Professional Development for Biology Teachers on Inquiry-Based Teaching Method in Nigeria

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Abstract- ***The paper examined professional development of biology teachers on inquiry teaching method in Nigeria. The paper examined what inquiry-based teaching is all about, that is a teaching strategy which is learner-centered and focuses on investigation of phenomena rather than mastery of content as the traditional approach. This paper also highlighted how biology teachers can be professionally trained through continuous specialized inquiry-based method. The current methods biology teachers use in teaching was also examining which include: transmission of information to the learners, emphasis on knowledge rather than process and attitude. Suggestions were proffered on how to develop an effective professional development progamme that will be responsive to a wide range of teachers and one that will have a longer impact on the teachers. This paper enumerated some benefits of inquiry-based teaching which includes: collaboration and team work among learners. The challenges often associated with inquiry teaching were considered, particularly the intensive and expensive nature of the method. This paper was concluded by looking at the nature of inquiry teaching and recommendations were made for future consideration.***

Indexed Terms- ***Professional Development, Inquiry Teaching Method.***

I. INTRODUCTION

Science education is tailored toward the scientific literacy of the learners in the application of scientific knowledge to everyday life, how they apply knowledge gained in a science classroom to everyday life challenges. Like managing health challenges, good hygiene and so on. An important aspect of science education is for it to be functional, preparing the individual for life and reforming the life of the community for relevance, thereby experiencing the richness and excitement of knowing natural world and the process of increasing their economic productivity through the use of knowledge, understanding and skills of the scientifically literate person in their careers, National Science Education Standard (NSES, 1996:13). Science education that is perceived as satisfactory must be able to transform an individual from a position of fewer resources to a position of abundance through innovation and application of skills acquired through process of learning, especially of science and technology education. However, students graduate from schools without sufficient thinking skills to connect and ask questions. Learners need to think creatively and have understanding of system connection, patterns and root causes of event (Orr 1992; Yager, 2013).

Science is a body of knowledge obtained through multifaceted procedures such as observation and analysis of events or phenomena that involves control in order to draw interferences. Dobson (1993) describes science as an ordered collection of facts, principles, techniques and methods for knowledge construction. While science education is the organized structured science content, process and product taught to learners in the school for the purpose of acquiring process skills needed to solve problems encountered in everyday life (Umoeduagu, 2009).

- Concept Of Inquiry Teaching Method

Following the revolution in science education, mainly in the United States of America around the early 1960s, it was agreed by National Research Council (NRC, 1996) that teaching of science must be modeled in the way science makes discoveries. This led to the concept of discovery-based learning which later emerged as inquiry-based learning (Khan & Iqbal, 2011). In Nigeria secondary schools there

seems to be less emphasis on inquiry teaching method, particularly for learning biology. Except the objectives of pre-primary school in Nigeria as stated in the National Policy on Education (FRN,2012) states that pupils be inculcated the spirit of inquiry and creativity as they explore their environment. Inquiry had been considered as an effective method of engaging students in real-world experiences, in other to explore the world, learners need to adopt the inquiry method of learning to investigate the world (Johnson & Adams, 2011).

What is inquiry teaching method? Vlassi and Karaliota (2013) described inquiry teaching method as an intentional process of diagnosing problems, critiquing experiments and distinguishing, alternatives, planning investigations, researching conjectures, searching for information, constructing models with peers and forming coherent arguments. While National Research Council (NRC, 2012) defines inquiring Teaching as a multifaceted activity that involves making observation; posing questions; and other sources of information to see what is already known, planning investigations, reviewing what is already known in light of experimental evidence.

Inquiring in science means active involvement of the learner in the discovery of information through investigations instead of the application of procedural knowledge. To investigate the World, inquiry skills are important because they must be applied in the process. Hanauer, Hatful and Jacobs-Serah (2009) went further to describe scientific inquiry as a rhetorical form designed to manipulate results in order to provide specific, historically define answer, and in agreement to this assertion, Kelly & Ho (2010) show how teachers manipulate the actual classroom demonstrations so that they conform to the accepted position or how they are supposed to be performed. To them, scientific investigation is manipulating processes to agree with known knowledge, which gives no room for critical thinking, explorations of ideas and procedures. However, scientific inquiring involves investigating phenomena to come up with personal experience, and new knowledge.

Rutherford (2006) differentiated inquiry content from using the method of science inquiry to learning science which he calls inquiry "technique" and he was more specific to state that: It is scientific inquiry we are concerned with, not inquiry in the general otherwise all that is intended by the inquiry method is that we encourage students to be inquisitive, curious, ask questions and try to find answers for themselves. These attributes describe the spirit of inquiry and is consistent with the science education program. Author like Piaget (1969) had used terms such as "divergent thinking", "creativity", "discovery" "scientific method", "the inductive method", the child-centered method" and problem-solving to mean inquiry. Inquiry in science is similar to terms such as discovery, problem solving, and scientific method. This view is consistent with the constructivist theory of learning, which involves active learning and question-driven. It is learner-centered, and the teacher is a facilitator. Inquiry method is a blend of the works of Jean Piaget, Lev Vygotsky, and David Ausubel, with the nature of learning and teaching known as constructivism. The constructivist approach emphasizes the construction of knowledge through active thinking, and the integration of existing knowledge. Teachers need specific inquiry-based science teaching competencies to support and facilitate students' learning (Kirschner, Schweller, & Clark, 2010).

The principles of inquiry method as outlined by NSES (NRC) (2012), includes: (1) Learners are engage in activities in order to reveal their prior knowledge (2) learners are engage in scientifically oriented questions (3) learners gives priority to evidence in responding to questions (4) learners are required to give explanations from evidence (5) learners formulate explanations from evidence (6) learners connects explanations to scientific knowledge (authority like textbooks) (7) learners communicates and justifies their explanations. Inquiry teaching method is being viewed from two perspectives: firstly, as what students should understand about scientific inquiry and the abilities learners develop based on their experiences with scientific inquiry. Secondly, as a teaching strategies which is associated with science activities.

The excellent benefits of inquiry teaching method is yet to be experience by biology students in our senior secondary as reported by Owolabi (2012); Caps and

Crawford (2012) due to lack of laboratory equipment and teachers' incomplete knowledge of inquiry method. Therefore, this paper is aim at examining the need for biology teachers to be trained on inquiry teaching method in order to equip them to teach biology using the inquiry process.

- Features of an Inquiry Class

According to National Research Council (NRC) (2012) inquiry features are those attributes that characterized the inquiry learning environment. Inquiry teaching method is described as a student-centered method, where learners take charge of their learning. Under inquiry method, learners identified questions and work to find answers to those questions. The features of inquiry method can also be seen as indicators that shows that inquiry learning is taking place in a particular learning environment. For example: (1) Learners engages in activities in order to reveal their prior knowledge (2) learners engages in scientifically oriented questions (3) learners gives priority to evidence in responding to questions (4) learners are required to give explanations from evidence (5) learners formulate explanations from evidence (6) learners connects explanations to scientific knowledge (authorities like textbooks) (7) learners communicates and justifies their explanations (Brunsell, 2010. They used the inquiry features rating the teachers' implementation of the inquiry method. To support that, Bodzin and Beerer (2003) adopted the inquiry features from NRC (1996) to assessed teachers' inquiry lessons. The rating were: 1= No inquiry at all; 2 = Fair; 3 = Good; 4 = Best. The authors reported that teachers were unable to implement effectively inquiry features in the classrooms because most of them did not do inquiry during their training

- Teachers' Roles In An Inquiry Class

Teachers' roles in an inquiry classrooms differ from those teachers in a conventional classroom. The teachers' roles are numerous and important. Instead of providing direct instructions to the learners, the teacher helps the learners to generate their own questions and at the same time help them by guiding through the investigation process. Teachers also perform several roles in a classroom to ensure that learning takes place unhindered and this include the classroom must be learner-centered. In addition, the teacher also perform the following roles: (1) encourager (2) facilitator (3) an advocate for the learners (4) creating conducive learning (5) Provides feedback to learners (6) provision of resources. According to Yussif (2022) the teacher is an encourager to the learner. The teacher encourages learners through creating conducive and supportive learning environment for all learners. An environment, where learners feel comfortable to ask questions and share their ideas. The teachers also encourage the learners to participate in class discussion and activities. That this allow learners to feel involved in the classroom and learn from the teacher. They also provide opportunities for all learners to participate, not just those who are vocal or have strong opinions. But, also those who are not. Additionally, they encourage learners to actively engage their learning process and to take ownership of their education and this involves creating an environment in which the learners feel free to ask questions, raise concerns and participate in the learning process which enhances achievements and development.

Yussif (2022) went further to state that teachers provides feedback to the learners on their academic performance and encourages them to continue learning. They provide instructions that are relevant to the interest of the learner, help learners to develop critical thinking skills, problem solving skills, team work spirits, so that they can work in groups and achieve common goals, promote sense of community, encourage learner to be able to resolve their own conflicts, promote a positive learning environment, and help learners to communicate their learning discoveries. Furthermore, teachers are a source of resource for students in the classrooms. Part of the roles include: provision of resources like textbook, reference materials, and online materials. They play the role of defense, providing support and guidance when needed. They Provide opportunities for students to participate in class in discussion and activities. Teacher also provide guidance, and support so that learners can develop skills and knowledge independently. In this way learners become life-long learners.

- Teachers' Effective Ways to Implement Inquiry Method

Yussif (2022) suggest that teachers can implement inquiry method in the classroom by (1) creating a climate of respect in the classroom. The teacher should create an environment in which learners feel safe and accepted, and where they know that they can express their opinions and ideas without fear of being punished for wrong answers. (2) Establish rules and guidelines early in a term and enforce the rules consistently, to make sure that no learner breaks the rules in order to maintain discipline in the classroom. (3) Teachers should encourage learners to take ownership of their own learning by providing opportunities for the learners to demonstrate their understanding by completing home-works and assignments. (4) Encourage creativity and innovation among the learners by given them free hand to ask their questions and find solutions to those their questions. (5) Encourage learners experiment with new approaches to learning and problem-solving and be encouraged to share their experiences with their classmates (6) Emphasize the importance of collaboration and teamwork among learners, and help the learners to ask questions and help when needed, and to teach learners critical thinking skills and to serve as facilitators during learners-led discussions and debates (Yussif, 2022). Kampa & Vilina, (2015) stated that the roles of learners in an inquiry classroom is that of asking questions such as: what do I already know? What do I want to know?; What have I learned.

- Students' Learning Of Inquiry Teaching Method

Inquiry teaching method for students is a process that involves open-ended investigations into questions or a problem, requiring the students to engage in evidence-based reasoning and creative problem-solving as well as problem-finding. With inquiry learning, students engage in learning by drawing upon their prior knowledge and experiences. It uses the student's prior knowledge "as building blocks to integrate new understanding with prior learning" (Lemlech, 1988; Kayikci, 2009). There is a general consensus in the literature regarding the positive impact of constructivist approaches on student disposition (Burris & Garton, 2007). In this constructivist learning method, the learner takes charge of his learning experiences, construct his learning and such learning can be retained. Herman & Knobloch, (2004) found that the constructivist approach increases students' affective and cognitive outcomes. Similarly, students are motivated by inquiry learning, not only because students are actively involved in the process but because the expectation of finding the answer motivates the search for it. Inquiry teaching method involves students' exploration of theory, building and experimentation. It encourages active thinking rather than rote learning (Herman & Knobloch, 2004).

- Biology Teacher's Current Teaching Practices

In recent years, science education and science curriculum developers have urged that students be actively involved in the inquiry process. However, literature reports have continued to reveal that science is being taught using the traditional approach. The traditional approach, the teacher transmits information to the learners; the emphasis of such learning is mastery of content, with less emphasis on the development of skills and nurturing of inquiry attitudes. The approach is teacher centered, with the teacher focusing on giving out information. The method focus more on learning about things while inquiry-based focus on learning things, students are not being encouraged to initiate their own inquiry (Kadroon, 2013). Consequently, Brunsell (2010) stated that teaching science through inquiry is important, but using inquiry approach to teaching biology is not the norm in schools because many teachers are still building shared understanding of what inquiry method means, and what it looks like. This means that teachers' knowledge of inquiry method is incomplete as stated by Capps and Crawford (2012).

- Professional Development For Biology Teachers

Teachers' professional development involves a systematic training given to teachers to bring about change in the classroom practices of teachers, their attitudes and beliefs, and learning outcomes of students (Darling-Hammond, Wei, Andree, Richardson, and Orphanos, 2009). Meeting the demands of learning biology, especially senior secondary schools in Nigeria as demanded by the

national policy on education (FRN, 2012), there is the need for a common consensus for the quality of teachers that teach biology. The teachers must have content knowledge of science, as well as the pedagogical knowledge. One of the ways to achieve that goal, according to Quint (2011) is through professional development programmes on inquiry teaching method. Professional development programmes are formal in-service training, often delivered by outside experts to upgrade the content knowledge and pedagogical skills of the teachers. Most pre-service teachers often times are not grounded in content knowledge and instructions strategies for science. Therefore, researchers have emphasized the need to expose the teachers to training. That such training programmes should focus on content knowledge, active learning, support collaboration, provides coaching and expert support, offers feedback and reflection and should also be of a sustained duration (Darling-Hammond, Hyler & Gardener, 2017).

Professional development programmes that can enhance teachers' instructions of biology, should be for many hours as 50-80 hours of instruction, practice and coaching before the new strategy is mastered (Blazer, 2005). Researchers revealed that teachers who received 80 hours of training or more of training were significantly more likely to use the teaching practice based on what they learned, than teachers who had less than 80 hours of training. Teachers' inquiry practices and beliefs need change for effective teaching and learning of science classrooms. Changing teachers' practice and beliefs will improve students' learning of biology through inquiry method. Teachers' practice of inquiry instruction is depended on their beliefs of the efficacy to implement the method in the classrooms. Due to teacher efficacy, a lot of restrictions are being experienced by the teachers such as lack of inquiry materials, knowledge dependence, and classroom management. Silm, Tiitsaar, Pedaste, Zacharia and Papaevripidou (2015) mentioned that high level of teacher efficacy is more positive toward inquiry teaching method. Furthermore, Darling-Hammond, Wei, Andree, Richardson, and Orphanos, (2009) examined nine different experimental research studies of teacher training programmes, they reported that training teachers on inquiry method for longer duration were positively associated with teachers' change and improvements in student learning.Professional development programme time must therefore, be dedicated to support teachers during implementation stage. Support at this stage helps teachers to navigate the frustration that comes from using a new instructional method. Studies also found that when teachers are supported during this phase, they change their teaching practices (Darling-Hammond, Hyler & Gardener, 2017). The authors went further to state that there are always significant differences between teachers who attended just a workshop and teachers who attended workshops and coaching. The researcher revealed that coached teachers could transfer the newly learned teaching practice, better than teachers who only had the workshop. Teachers who only had the workshop quickly lost interest in the skill and did not continue to use it in their classrooms. Again, Knight and Cornett (2009) found that those who had coaching along with an introductory workshop were significantly more likely to use the new teaching practice in their classes than those who were only exposed to the workshop. Modeling has been found to be highly effective in helping teachers understand a new practice. Expert can demonstrates such a practice particularly the one that has been found to be successful, in helping teachers to understand and apply the new practice and remain open to adopting it (Penuel, Fishman,Yamguchi & Gallanger, 2007). For example, instead of hearing about inquiry teaching in science, a master teacher might teach a science class using inquiry methodology while being observed by the teacher who is learning the skill. The current study is situated in this context.

- Challenges of Professional development

Although professional development is crucial in helping teachers to develop inquiry teaching method, the process is not devoid of challenges. The major challenges of professional development programme are that, it is intensive, expensive and difficult to sustain (Crawford, 2007). Also, such programmes typically reach a small percentage of the teachers who could benefit from the professional development learning experiences. In addition, the coherence that is so valuable in professional development programmes can be a problem if it is so preplanned that cannot be responsive to the varying needs of

teachers at different stages of the professional development. Another challenge of professional development as noted in literature is that even the sustained programmes do not last more than 2-3 years. The impact of the programmes are short live (Owolabi, 2012)., because there are no mechanism for providing teachers with ongoing support and moreover, the programmes are not embedded in school programmes and it is difficult to ensure that teachers are supported in implementing the ideas and practices they have learned.

CONCLUSION

In light of the facts discussed in this paper the author has concluded that teachers are important figures in inquiry teaching method. Therefore, biology teachers' professional development on inquiry teaching method is imperative because of the importance of inquiry teaching method in the lives of the learners. Researchers have reported that teachers have insufficient knowledge of inquiry method and seminars are piece-meal, fragmented, and of short duration; unable to make the desired impact on the teachers. So, they are unable to build capacity on inquiry teaching method consequently, cannot implement inquiry teaching in the classroom (Crawford, 2007). Hence the need for this paper to bridge the gap that exist in the incomplete knowledge of teachers on inquiry method.

RECOMMENDATIONS

Having critically examined the need for professional development of biology teachers, on inquiry teaching method, the following recommendations were made:

1. Comprehensive professional development programmes should be designed to last at least 8weeks, to offer biology teachers basic knowledge of the nature of inquiry teaching method.
2. Short time workshops in inquiry teaching method that do not have much impact should be replaced with in-service training programmes.
3. Supervision, evaluation and monitoring of the trained teachers should be carried out 8weeks after the training to ensure sustainability.
4. Support and coaching should be provided to teachers at the point of implementing inquiry teaching method.

REFERENCES

[1] Blazer, C. (2005). *Literature review on professional development for teachers.* Retrieved March 2, 2013, from drs. dadeschools.net reports-prof.

[2] Burris, S. & Garton, B. I. (2007). Effect of instructional strategy on critical thinking and content knowledge: using problem-based learning in the secondary classroom. *Journal of agriculture education, 48(1), 106-116. Doi: 10:5032/jae, 2009.01106*.

[3] Brunsell, E. (2010). *The five features of science inquiry: How do you know*? George Lucas Educational Foundation. Retrieved May 6th, 2023 from eutopia.org

[4] Capps, D. K. Crawford, B. A. (2012). Inquiry-based instruction and teaching about nature of science: Are they happening? *Journal of Science Teacher Education, 1,30.* Retrieved November 21, 2011 from www.researchgate.net

[5] Crawford, B. A. (2007). Learning to teach science as inquiry in the rough and tumble of practice. *Journal of Research in Science Teaching, 44 (4), 613-642*

[6] Darling- Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the united states and abroad.* Dallas, TX. National Staff Development Council. Retrieved August 5, 2016, from http://learningforward.org.

[7] Darling-Hammond, L., Hyler, M. E., & Gardener, M. (2017). *Effective teacher professional development.* Palo Alto, CA: Learning Policy institute org. Retrieved December 2, 2015, from www.sagepub.com

[8] Dobson, K. S. & Pusch, D. (1993). Towards the definition of science

[9] Federal Republic of Nigeria (2012). *National policy on education* (6th Ed.) Lagos: NERDC

[10] Hanuer, D. I., Hatful, F. G., & Jacobs-Serah, D. (2009). *Active assessment: Assessing scientific inquiry*: *Mentoring in academia and industry.* Retrieved April 20, 2015, from link.springer.com/book/10.1007/978-0-387-89649-6

[11] Herman, J. M. & Knobloch, N. A. (2004). *Exploring the effect of constructivist teaching on student's attitudes and performance from 2nd annual North-Central region research meeting*. IN: Lafayette, 21-35.

[12] Kadroon, Y. F. (2013). Professional development of mathematics teachers with lesson study and open approach: the process for changing teacher values about teaching mathematics. *Journal of Psychology, Vol.4, no.2, 101-164.*

[13] Kampala, K., & Vilina, C. (2015). *How to use inquiry-based learning with young learners.* Retrieved May 6th, 2023 from BritishCouncil.org

[14] Kayikci, K. (2009). The effect of classroom management skills of elementary school teachers on

[15] undesirable discipline behavior of students. *Procedia-social and Behavioural Sciences, 1(1),1215-1225*. http://wwwdoi:org/1016/jabspro.200901.218

[16] Kelly, Y. L. L & HO, T. I. (2010). *Metacognitive strategies that enhance critical thinking, 5 251-267.* Retrieved April 28, 2021, from Springerlink.com.

[17] Khan, M. & Iqbal, Z. M. (2011). Effect of inquiry laboratory teaching method on the development of scientific skills through the teaching of biology *(11), 1930-2949. www.language inindia.com*.

[18] Kirschner, P. A., Schweller, J. & Clark, R. A. (2010). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based learning. *Educational Psychology, 41(2)75-86* Retrieved July 24, 2014, from http://dx.doi.org/10.1207/s15326985ep4102-i

[19] Knight, J. & Cornett, J. (2009). *Studying the impact of instructional coaching*. Lawrence, K.S, Kansas coaching project for the center on Research on learning. Retrieved July 24, 2014, fromsciendirect.com

[20] Johnson, L. & Adams, S. (2011). *Challenged based learning*: The report from the implementation project. Austin, Texas: The New Media Consortium. Retrieved July 23, 2021, from learntechlib.org

[21] Lemlech, J. K. (1988). *Classroom management*. Long man Inc. second Ed. New York.

[22] National Research Council (NRC) (1996). *Inquiry and the national science education standards*. Washington DC: National Academy Press.

[23] National Research Council (NRC) (2012). *Scientific Research in Education.* Washington, D.C.: The National Academic Press

[24] Orr, D. (1992). *Ecological literacy: Education and the transition to a postmodern world*. (Sunny series in constructive postmodern thought). Albany, NY, SUNY press.

[25] Owolabi, T. (2012). Characteristics of professional development and impact of training science teachers' classroom practices. Retrieved April 17, 2014 from *Universal Research Journals.org*

[26] Penuel, W.R., Fishman, B. J., Yamaguchi, R. & Gallanger, L. P. (2007*).* Providing effective development, strategies that foster curricular implementation. *American Journal Education Research, 44(4), 921-958.* Retrieved May 30, 2014, from www.researchgate.net

[27] Piaget, J. P. & Inheleder, B. (1969). *The psychology of the child.* (2nd edition). New York: Basic Books. Retrieved July 3, 2015, from www.scirp.org

[28] Quint, J. (2011). *Professional development for teachers what two rigorous studies tell us.* Mdrc (Building knowledge to improve social policy. Retrieved August 15, 2019 from Files.eric.ed

[29] Rutherford, F. J. (2006). The role of inquiry in science teaching. *Journal of Research in Science Teaching, 2(2), 80-84.* Retrieved August 3, 2016 from onlinelibrary.wiley.com

[30] Silm, G., Tiitsaar, K., Pedaste, M., Zacharia, C. Z., & Papaevripidou, M. (2015). Teacher's readiness to use inquiry-based learning: An investigation of teachers' sense of efficacy and attitudes toward inquiry-based learning. *International of Science Education 28(4).* Retrieved July 7, 2019 from www.icaseonline.net.sei/december2017/p6.pdf

[31] Umoeduagu, J. N. (2009). *Functional science education for sustainable development in Nigeria*

[32] Ist CEDAG Distinguishing lecture series of college of education, Agbor, Delta State, Nigeria. Lincel Publisher, Onitsha.

[33] Vlassi, M. & Karaliota, A. (2013). The comparison between guided inquiry and traditional teaching method. A case study for the teaching of structure of matter to 8th grade Greek students. *Journal and Behavioural Sciences*, 93(21), *494-497*. Retrieved my 3, 2021, from sciencedirect.com.

[34] Yager, R. E. (2013). *Exemplary college science teaching*. http://www.nsta.org/store/product.

[35] Yussif, Y. (2022). *What is the role of the teacher in a student-centred classroom*. Retrieved May 3rd 2023 from classmanagementexpert.com.