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Assessment of Basic Science Teachers' Competencies for the Implementation of Inquiry-based Science Education in North-East Nigeria

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Abstract:
The recommended approach for delivering science instruction in Nigerian classrooms at the basic level of education is the inquiry approach. It is assumed that the use of this approach will enable the teacher assist the learner to lay a concrete foundation in science education which will in due course bring about the much needed scientific and technological development the country is in dare need of. It is based on this recommendation that this study was carried out with the aim of assessing the conditions necessary for the implementation of Inquiry-based science education in North-east Nigeria. The study was carried out in Gombe, Taraba and Yobe states of Nigeria on 349 basic science teachers. The instrument for the study was a structured questionnaire containing 25 items, and developed by the researcher. Data obtained was analyzed by the use of regression .Result of the study revealed that basic science teachers are very much aware of inquiry- based science education, the classroom condition warrants the implementation of inquiry-based science education among others. It was recommended among others that basic science teachers especially the newly employed and should be encouraged to go for regular In-service training in other to maintain the standard at hand.

Keywords*: Inquiry approach, Teachers' competency, classroom condition and inquiry- based science education.*

1. Introduction

As a field of study concerned with producing a scientifically literate society, science education in Nigeria has been given priority in schools. Science education is presented to the learner at the basic level of education as Basic science which happens to be a core subject. These reformations are due to the need for a scientifically and technologically developed nation which could be achieved through the laying down of a solid foundation for science and technological literacy at the basic level of education as enshrined in the national policy on education (Federal Ministry of Education (FME) (2013). One of the objectives of teaching basic science is to enable the learner to develop interest in science (Nigerian Education Research and Development Council (NERDC), 2007). To achieve this and other objectives, the teacher need to use the inquiry approach in presenting instruction to the learner (NERDC 2007). However, the use of this approach in Nigeria as a developing nation needs competent teachers, adequate classroom condition and others for implementing the recommended inquiry-based approach for curriculum delivery.

Competence can be referred to the awareness of what is expected of you and the ability to perform or complete such expectations effectively. It is defined as an excellent capability that includes knowledge, skills, attitudes and experiences which has to be target category of profession of the educator (Milan, 2008). Other science educators (Biemans, Nieuwenhuis, Poell, Mulder, & Wesselink 2004); view competence as the integrated performance- oriented capability of a person to reach specific achievements. Teacher's competencies according to Vickstrom (2008) influence learners. In the same vain, Bhattacharayya, Volk, & Lumpe (2009); Smolleck, Zembal-Saul, & Yoder (2006) submitted that teacher's competencies are essential to increase learners science literacy which consist of meaningful understanding of the subject matter, knowledge of scientific fact and concepts, improvement of their skills and interest in science (Lee, Lewis, Adamson, Maerten – Rivers, & Secada, 2007). Competence in the teaching profession is made up of four professional roles that teachers have viz: interpersonal, pedagogical, and organizational and the role of an expert in subject matter and teaching methods (Ester, Harm, Hilde, Argen, Ida and Martin, 2012). The authors posited that teachers fulfill these professional roles in relation to four groups of actors in

education: working with students, other teachers, the school professional network and himself/herself. This implies that the teacher that meets these requirements could be considered to be competent.

Competency in teaching could also include the teachers' ability to create a conducive classroom condition that warrants effective interaction in the classroom which is necessary for the implementation of inquiry-based science education. According to Exline (2004) the classroom condition should be such that allows the following:

- Students view themselves as learners in the process of learning
- Students accept an "invitation to learn" and willingly engage in an exploration process.
- Students raise questions, propose explanations, and use observations.
- Students plan and carry out learning activities.
- Students communicate using a variety of methods.
- Students critique their learning practices

Going by Exlines' submission, there is the need to find out whether the Basic science teacher is capable of creating a classroom condition that can support the use of inquiry approach in delivering instruction because that is what the Nigerian education sector needs for the implementation of the inquiry-based science education.

Inquiry approach according to Omiko (2016) refer to the use of innovative teaching methods such as discovery, problem- solving, open-ended field trips and Laboratory methods among others when disseminating instruction during the teaching process. It is expected that the use of this approach could enable the science teacher to guide learners unto achieving the set objectives of learning basic science thereby attaining the much needed scientific literacy that may eventually bring about scientific and technological development to the nation. However, Omebe and Omiko (2015) observed that these suggested methods of teaching basic science have been utilized for several years by basic science teachers and yet students' result in the Basic Education Certificate Examination (BECE) has not been encouraging. The authors submitted that the current statistics on students' achievement in BECE Ebonyi state (2011-2013) tend to show that the teaching and learning of basic science at the basic level of education is still inadequate. This status could be attributed to the inappropriate use of inquiry approach by science teachers. It could be in line with this assertion that the federal ministry of education (FME), in collaboration with Japan International Cooperation Agency (JICA), organized an In-Service Education and Training (INSET) program on Strengthening Mathematics and Science Education (SMASE) in Nigeria. The program which has been going on since 2011 till date is aimed at assisting science teachers in developing skills that will enable them use the inquiry approach effectively so as to bring about inquiry- base science education in the classroom (NTI 2010).

Inquiry- base science education (IBSE) is an approach to teaching and learning science that comes from an understanding of how students learn, the nature of science inquiry, and focus on the basic concept to be learned, (Duchi, Heidi & Andrew 2007). The authors reiterated that the approach is based on the belief that it is important to ensure that learners truly understand what they are learning and not simply learn to repeat content and information. They submitted that rather than a superficial learning process in which motivation is based on the satisfaction of being rewarded, IBSE goes deeper and motivation comes from the satisfaction of having learned and understood something. This implies that IBSE is not all about quantities of information memorized, but ideas or concepts leading to understanding that grows deeper and deeper as the learner gets older. This in turn enable the learner to develop intellectual competencies in the form of independent learning, problem – solving, decision making, and critical thinking National Research Council (NRC) (2011).

To achieve the assertion above, Schraw, Crippen & Hartlely (2006) outlined the following critical areas that need to be looked into:- Inquiry base approach, collaborative support, strategies for instruction to improve problem solving and critical thinking strategies for helping students to construct mental models and experience conceptual change, the use of technology and the impact on students and teachers beliefs. A close look at the Nigerian basic science curriculum shows the inclusion of the various critical areas stated above by Schraw, Crippen & Hartlely, indicating that science teachers are aware of what is expected of them as submitted by Hamza and Nkopodi (2014). The authors opined that the ideas purported by Schraw, Crippen & Hartlely are not new among science teachers, yet the much desired change anticipated at school level has been low. This condition is also experienced in Taraba state north – east, Nigeria where the percentage pass at credit level in the years 2011, 2012 and 2013 has been below 50% Taraba State Resource Centre (TSRC) (2017). This could be attributed to the way science instruction is presented to the learner, Kyle, 2006, Onwu & Kyle (2011). Science was presented to the learner from the perspective of normal logical positivism with more emphasis on the mastery of abstract concepts, principles and little connection with day to day life experience of the learner(Kyle, 2006, Onwu & Kyle, 2011).

The effective use of IBSE at the basic education level could enhance learners' understanding of natural phenomena thereby making science real and part of the learners' life, which happens to be what the twenty first century learning is advocating for (Koay 2013). There also seems to be a consensus among researchers in science education that in order to foster learners' high-level thinking, teachers need to possess not only an in-depth content knowledge, but also a good pedagogical knowledge on how to develop learners' high-order thinking in the content of the subject matter they are handling (Madu 2013, Lederman, Bartos, Berles, Mayer and Schwartz 2014). The FME is also aware of this need that is why the Strengthening of Mathematics and Science Education- In-Service Education Training (SMASE-INSET) program has been on for the past six years in Nigeria with the hope of equipping Science and Mathematics teachers with the much needed skills that will enable them implement IBSE effectively. Apart from assisting the teacher to achieve the set objectives of the curriculum, effective use of IBSE also allow learners to explore, explain scientific phenomenon, generate research questions, conduct investigations,

generate their own conclusions and communicate with peers in compliance with reform initiatives (NRC 2012). However, despite all the reform initiatives and limited empirical data documenting the reality of teachers' implementing IBSE in the classroom so far majority of teachers according to Capps & Crawford (2012) have been found to hold uninformed or naïve conceptions of the nature of science and what constitutes scientific inquiry and its process. . It is in the quest to find out whether this assertion holds true for Basic science teachers in North-East Nigeria that this research was carried out to ascertain their competencies in the implementation of IBSE.

The framework of this research, was the social constructivist theory (Vigotsky, 1978). Social constructivist believe that knowledge is subjective and can only be constructed through social interaction and through the ability to identify oneself mentally with and so understand a person, or thing. Regarding the implementation of inquiry base science education in the science classroom, it is important to consider how teachers' understanding of inquiry have developed as a result of the social context in the classroom. For instance in the process of teaching and learning, learners develop patterns of belief, constructing knowledge in ways they are more familiar with which could be useful to them. Lederman (1999) posit that since the construction process is influenced by a variety of social experiences, the knowledge constructed by learners tends not to be completely personal. Ledermans' view shows that the social constructivist perspective is well situated for studying the science teachers' competency in implementing inquiry base science education in classroom. With regards to this study, the researcher collected and analyzed quantitative and qualitative data with the aim of providing information on the competencies of basic science teachers on Implementation of inquiry base science education in Taraba state of Nigeria.

1.1. Problem of the Study

Going by the content of the basic science curriculum, Science teachers are expected to use the inquiry approach in delivering classroom instruction. It is assumed by so doing, the aim and objectives of teaching and learning science could be achieved. However, the turnout of senior secondary science students in Taraba State is not encouraging. In view of this there appears to be the problem of ineffective use of inquiry approach by basic science teachers. The problem of this study is therefore to assess basic science teachers' competencies in the implementation of inquiry base science education in Taraba State.

1.2. Purpose of Study

The main purpose of this study was to assess basic science teachers' competencies towards the implementation of inquiry based science education in Taraba State, Nigeria. Specifically the study intends to find out;

i. The extent to which basic science teachers' awareness of inquiry-based science education and classroom condition influence teachers' competency in implementing IBSE?
ii. The individual contributions of teachers' awareness and classroom condition on science teachers' capability of implementing IBSE?
iii. The influence of gender on teachers' competencies in implementing IBSE

1.3. Research Question

i. To what extent does basic science teachers' awareness of inquiry-based science education and classroom condition influence teachers' competencies in implementing IBSE in basic science classroom?
ii. What are the individual contributions of teachers' awareness and classroom condition on basic science teachers' competencies of implementing IBSE?

2. Methodology

The study employed descriptive survey research design. The population of the study consist of all basic science teachers in North- East region of Nigeria. A Purposive random sampling technique was used to draw sample from each of the educational zones in the state. The number of basic science teachers within the study area was about 2500 out of which 349 teachers were sampled from Taraba, Gombe and Yobe states for the study. The instrument for the study a structured questionnaire containing 25 items was developed by the researchers. The questionnaire was made up of 2 sections – section A contains information on respondents' demographic data while section B contains leading questions on teachers' capability in implementing inquiry base science education as well as classroom conditions for the implementation of inquiry-based science education at primary level of education. The items in this section were formulated on a four point rating scale of very high competence (4- points), high competence (3-points), medium competence (3- points) and low competence (1- point). The instrument was validated by 2 experts in science education, from Teachers Registration Council of Nigeria (TRCN) and Science Education department Taraba State University respectively. The instrument was also trial tested in North-Central zone of the country. Using Cronbach's alpha of internal coefficient the reliability of the instrument was found to be 0.65. Copies of the instrument were administered to basic science teachers under study after permission to do so was fully granted by appropriate personnel. Data collected were analyzed using regression analysis.

3. Result

- Research Question 1: To what extent does basic science teachers' awareness of inquiry-based science education and classroom condition influence teachers' competency in implementing inquiry-based science education?

In order to answer the above research question1, a multiple regression analysis was used where scores of the science teachers' idea of IBSE and classroom conditions of inquiry-based science constitute the independent variables while science teachers' capability of implementing IBSE represents the dependent variable.

		R = 0.700			
		R^2 = 0.49			
		Adjusted R^2= 0.483			
Standard error of the estimate = 0.59357					
Source of variance	**Sum of squares**	**Df**	**Mean square**	**F**	**p-value**
Regression	49.435	2	24.718	70.156	0.000*
Residual	51.439	51.439	0.352		
Total	100.875	100.875			

Table 1: Summary of regression analysis of the combined effect of the variables on the science teachers' capability of implementing IBSE
** Significant p<0.05*

Table 1 shows that, there is a positive multiple correlations among the science teachers' idea and classroom conditions for inquiry-based science education on science teachers' capability of implementing IBSE (R = 0.700). The table also reveals that R^2 value is 0.49 while the adjusted R^2 value is 0.483, which signifies that 49.0 % of the total variance of science teachers' capability of implementing science IBSE is due to these two factors and the remaining 51.0 % are due to other factors not investigated in this study.

The table also shows that, the R-value of 0.700 is significant (F= 70.156; p<0.05).This implies that, the R-value is not due to chance. These results show that, there is a combined effect of the science teachers' idea of inquiry-based science education and classroom conditions on the basic science teachers' capability of implementing Inquiry Based-Science Education. Therefore, the two variables predict the science teachers' capability of implementing IBSE. For science teachers to implement the IBSE, they must have a good knowledge of IBSE and good classroom conditions for its implementation.

- Research Question 2: What are the individual contributions of teachers' awareness and classroom condition on science teachers' capability of implementing IBSE?

IBSE factors	**B**	**Std Error**	**Beta**	**T**	**P-value**
(Constant)	0.283	0.189.		1.493	0.138
Science Teachers' idea	0.524	0.100	0.412	5.264	0.000*
Classroom conditions	0.394	0.086	0.357	4.567	0.000*

Table 2: Relative effect of IBSE factors on science teachers' capability of implementing IBSE
** Significant, p<0.05*

Table 2 reveals the relative contribution of the two independent variables on the dependent variable. Individually, both the science teachers' idea and classroom conditions contribute significantly to the science teachers' capability of implementing IBSE (p<0.05). However, science teachers' idea makes the greatest individual contribution to the capability of the science teachers in implementing IBSE (B=0.524, t=5.264, p<0.05).Classroom condition of inquiry-based science make the other significant condition {B=0.394, t=4.567, p<0.05). This means that, both the science teachers' idea of IBSE and classroom conditions of inquiry-based science collectively influenced teachers' capability of implementing IBSE. Individually, each is also a moderator of science teachers' capability of implementation of IBSE.

4. Discussion

The result of this study showed that the combined effects of teachers' view on inquiry approach and classroom condition predicts basic science teachers' competency in the implementation of inquiry base-science education in the study area. The result also revealed that each of the factors (i.e. teachers' idea and classroom condition) moderates the teachers' capability of implementing inquiry base science education.

Implying that the teachers have good knowledge of inquiry approach to teaching basic science. This finding is in line with the submission of Hamza & Nkopodi (2014) in which the authors stated that the Nigerian science teachers are aware of the use inquiry approach to teaching science. The result of this study showed a diversion from the opinions of Kyle (2006), Onwu & Kyle (2011) in which the authors opined that science is still been taught from the perspective of normal logical positivism with more emphasis on the mastery of abstract concepts and principles and life experience of the learner. The BECE 2016 (TSRC) basic science result with over 80% pass at credit level showed a remarkable improvement on learners' performance.

Insinuating that the teachers have an in-depth content knowledge as well as a good pedagogical knowledge on helping learners develop high- order thinking skills in the content of the subject matter as presented by (Madu, 2013; Lederman, Bartos, Berles, Mayer & Schwart, 2014). It can also be deduced from the findings of the study that the effort of the FME towards strengthening mathematics and science education in the country through the SMASE-INSET programme is beginning to yield encouraging result.

5. Conclusion

Based on the analyzed data it was concluded that basic science teachers in North-East Nigeria could be capable of implementing Inquiry base science education in science classrooms since the study revealed that the teachers have good knowledge of inquiry approach and an in-depth content knowledge as well as good pedagogical knowledge of helping leaners develop high – order thinking skills in the content of the subject matter.

6. Recommendation

Regular INSET for basic science teachers to maintain standard.
Regular supervision of basic science teachers to ensure the effective use of inquiry approach

7. References

i. BECE (2011). Basic education certificate examination result in basic science. Taraba State educational resource center (TSRC).
ii. BECE (2012). Basic education certificate examination result in basic science. Taraba State educational resource center (TSRC).
iii. BECE (2013). Basic education certificate examination result in basic science. Taraba State educational resource center (TSRC).
iv. BECE (2016). Basic education certificate examination result in basic science. Taraba State educational resource center (TSRC).
v. Bhattacharayya, S., Volk, T., & Lumpe, A. (2009). The influence of an extensive inquiry-based field experience on pre-service elementary student teachers' science teaching beliefs. *Journal of Science Teacher Education*, 20,199 – 218.
vi. Biemans, H., Nieuwenhuis, L., Poell, R., Mulder, M., & Wesselink, R. (2004). Competence-based VET in the Netherlands: Backgrounds and pitfalls. *Journal of Vocational Education and Training,* 56,523 – 538.
vii. Capps, K., Crowford, B. A. (2012). Inquiry based instruction and teaching about nature of science. Are they happening? *Journal of science teacher education. Springer.*
viii. Dusch, R., Heidi, S. & Andrew S. (2007). Taking science to school: learning & teaching science in grade k-8. Washington DC. The national academies press
ix. Ester A.T; Harm J.A.B.; Argen, E.J.W, Ida, O. & Martin, M. (2012). Inquiry-based science education. Competencies of Primary school teachers: a literature study and critical review of American national science education standards. *International journal of science education 34 (17). Pp 2609-2640.*
x. Exline Joe (2004). Inquiry-based learning. classroom.www.thirteen.org/edonline/concept2class/inquiry/index-sub2.html
xi. Federal republic of Nigeria (FRN, 2013). National policy on Education (4th edition). NERDC.
xii. Hamza, O. M and Nkopodi, N. (2014). Inquiry – based teaching in physical science: teachers' instructional practices and conceptions. *Mediterranean Journal of social sciences 5(23), MCSER publishing, Rome, Italy 1074-1082.*
xiii. Koay Suan See (2013). 21st century learning. Handout for third country training program, SEAMEO RECSAM, Penang, Malaysia.
xiv. Lee, O., Lewis, S., Adamson, K., Maerten-Rivera, J., & Secada, W.G. (2007). Urban elementary school teachers' knowledge and practices in teaching science to English language learners. *Science Education,92,* 733 – 758.
xv. Lederman, J.S.; Lederman, N. G.; Banjos, S.A.; Barles, S. L. ; Mayer, A. A.; Schwartz, R.S. (2014). Meaningful assessment of learners' understanding about scientific inquiry. The views about scientific inquiry (VASI) questionnaire. *Journal of research in science teaching 51(1) 65-83.*
xvi. Madu, A. V. (2013). Teaching difficulties from interaction in discourse in a science classroom. *Journal of science education & social research 3(3), 113.*
xvii. Milan Slavick (2008). Teacher's competencies https://www.slideshave.net
xviii. Mulder, M. (2001). Competentieontwikkeling in organisaties. Perspectieven en praktijk. [Competence development in organisations. Perspectives and practises]. 's-Gravenhage: Elsevier Bedrijfsinformatie.
xix. National research council, (2011). A framework for k-12 science education: practices, crosscutting concepts, and core ideas. . Washington DC: The national press.
xx. National research council, (2012). A framework for k-12 science education: practices, crosscutting concepts, and core ideas. Washington DC: The national academies press.
xxi. NERDC (2007). *Basic science curriculum* Federal Ministry of Education Nigeria.

xxii. Omebe, C. A. and Omiko, A. (2015). Effects of instructional resources on students' achievement in secondary schools in Ebonyi state, Nigeria. Journal of the Science Teachers' Association of Nigeria (JSTAN). 50(1)174-183.

xxiii. Omiko Akani (2016). An evaluation of classroom experience of basic science teachers in secondary schools in Ebonyi state of Nigeria. *British journal of education 4(11) 64-76.*

xxiv. Otuka, J.O.E. (2004). *Foundation of Science education*. National Open University of Nigeria. Macmillan.

xxv. SMASE- INSET Nigeria, (2010). Handout notes on strengthening mathematics and science education and in-service education and training in Nigeria. FME/NTI/JICA.

xxvi. Smolleck, L.D., Zembal-Saul, C., & Yoder, E.P. (2006). The development and validation of an instrument to measure pre-service teachers' self-efficacy in regard to the teaching of science as inquiry. *Journal of Science Teacher Education*, 17,137– 163.

xxvii. Schraw, G., Crippen, K. J, & Hartley, K. (2006). Promoting self-regulation in science: Metacognition as part of a broader perspective on learning. *Journal of research in science education, 36(1-2), 111-139.*

xxviii. Schwartz, R. & Lederman, N. (2008). What scientist say: scientist view of nature of science in relation to science context. *International journal of science education, 30 (6), 727-771.*

xxix. Vigotsky (1978). Mind in society, London. Harvard University.

xxx. Vikstrom, A. (2008). What is intended, what is realized, and what is learned? Teaching and learning biology in the primary school classroom. *Journal of Science Teacher Education,*19, 211 – 233.