# The criterion for senior secondary school (SSS) chemistry teachers' beliefs and their perceptions of effective practical and experiments (EPE) in Lagos, Nigeria

**BY:**

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**Abstract**

Chemistry had been a prerequisite subject for many fields of knowledge. The subject has a variety of applications in life and society. Effective practical and experiments (EPE) in chemistry have tendencies to open-ended investigative and knowledge-based learning. This study was primarily an appraisal of chemistry teachers' beliefs and perceptions of EPE in SSS chemistry learning, and with the purpose for improved learning experiences and learning outcomes in SSS chemistry. The research was a case involving 12 purposefully selected chemistry teachers. The teachers were experienced and they voluntarily expressed interests to participate in the research. The researchers had a six-month interaction with participants on demonstration, structured, investigation and problem-solving kinds of EPE. After which, the chemistry teachers were given another six months to incorporate EPE strategies into chemistry lessons. A Focus group meeting (FGM) was subsequently conducted. The structured items designed for FGM were based on three indicators: Students' learning experiences; students' challenges; and students' learning outcomes. Findings revealed that EPE gave students opportunities to perform tasks and to construct meanings into the understanding of chemistry concepts; that more periods should be allocated for elaborate laboratory activities in chemistry; and that small class sizes should be encouraged for SSS chemistry. The study documented chemistry teachers' beliefs and perceptions towards integrating EPE into the learning of SSS chemistry. The key findings encouraged chemistry teachers to have more tendencies to open-ended investigative and knowledge-based pedagogical process skills, which stimulates students' learning and engages them with hands-on activities, minds-on activities, and increased motivation towards learning chemistry.

**Keywords:** Appraisal; Learning experiences; Learning outcomes; Pedagogical process skills; Problem solving.

## I. INTRODUCTION

In the contemporary development among nations of the World, Chemistry has been receiving much emphasis because of its significance and relevance to life and society. Chemistry has been identified as a science subject with noticeable influence in innovation and development, particularly in the social processes, economic processes and chemical technology processes in societies. The Importance and scope of chemistry could as well be informed in numerous ways including, clothing, food and preservations, medicine and pharmacy, nursing, forestry, petroleum products, plastics, biotechnology, biochemistry, chemical engineering and materials science, clean air, clean water, clean environment and soil, shelter and energy usage, building and construction, agriculture and the rest. Chemistry has also contributed immensely into alleviating circumstantial problems resulting from emergence of new drugs and drug resistances, effects of genetics, genetic engineering and experimentations, ecological impacts of modern technologies, radioactivity and radiation, nuclear substances and their explosions, climate change, depletion of ozone layer and global warming. The study of chemistry in senior secondary schools (SSS) would equip students

with appropriate concepts, theories and principles, to be used for the understanding of their environments and for finding solutions to the challenges in the natural surroundings.

Chemistry is a prerequisite subject for many fields of knowledge. The substratum, as provided in the SSS curriculum aimed towards providing appropriate knowledge, competence, attitudes and skills for appropriate behavioural changes in acquiring salable skills and experiences, which help students to become entrepreneurs after schooling (Ezeyi, Ene and Nwosu (2021); Faniwole, 2017). Effective practical and experiment (EPE) in chemistry have more tendencies to open-ended investigative and knowledge-based learning, which engages students with hands-on and minds-on activities, and increased motivation (Nzewi, 2008; Nwagbo, 2008). The position of science educators and teachers on use of EPE for quality science pedagogy was also detailed by some researchers (Lin and Chiu, 2007; Clackson and Wright, 1992). These investigators believed that practical and experiments would provide students with conceptual and theoretical knowledge to learn scientific concepts and understand the nature of science.

Learning is a process of acquiring new knowledge, behaviour, skills, ethics, transparency, values or preferences and trustworthiness (Olave and Dillon, 2020), and modifying the existing ones (Amuda and Yahaya, 2020). The high level of interaction in EPE makes students to actively participate in learning process. Students' chemistry learning experiences become effective and valued, when they could use practical and experiments to initiate the synthesis of different types of information in concepts. Amuda and Yahaya (2020) pointed that students should be made to be actively engaged in the pedagogical process, so as for them to be critical in thinking, develop creative skills and take responsibilities for the knowledge and skills achieved in the pedagogical process. EPE as scientific process skills were capable of providing scientific inquiries skills and the development of intellectual skills and attitudes that are needed for achieving expected learning outcomes of chemistry concepts.

Effective practical and experiments (EPE) is an activity based learning process in chemistry. The phenomenon should be viewed as a mechanism through which materials and equipment were carefully and critically brought together to motivate learners about the veracity and validity of their learning experiences. There is no single methodology that could be conceived (in totality) to communicate the multi-various activities in chemistry, however, the high variability in the aptitude and attitudinal dispositions, as well as learners' background suggest the need for using suitable methods for different concepts in chemistry. The situation in this research emphasised SSS chemistry students' learning experiences; their challenges; and their learning outcomes, using four kinds of EPE vis: [1] demonstration, [2] structured, [3] investigation and [4] problem solving kinds of EPE. Of course, the experiences and opportunities in chemistry pedagogical process skills, for improving learning experiences and learning outcomes have been recorded in literature, but this study sought to add to the body of knowledge through the appraisal of chemistry teachers' beliefs and perceptions of effective practical and experiments (EPE) in senior secondary schools (SSS) chemistry.

## II. PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

This study was primarily an appraisal of chemistry teachers' beliefs and perceptions of effective practical and experiment (EPE) in senior secondary schools (SSS). The emphasis had been with the purpose for improved learning experiences and learning outcomes in SSS chemistry.

The following research questions guided the study:

i. To what extent do effective practical and experiments (EPE) improve students' learning experiences in senior secondary schools (SSS) chemistry?
ii. To what extent do effective practical and experiments (EPE) improve students' learning outcomes in senior secondary schools (SSS) chemistry?
iii. What beliefs and perceptions do chemistry teachers hold for enhancing effectiveness of practical and experiments (EPE) in senior secondary schools (SSS) chemistry?

## III. METHODOLOGY

A descriptive survey methodology was used for this study. The survey was accomplished with continuous use of effective practical and experiments (EPE) learning activities. Data were collected to describe and interpret the participants' beliefs and perceptions about the applications of EPE into the pedagogical practices and other on-going learning processes in chemistry. The research was a case involving 12 purposively selected, experienced and volunteered chemistry teachers in the Ojo local government, Lagos State, Nigeria. All the participants possessed more than 10 years experience of teaching chemistry. The researchers used case study, so as to produce a real-world situation of the report, thus, blending practical activities and experiments with the theories of perceived difficult chemistry concepts (Basitere, Rzyankina & Le-Roux, 2023).

The 12 volunteered chemistry teachers that participated in the study had interactive sessions with the researchers, specifically on the characteristics, processes and procedure in the learning pedagogical process (LPP) of: [1] demonstration, [2] structured, [3] investigation and [4] problem solving kinds of EPE. The participants and the researchers worked extensively and collaboratively together for six months. Meetings were fixed for the last Thursday of every month as scheduled and implemented. Duration of meetings ranges between 7 – 9 hours (a one hour of snacks & tea break inclusive). The meetings discussed difficulties and prospect in the teachers' use of EPE in SSS chemistry concepts. Importantly, the meetings created collegiality in chemistry teaching and learning, and opportunities for the chemistry teachers to be able to depend on one another (Peters-Burton, Rich, Kitsantas, Stehle and Laclede, 2022). After which, the chemistry teachers were given another six months to incorporate EPE strategies into their chemistry lessons. Prior to the second six months of the study, the purposefully selected chemistry teachers met with the researchers on the choice of concepts and determination of appropriate kind of EPE that would be most suitable for the LPP. One (1) chemistry concept was appropriated for particular LPP, therefore, four chemistry concepts were involved during the six months of teaching and learning activities of the study. The selection of chemistry concepts were guided with 2022-2023 WASSCE syllabus, Lagos State curriculum for SSS chemistry and scheme of works for SSS chemistry.

The quantitative data were obtained from the participants, by collecting numerical responses from them, in the form of rating each of the EPE learning pedagogical processes (LPP) characteristics. The teachers expressed their beliefs and perceptions of the students' learning experiences and learning outcomes after the use of different kinds of EPE learning pedagogical processes (LPP) characteristics. The ratings were made on a scale of 10. The maximum was 10 and minimum 1. The arithmetic mean ($\chi$) and standard deviation ($\Delta$) of scores collected from the participants were calculated, for each of the four (4) characteristics of LPP and findings were appropriately recorded.

The qualitative aspect of the research was made with focus group meeting (FGM), in order to augment results in the quantitative data analysis. The structured items designed for the FGM were centered upon the three indicators: Students' learning experiences (SLE); students' challenges (SC); and students' learning outcomes (SLO). The researchers used the FGM to elicit open responses from selected chemistry teachers. The respondents used the FGM to verbally express the situations observed on their students' learning experiences and learning outcomes after using EPE learning pedagogical processes (LPP). The FGM session allowed the teachers to explain their students' learning experiences, challenges and learning outcomes achieved, by using the learning pedagogical processes (LPP) of: [1] demonstration, [2] structured, [3] investigation and [4] problem solving kinds of EPE. The intention at the focus group meeting (FGM) with the chemistry teachers was appropriated to the purpose of obtaining information on SLE, SC and SLO.

## IV. RESULTS AND DISCUSSION

Basically, the exercises in this study were aimed at investigating chemistry teachers' beliefs and perceptions about the use of effective practical and experiments (EPE) in chemistry teaching and learning. The chemistry teachers used their improved knowledge from the earlier six months to incorporate EPE's learning pedagogical processes and strategies into lessons with their students in the latter six months. The researchers and the participants used the later six months for interactions and improvements on the applications of EPE's LPP with senior secondary school (SSS) chemistry students. The researchers had used the quantitative data collected in this study, to obtain the participants' beliefs and perceptions of EPE's LPP characteristics. Focus group meeting (FGM) was as well conducted with the chemistry teachers on an agreed date. Data were collected and analysed.

In the quantitative analysis, chemistry teachers specifically rated their beliefs and perceptions of the EPE's learning pedagogical process (LPP) characteristics of: [1] demonstration, [2] structured, [3] investigation and [4] problem solving. The ratings were made on a scale of 10. The maximum was 10 and minimum was 1. The arithmetic mean ($\chi$) and standard deviation ($\Delta$) were calculated for each of the four (4) characteristics of LPP and findings were appropriately recorded. The summary would be found in Table 1.

**Table 1:**
**Summary of Chemistry teachers' beliefs and perceptions of their students' learning outcomes with different kinds of EPE's LPP characteristics:**

| Chemistry Teachers | Demonstration EPE | | Structural EPE | | Investigation EPE | | Problem - Solving EPE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X | Δ | χ | Δ | X | Δ | X | Δ | | |
| 1. | 8.6 | 1.108 | 7.8 | 1.210 | 9.2 | 1.116 | 8.4 | 0.961 | | |
| 2. | 7.9 | 1.101 | 7.2 | 1.116 | 8.7 | 1.094 | 8.9 | 1.113 | | |
| 3. | 8.1 | 1.121 | 8.3 | 0.891 | 9.6 | 1.031 | 8.7 | 1.077 | | |
| 4. | 8.3 | 1.051 | 9.1 | 1.241 | 7.9 | 0.981 | 9.3 | 1.106 | | |
| 5. | 7.7 | 1.023 | 8.9 | 1.057 | 9.2 | 1.106 | 7.8 | 1.112 | | |
| 6. | 9.3 | 0.0869 | 8.4 | 1.129 | 9.1 | 1.173 | 9.1 | 1.191 | | |
| 7. | 7.8 | 1.116 | 7.8 | 0.973 | 9.1 | 1.189 | 8.6 | 0.885 | | |
| 8. | 7.5 | 1.131 | 8.7 | 1.113 | 8.8 | 0.941 | 8.8 | 1.109 | | |
| 9. | 7.9 | 1.088 | 7.9 | 1.025 | 9.2 | 0.963 | 8.4 | 1.115 | | |
| 10. | 8.3 | 1.135 | 7.6 | 0.917 | 7.9 | 1.117 | 8.9 | 1.017 | | |
| 11. | 9.6 | 1.118 | 8.5 | 1.148 | 8.8 | 1.106 | 9.3 | 1.128 | | |
| 12. | 7.2 | 0.962 | 7.7 | 1.110 | 9.0 | 0.927 | 9.1 | 1.116 | | |
| **Average Mean** | **8.18** | | **8.16** | | **8.88** | | **8.78** | | | |

Arithmetic mean = $\chi$; and Standard deviation = $\Delta$

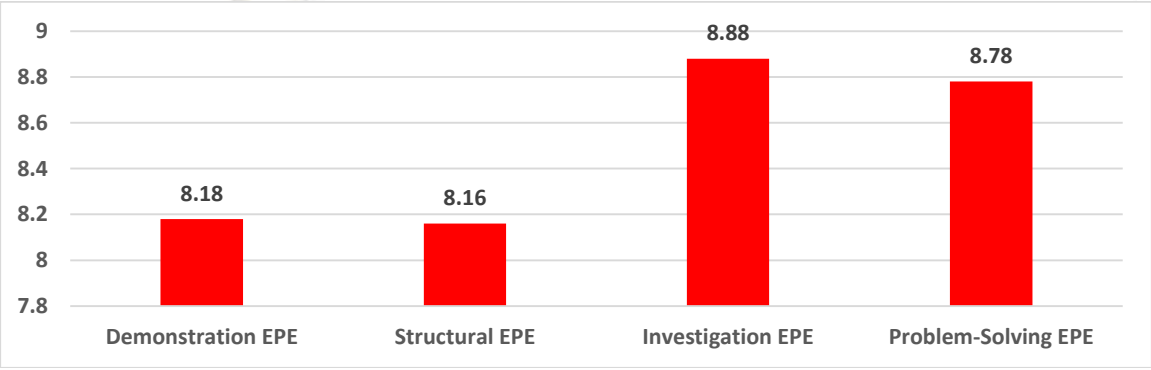


**Figure 1: Histogram of chemistry teachers' beliefs and perceptions of their students' learning outcomes with different kinds of EPE's LPP characteristics**

It was obvious from Figure 1 that the chemistry teachers perceived their students' learning outcomes for demonstration, structural, investigation and problem-solving kinds of EPE's LPP, as 8.18, 8.16, 8.88 and 8.78 respectively (please, recollect that the EPE's LPP characteristics were rated on a scale of 10). This showed that the highest rating was recorded for "investigation" kind of EPE's LPP (8.88). The "problem-solving" kind of EPE's LPP characteristics was closely followed with 8.78, while those of "demonstration (8.18)" and "structural (8.16)" kinds of EPE's LPP characteristics were in sequence followed hierarchically.

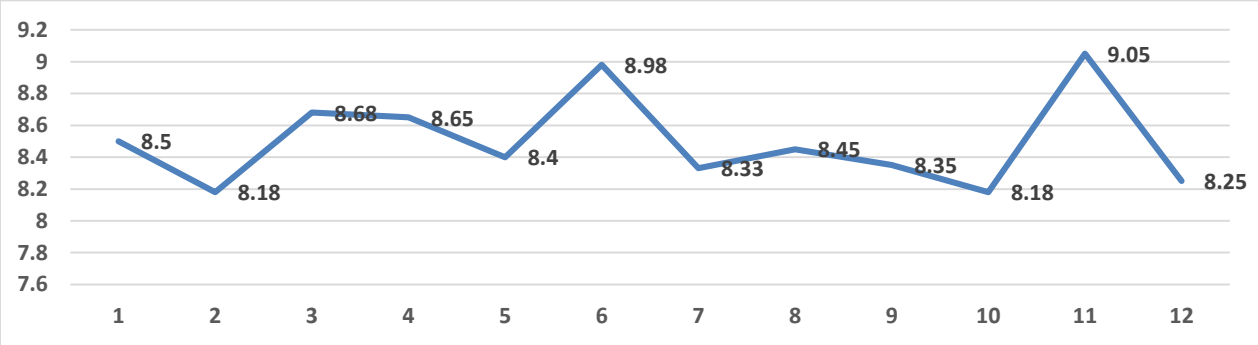


**Figure 2: Graph of individual chemistry teacher' rating of SSS chemistry students' learning outcomes with different kinds of EPE's LPP characteristics**

The outcome in Fig 2 showed that the best two ratings came from teachers 6 and 11 while the least rating came from teachers 2 and 10. The average rating for each of the chemistry teachers was in records between 8.33 and 8.68. The data interpret that chemistry teachers believed that they would use EPE learning pedagogical processes (LPP) and strategies to improve learning outcomes in SSS chemistry. Basically, the teaching and learning of SSS chemistry should be routinely carried out with effective practical and experiments. It is the responsibility of chemistry teachers to support students with suitable learning pedagogies, so as to make learning bearable for them.

The goal of this study was to produce a report in the form of an appraisal of teachers' beliefs and perceptions of effective practical and experiment (EPE) in senior secondary schools (SSS) chemistry learning. The emphasis had been with the purpose for improved learning experiences and learning outcomes in SSS chemistry. The researchers were guided by three research questions, which were focused on four learning pedagogical processes (LPP) of EPE vis: [1] demonstration, [2] structured, [3] investigation and [4] problem solving kinds of EPE. The EPE's LPP as used in chemistry teachers' focus group meeting (FGM) was constructed with perceptions towards bringing out results that will reveal students' learning experiences and their learning outcomes in chemistry (Obanya and Taure, 2003). The data obtained from focus group meeting (FGM) were analysed with use of content analysis

In the focus group meeting (FGM), the researchers started with participants' descriptions of how they make use of practical and experiments in teaching chemistry concepts. The teachers reflected on the poor state of laboratories, which potentially limited their interests and application of effective practical and experiments. The comments of Teachers 2, 6, and 7 were narrated thus:

*Teacher 2:* "*…The major problem with SSS chemistry teaching and learning is the lack of equipment and materials in our laboratories…The laboratories are virtually empty…"*
*Teacher 6: "…We need laboratories in our schools for practical and experiments… We also need relevant laboratory materials and resources for practical chemistry. …There should be more practical work and inquiry learning in chemistry teaching and learning processes*."
*Teacher 7:"…Practical chemistry equipment and materials should be made available in the laboratories for use and chemistry laboratories should be well equipped. ..There are old and expired chemicals in our chemistry laboratories, which should be replaced with new ones… Chemistry practical and experiments would improve teachers' illustration of concepts. …The SSS chemistry curriculum emphasised learning with experiments, but…"*

Teachers 11and 3 delineated needs for regular supply of basic and social amenities in chemistry laboratories. The participants also explained that the large chemistry classes in schools are difficult for them to manage.

*Teacher 11:* "*…Effective practical and experiments in chemistry laboratories requires regular supply of gas, water and electricity... Chemistry practical and experiments make our work easy and well organised… and students can discover learning on their own…. We would be able to discover how the students are improving in their sense of imagination, cleverness innovativeness…"*

*Teacher 3:"…With more basic amenities, we shall have more practical and experiments… we will be capable of organising our lessons efficiently with creativity and easy learning environments for our students,… but the laboratories were not of good standards and the students are many…and we are not well prepared for managing large class works in practical and experiments..."*

**KEY FINDING 1:**
The study observed that chemistry laboratories and resources were not enough in schools. It was also found that basic amenities like water, cooking gas and electricity were not of fairly-regular supply in schools. It was informed that the learning processes in chemistry should be based on how to integrate effective practical and experiments into the theory of chemistry. The research further indicated that SSS chemistry pedagogy should focus on discovery in learning, by means of practical and experiments. Finally on this, the study considered effective practical and experiments as opportunities for chemistry teachers to have well prepared and efficiently organised lessons and pedagogy. Invariably, effective practical and experiments would project easy learning environment, creativity and improved learning.

***Research Question 1:***
*To what extent do effective practical and experiments (EPE) improve students' learning experiences in senior secondary schools (SSS) chemistry?*

The beliefs and perceptions of participating chemistry teachers were sought about how the features of effective practical and experiments (EPE) would improve students' learning experiences in senior secondary schools (SSS) chemistry.
*Teacher 8:"…as teachers we can do better if necessary and needed resources are in our laboratories …we have found that effective practical and experiments would provide a real-world situation in the teaching and learning… make ease flow of curriculum and better understanding of concepts…The curriculum should be revised to give more opportunities for achieving better results in learning…"*

The teachers also believed that learning experiences were achieved with all sensory organs at work during lessons. Teachers 10, 3 and 7 opined that EPE had encouraged improved learning experiences.
*Teacher 10:"…Students experienced learning by easily differentiating among common examples demanded from them …in their imagination and ingeniousness…These experiences will improve learning. …Practical and experiments have characteristics for all sensory organs to be working at the same time …the hand, eyes, ears, head and other sensory mediums…everything …all students are participating and interacting at the same time…"*

*Teacher 3:* "*…Effective practical and experiments also allow students to have opportunities to cooperate among themselves in order to achieve considerable learning experiences during lessons … We also noticed that experiments gave the students improved and equal access to learning..."*

*Teacher 7:"…During practical, students benefit better among themselves…and they have more confidence in learning when they are in practical class groups…They have more time for consultations and collaborations…"*

**KEY FINDING 2:**
Chemistry teachers believed that EPE improved learning experiences by making the curriculum to flow easily and creating better understanding of concepts. The study also instituted that chemistry curriculum should be prone towards driving better results in students' learning. It was also revealed that EPE strengthen mastery of content and improve

***Research Question 2:***
*To what extent do effective practical and experiments (EPE) improve students' learning outcomes in senior secondary schools (SSS) chemistry?*

The views of participating chemistry teachers were sought, so as to know their beliefs and perceptions of the application of effective practical and experiments (EPE) for improved learning outcome in SSS chemistry. The thoughts and opinions were recorded for teachers 1, 6, 9, 11, and 12.
*Teacher 1:"… Effective practical and experiments (EPE) would improve the understanding of chemistry concepts and enhance the chemistry teaching and learning… EPE encourages students to learn at their pace and makes them to be more confident and committed to learning chemistry…"*

*Teacher 6:"… with minimal guide the students were excited with activities in practical classes…and were able to work successfully together with little or no supervision …this is about achieving overall learning outcomes for all students …students were able to understand how the knowledge in chemistry concepts are useful to them…"*

*Teacher 9:* "*…students have better skills in handling and using apparatus and other laboratory equipment… they are going-on well in the understanding of chemistry concepts by linking chemistry theories with experiments and practical…"*

*Teacher 11:* "*…our students can now improvise and make suggestions for improvisable materials and equipment… students' understanding of alternative laboratory equipment and materials would equip them with knowledge and skills for achieving better learning outcomes…"*

*Teacher 12:"…the support to learning and activities in effective practical and experiments makes students to understand the process in learning and achievements… and that the motivation and engagements provided by EPE, makes lessons interesting ….students would be able to use their heads, hearts and hands at the same time in learning process… had positively impacted and improved the learning outcomes in chemistry…"*

**KEY FINDING 3:**
Chemistry teachers explained that EPE helped to improve the understanding of chemistry concepts and encouraged students' learning. It was deduced that SSS chemistry students learn with more confidence and further commitments towards learning chemistry. It was also inferred that EPE helped SSS chemistry students to work successfully and independently with little or no supervision. Finally, the study established that motivation and engagements in effective practical and experiments makes chemistry lessons interesting, as such, all learning domains (i.e. cognitive, affective and psychomotor) would be involved and committed to the learning of chemistry concepts.

***Research Question 3:***

*What beliefs and perceptions do chemistry teachers hold for enhancing effectiveness of practical and experiments (EPE) in senior secondary schools (SSS) chemistry?*

The participants expressed their beliefs and perceptions about enhancing effective practical and experiments (EPE) in senior secondary schools (SSS) chemistry. Their thoughts and views were narrated by Teachers 10, 5, 12, 9, 8 and 4:

*Teacher 10: "…our main difficulties with the use of EPE in chemistry teaching and learning were the incessant changes in chemistry curriculum and scheme of work, with the increasing scope and volume of chemistry concepts compiled for schools to cover…Again, there are few chemistry teachers in schools, coupled with shortage in supply of chemistry resources and materials …all these would limit the effectiveness of practical and experiments in chemistry classes…"*

*Teacher 5: "…there is the improper coordination of subjects on the school time table…and we have to contend with the over loaded syllabus…even as chemistry teachers, we teach other science subjects and have other school-based assignments to attend to…we have too much work load…"*

*Teacher 12: "…most of the public schools in this district did not have chemistry laboratory…schools are now converting their former laboratories into classroom, because of the over-blotted school population …schools did not have enough classrooms…so, there were insufficient teaching and learning materials, facilities and resources for SSS chemistry…"*

*Teacher 9: "… In order to enhance EPE, learners should have equal opportunities in sharing and use of learning materials …during teaching and learning processes…and be motivated to work collaboratively and as groups. …students should also communicate effectively among themselves…"*

*Teacher 8: "….there is a need to invite teachers to be part of chemistry curriculum organisation and development meetings …there is a need for periodic workshops…for chemistry teachers to discuss the progress achieved and difficulties encountered in the course of implementing SSS chemistry curriculum…"*

*Teacher 4: "….chemistry teachers should be meeting regularly, in order to give updates on the extent to which they understand and use the chemistry curriculum documents…and to be able to interact and support each other on the selection of practical and experiments for different chemistry concepts…"*

**KEY FINDING 4:**
Data analysed revealed that there is paucity of chemistry teachers in Lagos State schools and SSS chemistry classes are large, which translates to heavy workloads for the subsisting chemistry teachers. It was also suggested that chemistry teachers should organise themselves into groups and be meeting regularly, so as to help each other with better understanding of the effective use of practical and experiments in chemistry. The researchers established that there would be a need for intervention towards supporting SSS chemistry teaching and learning. The endeavour could be related to better funding, sufficiency in the supply of teaching and learning facilities, infrastructure and resources, and better condition of service for chemistry teachers. So far, such moves as believed, would probably limit the difficulties in the application and use of effective practical and experiments in SSS chemistry pedagogy.

All teachers that participated in this research indicated the need for chemistry teachers to harness the opportunities provided by effective practical and experiments (EPE) for improved students' learning experiences (SLE) and students' learning outcomes (SLO). Further, Braimoh (2021) had earlier clarified the significance for well organised and effectively managed curriculum in appropriating students' learning experiences. Despite the challenges explained by the participants, a major highlight of the study was that EPE supported chemistry students to develop knowledge that would help them to solve problems and improve their learning outcomes in chemistry.

## V. CONCLUSION AND RECOMMENDATIONS

The study documented chemistry teachers' beliefs and perceptions of effective practical and experiments (EPE) in SSS chemistry. Participants emphasised and encouraged the use of process skills in chemistry pedagogy. The research on effective practical and experiments opened-up opportunities for students to participate in pedagogical processes. EPE was discovered as a learning process, which provided feedbacks on activity-based learning. Effective practical and experiments (EPE) in chemistry also informed about how students could interact and collaborate in learning processes, and about how students interests were stimulated in learning chemistry with activity-based, hands-on and minds-on behaviours.

This study developed suggestions for improved learning experiences and learning outcomes in senior secondary school (SSS) chemistry. Data were obtained within the framework of chemistry teachers' beliefs and perceptions in effective practical and experiments (EPE). Based on the findings of this study, it was recommended that:

i. Senior secondary school (SSS) chemistry needed more laboratories, laboratory materials and resources. There should be more practical work and inquiry learning in chemistry pedagogical processes. Further, it was established that effective practical and experiments would make teachers to efficiently organise lessons, with creativity and easy learning environments for students. The focus should be on how the students would achieve the knowledge and understanding of core concepts of chemistry. The learning pedagogical processes (LPP) should emphasise more on how to integrate effective practical and experiments (EPE) into the theories of chemistry. Students should acquire learning through hands-on and minds-on activities. The process of learning in EPE provides opportunities for students to ask questions and seek answers.

ii. Chemistry teachers should be particular about improving students' learning experiences. The focus would be towards achieving end goals and objectives of enhancing quality learning outcomes. That would be accomplished by creating ease flow of curriculum with EPE and better understanding of concepts. There is a need for change in the pedagogical paradigm. Chemistry teachers' tendencies for driving better results should be based on effective practical and experiments. Basically, this study showed that EPE strengthened improved social learning, process skills, participation and collaborative engagements among chemistry students. EPE also gave chemistry teachers the leverage to easily drive home the content of chemistry concepts, which made the teachers to be able to consolidate on their students' learning difficulties.

iii. Effective practical and experiments (EPE) helped to improve the understanding of chemistry concepts and encouraged students' learning. With EPE, SSS chemistry students would be motivated to be more confident, self-reliant and committed to process learning in chemistry. The process learning associated with EPE would stimulate chemistry students to work together successfully with little or no supervision.

iv. It is difficult to achieve chemistry process skills in large classes with over-worked teachers and over-stretched materials and facilities. The findings revealed the need for more chemistry teachers and reduced chemistry class sizes for effective practical and experiments in senior secondary schools chemistry.

v. This study also showed that chemistry pedagogical processes would require support related to better funding, sufficient teaching and learning facilities, infrastructure and resources, and better condition of service for chemistry teachers.

vi. The researchers observed that EPE gave learners equal opportunities to participate in learning processes, therefore it would be imperative for chemistry teachers to allow their students to function and participate in the learning of chemistry concepts, so as to stimulate feedback in learning activities.

## VI. LIMITATION

The limitation to the study was that data were only collected from one local government area and only 12 purposively, experienced and volunteered chemistry teachers were involved. It would be important to establish further knowledge-based evidences on effective practical and experiments (EPE) from other science disciplines.

The researchers believed that using more science teachers from other science disciplines would broaden the scope of this study to further provide opportunities for encouraging chemistry teachers to have more tendencies to open-ended investigative and knowledge-based pedagogical process skills. This circumstance would stimulate students' learning and engage them with hands-on activities, minds-on activities, and increase their motivation for learning chemistry. On a final note, the authors suggested that there should be a need for government agencies in education sectors, to synergise with research establishments and universities, for the purpose of institutionalising process skills in the pedagogy of chemistry. In such circumstance, there would be opportunities for backing policies with researches that were based on achieving learning oriented pedagogical praxis in chemistry teaching and learning.

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