



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

Assessment of Competency Improvement Needs in Teaching and Learning of Laboratory Technique Concept among Secondary School Chemistry Teachers in South East, Nigeria

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Abstract

Chemistry is a core science subject which requires hands-on laboratory activities to promote effective teaching and meaningful learning. Despite its importance, research evidence indicates that many chemistry teachers lack the necessary laboratory skills needed to adequately conduct practical sessions. This gap underscores the need for competency improvement in laboratory techniques to enhance teachers' capacity to effectively guide learners through laboratory activities. The present study investigated the competency improvement needs of secondary school chemistry teachers in South East Nigeria with emphasis on laboratory techniques. The study adopted a descriptive survey design guided by three research questions and three hypotheses tested at .05 level of significance. A total of 100 examiners who marked WAEC chemistry practical were randomly sampled from a population of 240 examiners that assessed WAEC chemistry (Paper 3) in the 2022/2023 academic year in South East Nigeria. Data were collected using a validated questionnaire, which yielded a reliability coefficient of 0.81 using the Cronbach Alpha method. Research questions were analysed with mean and standard deviation, while the null hypotheses were tested using t-test. Findings indicated that chemistry teachers need competency improvement in all areas of laboratory techniques and there was no significant difference between the mean responses of WAEC examiners from Abia and Enugu in all the items. Furthermore, results showed that chemistry teachers need competency improvement in developing proper marking guides for reported practical work in qualitative and volumetric analyses and there was no significant difference in the mean responses of WAEC examiners from Abia and Enugu in each case. Based on the findings, recommendations were made.

Keywords: Competency, competency improvement needs, chemistry teachers and laboratory techniques

Introduction

Chemistry as a core science subject plays a vital role in equipping learners with the knowledge and skills necessary for scientific literacy, industrial development, and technological advancement. At the secondary school level, chemistry education is designed not only to transmit theoretical concepts but also to develop students' practical competencies in laboratory techniques, problem-solving, and scientific reporting. A key component of chemistry learning is practical work, which provides students with opportunities to engage in hands-on experiments such as volumetric and qualitative analyses. These activities train learners to observe carefully, record accurately, interpret results logically, and apply scientific principles in real-life situations. According to Eze, Ugwu and Chukwumeka (2025), chemistry laboratory is an integral part of the chemistry learning experiences designed for secondary schools because the nature of chemistry demands hands-on learning experiences using apparatuses, tools, equipment and reagents for effective instruction. However, the effective delivery of chemistry practical activities largely depends on the competency of the teacher. Teachers are expected to be proficient in laboratory techniques, preparing reagents, handling of apparatus, guiding students in making precise observations and ensuring accurate recording of experimental results. They must also possess the skills to develop and apply proper marking schemes in order to assess students' work objectively (Nwafor, Ezeanya & Muoneke 2023). Unfortunately, studies and classroom experiences in Nigeria reveal that many secondary school chemistry teachers experience gaps in these competencies due to inadequate pre-service and in-service training.

The consequence of such competency gaps is reflected in students' persistent weaknesses in chemistry practical examinations. Examining bodies such as WAEC have frequently reported that candidates struggle with accurate titration readings, use of significant figures, balancing of equations, systematic tabular reporting and correct inferences in qualitative analysis. Such recurring deficiencies strongly suggest that teachers themselves may lack the requisite competencies to guide students effectively. Competency is a holistic construct that integrates knowledge, skills, abilities and attitudes necessary for a workplace. Eze (2019) defined competency as those noticeable behavioural tendencies, skills and abilities that enable an individual perform optimally in a workplace. Competency in teaching, according to Adodo in Eya, Attah and Unmate (2020) is the ability of the teacher to exhibit on the job skills and knowledge gained as a result of training. In



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

practical chemistry, a teacher's competency is their overall capacity to plan, conduct and assess laboratory activities in a way that ensures students acquire hands-on skills, scientific reasoning and safety awareness. For example, a teacher is said to have 'competency in teaching practical chemistry' if they can organize laboratory sessions, demonstrate experiments effectively, manage students safely and assess practical work. Competence in laboratory techniques is the demonstrated ability of a teacher or learner to effectively and safely perform scientific procedures and experiments using appropriate tools, equipment and methods. Competence in laboratory techniques goes beyond simply knowing theoretical concepts and emphasizes practical application in real laboratory settings. It involves proper understanding of; laboratory rules, safety regulations, handling of chemicals and apparatus, experimental procedures, accurate measurement, titration, heating, preparation of standard solution, preparation of bench reagents as well as recording experimental procedures and results accurately. However, the teaching of laboratory techniques alone is incomplete without an effective assessment of students' laboratory work which provides evidence of how well learners apply these techniques in practice. Assessment goes beyond checking correctness of results; it also evaluates accuracy of procedures, adherence to safety standards, problem-solving ability and communication of findings. To be precise, a laboratory session is only complete when the teacher has assessed students' work and provided constructive feedback to guide their learning. Therefore, assessing students' laboratory work not only enhances their learning outcomes but also highlights the areas where teachers themselves may require further development, thereby pointing to the need for competency improvement.

Competency improvement needs are the gaps between the knowledge, skills, attitudes and behaviours teachers currently have and the competencies they need to perform their jobs effectively. Identifying these needs is a systematic process that guides targeted professional development so that teacher practice and ultimately student learning improves. In other words, competency improvement needs refer to the specific areas where teachers require additional knowledge, skills and retraining in order to perform effectively. Several studies have revealed that secondary school chemistry teachers often lack adequate competence in laboratory techniques. For example, Achimugu (2012) lamented that many chemistry teachers lacked the ability to effectively organize and conduct practical classes. The author further noted instances where candidates' volumetric analysis results could not be marked because the supervisors' recorded titres differed significantly from those of the students. Eya, Attah and Unmate (2020) reported that chemistry teachers are not competent in designing experiments, conducting practical sessions and evaluating students' practical work at the levels of affective and psychomotor domains. Chama (2019) reported that chemistry teachers lacked creativity and innovation in designing practical activities. According to Ode, Akpoghol and Gbue (2023), in-service chemistry teachers had low competency in the use of ms word, power point, multimedia applications, internet search engines and in creating models for simulation in chemistry lessons. A research study by Nwafor, Ezeanya and Muoneke (2023) indicated that chemistry teachers do not have competence in assessing student learning, providing feedback, as well as understanding child development and learning theories but they have competence in creating positive learning environments and differentiating instruction to meet the needs of all students. Again, Eze, Ugwu and Chukwuemeka (2025) reported that secondary school chemistry teachers needed capacity building in all aspects of laboratory management skills. Although previous studies have highlighted several challenges confronting chemistry teachers, such as inadequate competence in conducting practical classes, limited innovation and creativity in designing experiments and poor laboratory management skills, there is little attention on the specific competency improvement needs of chemistry teachers in laboratory techniques, which are crucial for effective delivery of practical chemistry. The present study therefore seeks to identify and address the competency improvement needs of secondary school chemistry teachers in laboratory techniques.

Research Questions

1. What are the competency improvement needs of chemistry teachers in laboratory techniques?
2. What are the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in volumetric analysis?
3. What are the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in qualitative analysis?

Hypotheses

H₀₁: There is no significant difference between the mean responses of Enugu examiners and Abia examiners on the competency improvement needs of chemistry teachers in laboratory techniques.



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

H₀₂: There is no significant difference between the mean responses of Enugu examiners and Abia examiners on the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in volumetric analysis

H₀₃: There is no significant difference between the mean responses of Enugu examiners and Abia examiners on the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in qualitative analysis.

Research Methodology

The study employed a descriptive survey design. The population comprised 240 WAEC chemistry (Paper 3) examiners from the 2021//2022 session in South East Nigeria. Abia and Enugu States were randomly sampled with one marking centre drawn from each. A total of 107 examiners (57 from Enugu and 50 from Abia) participated but only 100 questionnaires were returned (50 from Abia and 50 from Enugu). Data were collected using a validated questionnaire titled Competency Improvement Needs of Secondary School Chemistry Teachers in Laboratory Techniques. The instrument had two sections; demographic data (Section A) and competency improvement needs (Section B), measured on a four-point rating scale. Its reliability was confirmed with a Cronbach Alpha coefficient of 0.81. Two research assistants administered and retrieved the questionnaires. Data were analysed using mean and standard deviation while the null hypotheses were tested at .05 significance level with a t-test.

Presentation of Results

Research Question 1: What are the competency improvement needs of chemistry teachers in laboratory techniques?

Table 1: The Competency Improvement Needs of Chemistry Teachers in Laboratory Techniques.

S/N	Item	Abia Examiners		Enugu Examiners		Pooled Mean	Remarks
		Mean	SD	Mean	SD		
1.	Ability to prepare bench Reagents	3.48	0.65	3.60	0.57	3.54	VHN
2.	Ability to prepare percent solutions	3.56	0.76	3.72	0.67	3.64	VHN
3.	Ability to prepare indicators	3.28	0.67	3.60	0.57	3.44	HN
4.	Ability to dilute concentrated solutions	3.56	0.58	3.64	0.56	3.60	VHN
5.	Ability to set up titration apparatus	3.68	0.55	3.44	0.64	3.56	VHN
6.	Ability to prepare bulk acid solutions	3.64	0.69	3.20	0.70	3.42	HN
7.	Ability to prepare bulk alkaline	3.56	0.64	3.44	0.91	3.50	VHN
8.	Ability to prepare molar and standard solutions						



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

Data in table 1 reveal that Abia and Enugu examiners agree that chemistry teachers have a very high need for competency improvement in items 1, 2, 4,5, and 7 with pooled mean ratings of 3.54, 3.64,3.60, 3.56 and 3.50 respectively. Additionally, items 3,6 and 8 were rated as having a high need for improvement, with pooled mean ratings of 3.44, 3.42 and 3.30 respectively.

Research Question 2: What are the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in volumetric analysis?

Table 2: The Competency Improvement Needs of Chemistry Teachers in Developing Proper Marking Guides for Reported Practical Work in Volumetric Analysis.

S/N	Items	Abia Examiners		Enugu Examiners		Pooled Mean	Remark
		Mean	SD	Mean	SD		
1.	Practical in volumetric analysis is reported in a tabular form with a minimum of three sets of readings	3.56	0.64	3.32	0.74	3.44	HN
2.	Burette readings are recorded in the table.	3.08	0.70	3.36	0.69	3.22	HN
3.	Burette readings are recorded in two decimal places e.g 23.00, 18.00	3.36	0.48	3.36	0.94	3.36	HN
4.	Volume of pipette is clearly stated	3.52	0.65	3.52	0.76	352	VHN
5.	Answers to calculations involving molar concentrations and mass concentrations should be expressed in three significant figures e.g 24.5, 0.0245,2.45	3.64	0.48	3.40	0.76	352	VHN
6.	Average volume of acid used should be determined by averaging concordant titre values (i.e values that do not differ by more than = 0.20cm ³)	3.64	0.48	3.16	0.89	3.40	HN
7.	Spelling must be correct to score	3.44	0.76	3.20	0.81	3.32	HN
8.	Correct IUPAC names to score	3.24	0.77	3.08	0.75	316	HN
9.	Correct formula for cations and anions	3.24	0.72	3.44	0.64	3.34	HN
10.	Reaction equation must be balanced	3.44	0.64	3.56	0.76	3.50	VHN
11.	Correct symbols of elements to Score.	3.32	0.79	3.48	0.76	3.40	HN



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

Table 2 shows that chemistry teachers have a very high need for competency improvement needs in items 4, 5 and 10 with pooled mean ratings of 3.52, 3.52, and 3.50. Again, items 1, 2, 3, 6, 7, 8, 9, and 11 were rated as having a high need for improvement with pooled mean ratings of 3.44, 3.22 and 3.36, 3.40, 3.32, 3.32, 3.34 and 3.40 respectively.

Research Question 3: What are the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in qualitative analysis?

Table 3: The Competency Improvement Needs of Chemistry Teachers in Developing Proper Marking Guides for Reported Practical Work in Qualitative Analysis.

S/N	ITEMS	Abia Examiners		Enugu Examiners		Pooled Mean	Remarks
		Mean	SD	Mean	SD		
1.	Practical work in qualitative analysis is reported in a tabular form showing three columns for test observation and inference.	3.68	0.47	3.16	0.89	3.42	HN
2.	Correct colour observation is made Correct odour of gas is noted	3.04	0.67	3.56	0.76	3.30	HN
		3.24	0.82	3.48	0.65	3.36	HN
3.	Effervescence is observed.	3.56	0.50	3.56	0.64	3.56	VHN
4.	Distilled//deionised water is used to dissolve chemicals	2.92	0.57	3.32	0.84	3.20	HN
		2.92	0.99	3.04	0.78	2.98	HN
5.	Observation is made as reagents are added in drops and then in excess	3.32	0.74	3.32	0.94	3.32	HN
6.	Spelling must be correct to score	3.48	0.65	3.28	0.88	3.38	HN
7.	Charges on cations and anions must be correct e.g Cu ²⁺ , OH ⁻ , Cl ⁻ , O ²⁻ , Na ⁺ etc	3.28	0.67	3.32	1.13	3.30	HN
8.	Test must be correct for observation to score	3.20	0.64	3.16	0.93	3.18	HN



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

Results in table 3 indicate that Abia and Enugu examiners have a very high need for competency improvement in item 2 with a pooled mean of 3.56. Again, items 1,3,4,5,6,7,8,9, and 10 have high need of competency improvement with pooled mean ratings of 3.42, 3.36, 3.30,3.20, 2.98, 3.38, 3.32, 3.30 and 3.18.

HO₁: There is no significant difference between the mean responses of Enugu examiners and Abia examiners on the competency improvement needs of chemistry teachers in laboratory techniques

Table 4: T-test Showing the Mean Responses of Enugu Examiners and Abia Examiners on the Competency Improvement Needs of Chemistry Teachers in Laboratory Techniques.

Examiners	N	Mean	Std.	t-value	p-value	Remarks
Abia Examiners	50	3.4800	.35116	-0.460	0.647	NS
Enugu Examiners	50	3.5200	.50467			

Result in table 4 shows no significant difference between the mean responses of Enugu examiners and Abia examiners on the competency improvement needs of chemistry teachers in laboratory techniques with p-value 0.647 which is greater than .05 level of significance set for the study.

HO₂: There is no significant difference between the mean responses of Enugu examiners and Abia examiners on the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in volumetric analysis

Table 5: t-test Showing the Mean Responses of Enugu Teachers and Abia Teachers on the Competency Improvement Needs of Chemistry Teachers in Developing Proper Marking Guides for Reported Practical Work in Volumetric Analysis.

Examiners	N	Mean	Std.	t-value	p-value	Remark
Abia Examiners	50	3.4073	.40666	0.576	0.566	NS
Enugu Examiners	50	3.3527	.53251			

Table 5 indicates no significant difference between the mean responses of Abia examiners and Enugu examiners on the competency improvement needs of chemistry teachers in developing proper marking guides for reported practical work in volumetric analysis with p-value of 0.566 at .05 level of significance. The null hypothesis is not rejected.

Discussion of Findings

The findings reveal that secondary school chemistry teachers in Abia and Enugu States have considerable competency improvement needs in fundamental laboratory techniques. Specifically, very high needs were observed in the ability to; prepare bench reagents, prepare percent solutions, dilute concentrated solutions, set up titration apparatus and prepare bulk alkaline solutions. The high ratings suggest that teachers may be inadequately skilled in handling solution preparation and experimental setup, which are essential for guiding students effectively. High needs were also observed in preparing bulk acid solutions, preparing molar and standard solutions as well as preparing indicators. This implies that teachers may struggle with precision and accuracy in solution standardization, a skill that directly influences the reliability of students' laboratory results. This aligns with WAEC Chief Examiner's Report (2022) indicating that improper preparation of reagents contributes to students' errors during practical examinations.

Again, results showed high competency gaps in reporting practical work in volumetric analysis; stating the volume of pipette clearly and balancing reaction equations. Other areas of high need include; tabular reporting of results with three sets of readings, accurate recording of burette readings to two decimal places, proper use of significant figures in calculations, determining concordant titres, issues of spelling, correct use of IUPAC names and writing correct formulae and symbols. These results suggest that unless teachers are trained in these competencies, they may continue to transmit inadequate skills to students, thereby reinforcing the cycle of poor outcomes in volumetric analysis. This finding is consistent with the work of Eya, Attah and Unmate (2020) who found out that chemistry teachers do not have competence in evaluating chemistry practical at the levels of affective and psychomotor domains. It also aligns with Achumugu (2012) who lamented that many chemistry teachers lacked the ability to effectively organize and conduct practical classes. Further,



Assessment of Competency Improvement Needs in ... Eze, G. N. (2025)

a very high need was observed in making correct colour observations which is a crucial skill in identifying ions and detecting chemical changes during reactions, reporting results in tabular form, noting the correct odour of gases and observing effervescence. High needs were also recorded in proper use of distilled water to dissolve chemicals, making observations when reagents are added in drops or excess, correct spelling of terms, accuracy of charges on ions and ensuring that test, observation and inference align correctly. These findings are congruent with the report of Eze, Ugwu and Chukwuemeka (2025) which showed that chemistry teachers had poor laboratory management skills.

Conclusion

The study has shown that secondary school chemistry teachers in Abia and Enugu States have significant competency improvement needs in laboratory techniques and in assessment of students' report in practical work in both qualitative and volumetric analyses. These gaps reflect inadequacies in both pre-service preparation and in-service training, posing a challenge to effective teaching and assessment of chemistry practicals.

Recommendations

Based on the findings of this study, the following recommendations are made to address the competency improvement of secondary school teachers:

1. Targeted capacity building workshops; Ministries of Education and professional bodies such as Science Teachers Association of Nigeria (STAN) should organize regular workshops and refresher courses for chemistry teachers, focusing on laboratory techniques, qualitative analysis and volumetric analysis.
2. Teachers should be given opportunities for practical retraining in the preparation of reagents, standard and molar solutions, dilution techniques and titration setup to strengthen their laboratory management skills.
3. Training organized by professional bodies should emphasize the development and application of proper marking guides for practical chemistry. This will help teachers assess students' reports more accurately.

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