citizens and consumers or professionals in the field. Also, it sees authentic assessment as one that calls upon the examinee to demonstrate specific skills and competencies; that is, to apply skills and knowledge they have mastered.
- "The assessments call upon the examinee to demonstrate specific skills and competencies; that is, to apply the skills and knowledge they have mastered.

Authentic assessment engages students in applying knowledge and skills in the same way they are used in the "real world" outside of school. It is a performance-based assessment that requires a student to go beyond basic recall and demonstrate significant, worthwhile knowledge and understanding through a product, performance, or exhibition. The assessment comprises an authentic task, such as participating in carrying out titration, writing for the laboratory report, calculating numerical figures etc.

Performance Assessments: Performance assessment, also known as alternative or authentic assessment (US Ed Dept 1993), is a form of testing that requires students to perform a task rather than select an answer from a ready-made list. For example, a student may be asked to generate scientific hypothesis, solve mathematics problems, (US Education Department 1993). Advocates said that performance assessment may be a more valued indicator of what students know and what he/she is able to do (knowledge & abilities), that it promotes active learning and curricular-based testing, , but requires a greater expense of time, planning and thought from students and teachers. Users also need to pay close attention to technical and equity issues to ensure that the assessments are fair to all students.

Alternative Assessment

Alternative assessment includes any assessment in which students create response to a question-short answer and essay. An example from a chemistry question on acids, bases and salts might be useful. For instance,

Which of the following is a characteristic of an acid? An acid:

(a) turns red litmus paper into blue

(b) releases hydroxide ions in solution

(c) tastes sour

(d) feels slippery

The correct answer is C.

*Alternative:*Differentiate between an acid and a base.

*Authentic:*Your mother took lime last night for acid indigestion, why? Trace the lime through her system, describing the correct chemical reactions (South East Region Vision for Education 1998).

Performance: Take 2cm3 of each of solutions A&B in separate test tubes. To each, add a drop of litmus solution, write down your observation, and make inferences (WAEC derivedassessment).

Generally the upper class and sometimes few lower class students can learn and practice most BSPSskills through fun and engaging activities. For instance SPS of predicting more than just taking a valid guess. It requires students to use prior knowledge to figure out what they think will happen in the future. Students should be able to observe procedurally and have a clear understanding of the purpose of observation in scientific investigation. Consider,addition of sodium hydroxide to unknown solution, a white gelatinous precipitates in drops which is soluble in sodium hydroxide. The prediction or assumption is Zn^{2+},Pb^{2+}or Al^{3+}but when sodium hydroxide is in excess, students should be able to observe accurately the precipitates dissolution confirming Zn^{2+} ions as an inference because only Zn^{2+} ion precipitates dissolves in excess sodium hydroxide. Similarly, allowing students to experiments adding "water on to acid"or vice versawhich they should know which to add to which. Students might add water directlyonto acid. They should have the skill of predict that the reaction could run the risk of violent reaction by catching fire but instead acid be added on to water slowly.

Science is classified as a dynamic interaction between processes and outcomes rather than being a description of the natural phenomena. SPS include life learning skills used by the learner to deal with the daily problems (Zaytoon, 2002). That is why the learning is not limited to providing the learner with only scientific knowledge, but the most important is to convert the knowledge into behavior, through which the learner can solve problems in a creative scientific method that helps them to keep on with the scientific technology progress, and the human knowledge development, (Al Dosari, 2013, & Ata-Allah 2001).Teachers association underlined that a reasonable part of science curricula should focus on the science process skills (Padilla, 1990). Anything considered in this present study is of major importance.

Any education system should provide citizens with scientific culture that allows a successful integration into and a decent adaptation to working life. , as life in modern societies relies on science and its techniques. The central purpose of science education is to improve students' reasoning abilities in addition to help

students to understand scientific knowledge and bind students' abilities using scientific approaches Shahali & Halim, 2010.

To assess the validity of Piaget's theory (1926), of formal thought and its relation to educational practice is of much concern to science educators. The central objective of schools establishment is to help students become formal thinkers Science and teaching students about science means more than scientific knowledge. Science education aims at emphasizing three components namely **knowledge, scientific skills** which include science process skills, manipulative skills, and **scientific attitudes and noble values**.Therefore, science process tests become a necessity to measure the science importance extent as to intellectual aspect of the learner, and further is to measure its impact through being aware of the acquired skills, starting from observation and measurement, classification and prediction skills, reasoning and communication, data interpretation, procedural definition, variables adjustments, hypothesis formulation, accessing to trial skills, (Partick, 2010; Baxter & Kurtz, 2001).

Science process skills are considered as a group of mental special capabilities and processes which are necessary for applying learning methods and scientific thinking in accurate manner (Zaytoon, 2010).Therefore it is considered as a basis of scientific exploration and discovery .Scientific skills are set of specific skills that assist students in learning science, setting them to be more actively involved and consciously expand their capabilities. Bredderman, (1983) defines scientific skills as cognitive skills that can be used to understand and disseminate information.

The acquisition of science process skills makes a meaningful subject since it is very much related to our daily life. (Akinbobola, 2006). It encourages logical and rational thinking with problem solving ability (Akinbobola & Afolabi, 2010).For instance in the process of observing qualities using the five senses organs, using words to describe what is seen, felt, heard, smelled and if appropriately tasted, notice details and break things into parts. Likewise to make an inference is to state ones assumptions. I assume this is Cu^{2+}ions present because it has deep blue characteristics precipitate. This clearly illustrate that making quality observation are closely linked to thinking skills since it involves using the senses to describe what is seen. Students' science process skills can be improved by involving students in scientific activities, one of which is the optimization of process orientated laboratory activities which offer authentic

experience to the students that helps them to understand various scientific concepts and enhance their performance level. In line with this statement, Myers and Dyer (2006) stated that students who are taught using the investigative laboratory approach tend to have better content knowledge and higher science process skills than those who are taught using the prescriptive laboratory approach.

The development of teaching science should emphasize that students acquire knowledge, skill and scientific attitude to have higher achievement that can arrange for students to participate in most activities, and take action on their own. Science process skills which may be developed in the life of science laboratories are variable, and thus they are distributed to skills of basic processes occupying the process learning pyramid base (Zaytoon, 2010).Teachers are those who have a critical role in promoting learning and development of activities for the students to learn science process skills and have fun in learning science to achieve the goals set.(dept. of education, 2002).

Problem statement

Science process skills are crucial for meaningful learning, because learning continues throughout life, and individuals need to find, interpret, and judge evidences under different conditions they encounter. Therefore it is essential for both the teachers and the student's future to be provided with SPS.

The science process skills are useful in science and non-science situation particularly the integrated science process skills which are the working behavior of the scientist and technologist. Thus both basic and integrated science process skills are relevant and appropriate for all science subjects. Hence there is the need to determine the understanding of chemistry teachers of science process skills and relates it to its assessment by teachers to chemistry learning whether SPS is fully understood and are assessed by teachers in accordance with stated laydown proscribed method.

Purpose of the study

The purpose of the study was to investigate the extent to which Science process skills are understood by Chemistry teachers whether the teaching approaches used in the teaching and learning process of chemistry are able to provide the opportunity to inculcate SPS in the students and to assess these skills during the

lesson.The result of this study will also serve as a tool for teachers on identifying the strength and weaknesses of the students' performance on the different scientific process skills namely, observing, measuring, data gathering and following the procedures systematically.

Objectives of the study

The study is design to determine the following objectives.

- chemistry teacher's opinion about SPS
- chemistry teacher's ideas about SPS
- SPS indicators that are trained to students.
- chemistry teacher's ideas about how to assess students SPS
- SPS indicators that are assessed in chemistry.
- difficulties faced by teachers in assessing SPS

Research Questions

Six research questions guided the study based on the stated objectives.

i. What do you know as a chemistry teacher about science process skills (SPS)? Explain your answer.
ii. How do you teach SPS to students in chemistry learning?
iii. What SPS indicators that are trained to students?
iv. How do you assess your students in chemistry as a subject?
v. What SPS indicators are assessed in Chemistry?
vi. What is the difficulty in assessing SPS?

Methods and Procedures:

Population and Sample.

The methodology of this study was qualitative case study. The sample in this study consists of eight (8) chemistry teachers from Chemistry department of Kashim Ibrahim College of Education, Maiduguri. Two (2) teachers with 1-10 years of teaching experiences and the remaining six (6) with teaching experiences of more than ten years forms the population.

Study tool

The research tool was a questionnaire design to measure SPS understanding (opinion and ideas) of teachers about SPS and the assessment method employed

by the teachers that can be evaluated. The data was collected by semi structured questionnaire with six questions presented. The questions raised andthe data gathered were classified based on the suitability of the teachers' answers (SPS understanding) to the SPS been assessed.

Data analysis

Data gathered were analyzed by connecting the questions results in a table form for each questionraised using frequencies count.

Findings and Discussion

The results from the semi structured questionnaire as shown in the following tables 1-6.

Research question 1: what do you know as a chemistry teacher about SPS? Explain your answer

Table 1. Chemistry Teachers' Opinion about SPS

Category of ideas	Frequencies	Chemistry Teachers'ideas
Scientific method	5	SPS is a skill in using scientific methods
Theoretical understanding	1	SPS is student's ability to understand science.
Learning approaches	2	SPS is a learning approach which is designed for students to discover facts and concepts

Source:Field work on Chemistry Teachers Opinion, 2019

As seen from the table five chemistry teachers have understanding that SPS is a skill used in scientific methods. One teacher understand that SPS is a concept and the remaining two teachers look at SPS as a learning approach. This results suggest that chemistry teachers have a weak understanding of science process skills.

Research Question 2: How do you teach SPS to students in chemistry learning?

Table 2: Chemistry teachers' Ideas about Teaching SPS to students in chemistry learning.

Chemistry teachers' Ideas	Frequencies
Practical work/ laboratory performance	8
Science project	3
problem based learning	2

Discussion	1
Visiting industry	2
Adoption of Lecture method	1

Source: Field work on Chemistry Laboratory Work as method teaching, 2019

Table 2 shows that most of the chemistry teachers believes that SPS can be trained to students through practice in the science laboratory, involvement in science projects and problem-based learning. Few argued that discussion and adoption of lecture method can be used as SPS learning methods and this has fallen within the definition of SPS as SPS cannot be trained through discussion and lecture approach.

Research Question 3: What SPS indicators that are trained to students?

Table 3. Chemistry Teachers' Ideas about SPS Indicators that are trained to students.

Category of ideas	Frequencies	Chemistry Teachers' ideas
Scientific method	4	Skills in practical work in laboratory such as observing, Formulating problems, hypothesizing, designing experiment analyzing data, drawing conclusion, and communicating
Skills using equipment	2	Skill in utilizing laboratory equipment
Concept learning	1	understanding of scientific concepts in chemistry
Learning activities	1	students active performance in learning process

Source: Field work on Chemistry Teachers ideas of Laboratory activity, 2019

In this table 3 which reveals that 50% of the chemistry teachers train SPS to students as a scientific skill that include laboratory practice. However, some teachers instruct SPS less in areas of skills acquisition of handling and using laboratory equipment and conceptual understanding.Although SPS is not only about the skills of using equipment but also as mere conceptual understanding of the learning process

Research Question 4: In chemistry, how do you assess student's SPS?

Table 4. Chemistry Teachers' Ideas about how to assess student's SPS.

Category of ideas	Frequencies	Chemistry Teachers' ideas
Observation of practicum	4	Observation from laboratory performance
Paper and pencil test	4	Written test about conceptual understanding
Observation of class activity	0	Observation during learning in the classroom

Source: Field work on Chemistry Laboratory activity, 2019

In table 4. It shows that four chemistry teachers assess SPS through observation of practicum and by using paper and pencil work approach each in the laboratory, and none pay attention to the observation of class/laboratory activity. However, observation during practical work in the laboratory is essential to assess SPS but observation of written activity test concept comprehension is not possible unless the question indicators do refer to SPS. Hence classroom observation is not suitable to assess SPS as optioned by most teachers.

Research Question 5: What SPS indicators are assessed in chemistry?

Table 5. Chemistry Teachers' Ideas about SPS Indicators that are assessed in Chemistry

Category of ideas	Frequencies	Chemistry Teachers' ideas
Scientific method	5	Skills in laboratory performance such as observing, formulating problems, hypothesizing, designing experiment analyzing data, drawing conclusion and communicating. Communicating
Skills using equipment	2	Skill in utilizing laboratory equipment
Concept learning	1	understanding of scientific concepts in chemistry

Source: Field work on Chemistry Teachers methods of assessing SPS through Laboratory Work, 2019

In table 5. It shows that chemistry teachers assess SPS based on the learning activities that are in the training of SPS, indicators such as integrated skills in the laboratory. Only one teacher assess SPS through skill in conceptual understanding and attitudes during learning process, and two teachers in using laboratory equipment

Research Question 6: What is the difficulty in assessing SPS?

Table 6. Chemistry Teachers' Ideas about the difficulty in assessing SPS?

Category of ideas	Frequencies	Chemistry Teachers' ideas
Instrument of assessment	4	There is no special assessment to assess all SPS indicators, so the assessment is subjective
Students ability to exhibit SPS	3	Students are not accustomed to doing

		problem- Solving, so SPS is difficult to perform
Assessment method been adopted	1	Teachers cannot assess student's SPS one by one accurately because of the weakness of the observation method

Source: Field work on Teachers Opinion on difficulty in assessing SPS, 2019

In table 6. It reveals that most teachers assess SPS based on subjective observation because there is no particular instrument that is available to be used. The observation as an instrument cannot be used sorely to assess SPS accurately. However, a combination of various instrument in at the same time is adequate and suitable so that misconception of the understanding of SPS and their assessment among teachers is put to rest.

Results and Discussion.

In tables 1-6 above, it shows that chemistry teacher's answers to the questions of SPS and its assessment, majority do not fully understand SPS. They can adequately define SPS but cannot mention skill indicators in the SPS. Some teachers lack in the operational practices though they understand the concept. Most teachers train SPS to students through practical work only in the laboratory. It is considered to take place in the laboratory but becomes the practical work only about using apparatus and following instructions.

Students who can utilize formal thought linked with the acquired basic SPS tend to achieve more than they students who cannot utilize formal thought and basic SPS. Students who are able to make use of basic SPS are able to solve problems beyond the capabilities of those who did not possess modes of reasoning and basic SPS. Moreover students who can acquire BSPS and ISPS tends to think analytically and are more successful with new problems than those who do not possess SPS.

Implications and conclusion

Science process skills are crucial for meaningful learning, because learning continues throughout life, and individuals need to find, interpret, and judge evidences under different conditions they encounter. Science processes is not just useful in science, but in any situation that requires critical thinking.

Therefore it is essential for both the teachers and the student's future to be provided with SPS.

From the results of this study chemistry teacher's answers to the question of SPS and its assessment, majority of teachers do not fully understand SPS. It was found on the general nutshell that the skills such as predicting, hypothesizing, identifying and controlling variables and recording data were not sufficiently understood by the teachers. They can adequately define SPS but cannot mention skill indicators in the SPS. Some of the teachers already understand the concept of SPS but lack in SPS operational practices. This is probably could be due to lack of professional training background. Most of the chemistry teachers train SPS to students through practical work in the laboratory and these are considered only to be taking place in a science laboratory using apparatus and following instruction where many of the skills associated with experimental investigation are rarely taught explicitly. Teachers assume that students obtain SPS skill only through experience by doing practical work in the laboratory. That assumption is okay to facilitate the acquisition of the operational aspects of the SPS but does not promote a conceptual understanding of the accuracy of the scientific inquiry process involved in the investigation.

Chemistry teachers understand that observation can be used as an SPS assessment, but in practice, teachers observe without using appropriate assessment instrument such as assessing the SPS of each studentprocedural report and recording during laboratory exercise. This could be due to difficulty of having large number of students in laboratory by the teacher. Teachers assess SPS through written test which measures the concepts and theories instead of SPS. There are also teachers who only measure SPS from student's accuracy in using scientific instruments.

The **implications** of the above is that as part of the study of science, students have to develop the capacity to deal with the problems in his day to day life. It can be achieved only through his constant involvement with the process of science. The purpose of science education is to enable individuals to use scientific skills, in other words, to be able to define the problems around them, to observe, to analyze, to hypothesize, to experiment, to conclude, to generalize and to apply the information they have with the necessary skills. Scientific process skills include skills that every individual could use in each step of

his/her daily life by being scientifically literate and standard of life by comprehending the nature of science.

Therefore a process oriented approach to science teaching and learning can serve the causes of science education. Science process skills enable student how to think scientifically by applying problem solving techniques to science lessons, while all lessons should incorporate process skills in discovering science concepts, teaching science process skills starting at primary level will specifically help students retain science lessons longer.Chemistry teachers should emphasize the inquiry method starting from mere observations of simple objects and lead onto higher process skills which includes hypothesizing, inferring and predicting etc. Teachers should centered on explanations of concepts, make use of graphic materials and engaged students maximally with the activities that should help them to develop the spirit of inquiry through their exploration of nature from the local environment. All these will help for development of reasoning ability and equip them with intellectual skills employed in the classroom as well as other life situations.

Chemistry teachers are therefore required to have an in-depth understanding of SPS as well as how to teach the SPS. Content and pedagogical knowledge should be integrated to create new knowledge.

Recommendations: In the light of these findings, the following recommendations are put forward.

i. Teachers as examiners should have a proper understanding of SPS through training retraining on the importance of SPS and to include more ISPS (higher order) into chemistry laboratory practical work to enable their students to be exposed to creativity, problem solving, reflective thinking, originality and invention which are vital ingredients for science and technological development.
ii. Opportunities should be given to students to handle and manipulate scientific materials, tools and equipment during the laboratory activities to test their ideas experimentally, collect, compare and interpret data, formulate models and draw conclusions.
iii. Guided discovery/inquiry method should be emphasized to improve student's levels of SPS acquisition.

iv. The states and Federal Ministries of Education should ensure that only teachers with the perquisite science education based knowledge, laboratory Technologist and technicians are employed to teach and man the science laboratories for one's professional knowledge which is informed by one's professional background and experience.

v. Teachers that teach students in secondary schools studying Basicscience& Technology, Biology, Chemistry and Physics should emphasize the inculcation of SPS right from the first year of students in the school

References

Akinbobola, A.O. (2006). Effects of cooperative learning strategy on academic performance of students in physics. Journal of Research in Education, 3(1), 1-5

Akinbobola A.O & I.B. Ado, (2007) .Hands-on and minds on strategies for teaching of force: Guided discovery approach. In E.Udo, U. Uyoata, N.E.U Inyang. H. Yero & G. Bello (Eds), Hands on and minds on strategies in the teaching of force. Proceedings of the STAN primary science workshop. Uyo. Afahaide & Bros printing & publishing co. 65-72

Akinbobola, A.O, & Afolabi, F. (2010). Analysis of science process skills in West African Senior Secondary School Certificate physics practical Examination in Nigeria. American-Eurasian Journal of scientific Research, 5(4), 234-240.

Al Dosari, N.(2013). The level of mastery of students in the sixth grade of primary operations. Unpublished Master's Thesis, King Saud University, Saudi Arabia.

American Association for Advancement of science (n.d) science process skills. Retrieved from www.scribed.com/doc/5567816/scienceprocesskillson 18thMay2019.

Ata Allah, M. (2001). Methods of teaching science. 1ST Edition.Amman; Almaseera Dar.

Aydin, A. (2013). Representation of science process skills in the Chemistry curricula for grades 10,11, and 12/ Turkey International Journal of Education and practice, 1(5), 51-63.

Baxter, L. M and Kurtz, M.J, (2001). When a Hypothesis is NOT an Educated Guess? Journal of Qualitative Education. Science and Children, 38(7), 18-20.Japan

Beaumont-Walters, Y. & Soyibo K. (2001). An analysis of high school students' performance on five integrated science process skills, *Research in Science & Technological Education*, 19(2), 133-145.

Bredderman, T. (1983). Effects of activity-based elementary science on student outcomes: A quantitative synthesis. *Review of Educational Research*, 53,(4), 499-518.

Brotherton, P.N. & Preece, P.F.W. (1995). Science process skills: Their nature and Interrelationships. *Research in Science and Technological Education*, 13(1), 5-11.

Brederman, T. (1983) Effects of activity based elementary science on student outcomes: a quantitative synthesis. Review of Educational Research, 53, 499-518

Chin, C, & kayalvizhi, G. (2005).What do people think of open science investigations? A Study of Singaporean primary 6 pupils. Educational Research, 47(1), 107-126

Department of Education. (2002). A Guide to Learning science. Bangkok; Thailand.

Eilam, B. (2002) Phases of learning: ninth graders' skill acquisition. *Research in Science and Technological Education,* 20(1), 5-24.

Federal Republic of Nigeria (FME, 2004). National policy on Education Lagos: NERDC press

Fitzpatrick, F.C. (1960). *Policies for science Education.* New York: Bureau of Publications.

Germann, P.J. & Aram, R.J. (1996a). Identifying patterns and relationships among the responses of seventh-grade students to the science process skill of designing experiments, *Journal of Research in Science Teaching,* 33(1), 79-99.

Harlen, W. (1999). Purposes and procedures for assessing science process skills. *Assessment in Education: Principles, Policy & Practice,* 6(1), 129-144

Johnston, J.S (2009). What does the skill of observation look like in young children? International Journal of science Education, 31(18), 2511-2525

Kazeni, M.M (2005). Development and validation of a test of science process skills for further Education and Training of learners. Unpublished M.Ed.Dissertation. Faculty of Natural and Agricultural science. University of Pretoria., South Africa.

Martin,R.E, Sexton, C. Franklin T, & McElron, D.(2001). Teaching science for all children (3rd ed.). Massechusetts. Allum & Bacon.

Menon, S.B. (1986). System of science and the perspective of the process of science inquiry. An unpublished Doctoral thesis in Education, The Maharaja Sayajirao university of Baroda, Vadodara. In M.B. Buch (Ed.). *Fourth Survey of Research in Education, NCERT.*

Myers,B.E & Dyer J.E. (2006). Effects of investigative laboratory instruction on content knowledge and science process skills achievement across learning styles. Journal of Agricultural Education, 47(4), 52-63

Omotayo, K.A and Yusuf, M.A (2002). The acquisition of qualitative skills among girls at the junior secondary school level. Teacher Education Today. 2(1 &2) 49-55

Padila, M. J. (2004). The science process skills, Research matters to science teacher No. 9004. Retrieved on May, 2019 from http://www.narst.org/publications/Research/skills.cfm.

Padila, M.J. (1990). The process skills. Research to the science Teacher, no. 9004. Available from http://www.ufrgs.br/psicoeduc/aquivos/piaget repres monde intro.pdf.

Piaget, J (1926). La representation dl monde chez I, enfant. Foundations Jean piaget .Available http://www.ufrgs.br/psicoeduc/a"quivos/piagetrepress monde intro.pdf.

Partick, O. A. (2010).Processes of science skills acquisition: competences required of science teacher for imparting them. Journal of Qualitative Education, 6(4), 1-148. Japan.

Shaha, E H M and Halim L, 2010. Development and validation of a test of integrated science process skills Procedia-Soc.Behav.sci.9-142-6

Schlessinger, C. (2000). Teaching of Science. Ludhiana: Tandon Publication.

US Department of Education (1993) Performance Assessment, in Zimmermann, J. (Editor) *Consumer Guide, Office of Educational Research and improvement*, 2

Zaytoon, K (2002). Teaching science to understand. 1st Edition. alam Alkotob-Cairo.

Zaytoon, A. (2010). Contemporary global trends in science curricula and teaching. Dar Alashoroug. Amman.a