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PROFESSIONAL DEVELOPMENT OF SENIOR SECONDARY SCHOOL BIOLOGY TEACHERS ON INQUIRY-BASED TEACHING METHOD

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Abstract

The paper examined professional development of senior secondary school biology teachers on inquiry-based teaching. To become and remain a competent biology teacher requires a continuous process that starts from pre-service experiences in undergraduate years to the end of a professional career. Science knowledge is constantly changing and expanding its relevance to societal issues therefore, these teachers needs constant opportunities to build their understanding and abilities in the same direction. Consequently, the National Science Education Standards (NSES) presented a vision of learning and teaching science in which students will have the opportunity to become scientifically literate. (NSES)(NRC, 1996: 56). In the vision, science teachers are professionally responsible for their own professional development and for the maintenance of their teaching profession, hence this paper. Professional development is a specialized training, formal education or advanced professional learning to offer help to administrators, teachers and other educators improve their professional knowledge, skill and effectiveness in the teaching of biology in the classroom (hidden curriculum, 2014). The paper considered some majors issues that leads to teacher professional development which includes:

professional development for biology teachers on inquiry-based teaching, teachers current teaching of biology, concept of inquiry-based teaching, student learning of biology, consensus or standards for professional development programme, impact of professional development programme, researches on professional development programme, challenges of professional development programme, the paper was concluded by stating that coaching and support for teachers at points of implementation should be encouraged, professional development programs should be for a longer period of time more than what is obtainable presently, proper monitoring and evaluation of training received and its implementation among others.

Keywords

Professional Development, Senior Secondary School Biology Teachers, Inquiry-Based Teaching, Positive Impact of Professional Development, Extended Period of Professional Development Programme

1. Introduction

There has being confusion about what teaching science as inquiry means regardless of the definitions, its implementation in the classroom especially to science teachers, the idea is being taught but it is not carried out in the classroom (Wheeler, 2012). Science is hardly being taught as inquiry in the classroom due to several reasons as revealed by literature. For example, Demir & Abell (2011) asserted that one of the reasons is lack of understanding of inquiry-based teaching by the teacher, very few of the science teachers can describe what inquiry-based instruction is, and most of them if they can, they equate it with hands-on learning (Capps & Crawford, 2007). Similarly, an average science teacher is said to have less knowledge about inquiry instruction; while some have not yet completely understand how to teach students biology using inquiry, perhaps, due to training or beliefs. However, part of the reasons for the situation could be attributed to the fact that researchers and science educators have not maintain one definition of inquiry-based teaching method in the classroom (Crawford, 2007). Crawford (2007) notes that some professional teachers do not feel confident and or enthusiastic about engaging students in inquiry-oriented teaching. The researcher went on to say that most of the teachers do not feel equipped enough to conduct inquiry based instruction for students to understand inquiry and use it to learn science. Similarly, Jacqueline (2003) reported a study that most of the teachers studied have limited experiences with inquiry-based teaching, hence this paper. However, National Science Education Standard (NSES) National Research Council

(NRC, 1996) suggests that teachers should be master inquiry strategy themselves before implementing such in their classrooms.

However, professional development programme in education is a wide range of specialized training or professional learning purposefully designed to help teachers improve their professional knowledge (Hidden curriculum, 2014). Professional development programme is supposed to be an continuous, focused, daily learning for teachers individually and collectively (Fullan, Hill, & Crevola, 2006:21). This training will offer the teachers the opportunity to improve their knowledge and skills of inquiry method. Capps, Crawford, and Constas (2012) stated that one of the key features of effective training for inquiry-based teaching is to have long term support for the teachers; because it offers the teachers the opportunity to interact with each others, ask questions and receive feedback about inquiry-based teaching process outside the training session during their own implementation process. The teacher training programmes should include: intensive workshops with a good combination of advanced, experienced and non-experience teachers who are brought together to help each other to practice by following examples, develop further and reflect on their best practices and understanding on various subjects such as: what is inquiry process, instruction, and biology teaching, what are the main advantages of the method, which are the common mistakes to avoid? (Crawford, 2012). This kind of workshops can be offered parallel within the framework of professional development programme and on a regular basis so that more teachers can be involved (Ark of inquiry, internet).

1.1 Concept of Inquiry-Based Teaching

The United States of America had a revolution in science education, around the early 1960s, it was agreed then, by many that teaching of science must be modeled the way scientists makes discoveries. This led to the concept of discovery-based learning which later emerged as inquiry-based learning (Muzaffar & Iqbal, 2011). Inquiry 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 (Lin, Davis, & Bell, 2004). While National research council (NRC, 1996) defines inquiring as a multifaceted activity that involves making observation; posing questions; examining books and other sources of information to see what is already known, planning investigations, reviewing what is already known in the light of experimental evidence, using tool to gather, analyze, and interpret data, proposing answers, explanations and predictions, and

communicating the results. Inquiring requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. Inquiring in science education therefore, means the active involvement of the learner in the discovery of information through investigations. These processes of inquiry learning make it more important for teachers to know how to successfully conduct it in the classroom, hence the training.

It is no doubt, that inquiry-based teaching strategy is an important method of teaching biology, Barrow (2006) stated that inquiry-based teaching method has been identified as an effective method of engaging students in real-world experiences. While the U.S. reform documents American association for the advancement of science (AAAS) (1993)(NRC, 1996) stated that inquiring teaching strategy should be considered a major strategy for teaching science, which teachers must know how to conduct in the classrooms. The method is beneficial to the learners, because it is learner-centered, involves effective collaboration and it is investigative in nature. However, biology teachers are yet to fully adopt the strategy in the classroom.

Although Crawford (2007) attributed the problem to what the author noted as, there are little empirical evidences of effective ways to support teachers to understand the nature of scientific inquiry and how to implement it in the classroom. The researcher went further to states that inquiry- based teaching is a complex and sophisticated way of teaching that requires the teacher to have an adequate understanding of the method.

1.2 Teachers Current Practices (teaching) of Biology

In recent years, science education and science curriculum developers have urged that students be actively involved in the inquiry process. However, research findings have continued to show that students are not being encouraged to initiate their own inquiry (Kadroon 2013). Science education reforms called on teachers to adopt inquiry as a major strategy of their teaching (AAAS, 1993; NRC, 1996). But Asherson (2006) examined classroom practices in schools and reported that teachers often used the curriculum materials developed to support and foster inquiry teaching, but, that the materials were not being used in a manner consistent with the philosophy. However, the author suggested that students must be allowed to determine the questions to be investigated, the procedure to address those questions which are the process of inquiry-based learning, for example, asking questions and finding answers to the questions based on evidence as described by NSES (NRC, 1996). Colburn (2003) states that exemplary teachers shift the focus of the curriculum from the teacher to the learner, they advocate peer interaction to promote learning (Alsop, Bencze Pedretti 2005). Lunetta (2007); Hofstein (2004) studied three

high school curricula in biology, chemistry and physics. Their findings showed that almost all investigations were highly structured "and that" Seldom, if ever, are students asked to (a) Formulate a question to be investigated (b) Formulate an hypothesis to be tested (c) Predict experimental results; work according to their own design (d) formulate new questions based on the investigation" In addition, these researchers point out that students are often asked to perform manipulation and observational procedures and interpret the result of the investigations".

Peters (2005) used the same classification tools to studied nine biology laboratory manuals and found, once again, that biology laboratories are highly structured and that students were seldom provided with opportunities to "pose questions to be investigated; formulate a hypothesis to be tested; predict experimental results; design observation and so on.

1.3 Students' Learning of Biology Teaching

Inquiry-based learning for students, the process often involves open-ended investigations into questions or a problem, requiring them to engage in evidence-based reasoning and creative problem-solving as well as problem-finding (Lemlech, 1988; Kayikci, 2009). Inquiry learning engages students in learning that is based on drawing upon their prior knowledge and experiences (Lemlech, 1988; Kayikci, 2009). It uses the student's prior knowledge "as building blocks to integrate new understanding with prior learning" (Lemlech, 1988; Kayikci, 2009). This form of Learning makes more meaning for students as it becomes a more relevant part of their lives and they begin to better understand the world around them. The basic principle driving inquiry-based teaching is that, this approach can more effectively prepare pupils for future challenges and supports a better understanding of science and conducting science in general (Ledderman, Antink & Bartos, 2014). Inquiry-based learning of biology is process oriented rather than product oriented. Students participating in inquiry-based teaching achieved better learning outcomes than those in traditional courses (Akkus, Gunells & Hands, 2007; Minner, Levy & Century, 2010). There is a general consensus in the literature regarding the positive impact of constructivist approaches on student disposition (Burris & Garton, 2007). Herman & Knobloch, (2004) found that the constructivist approach generates increases in affective and cognitive outcomes. They reported that students preferred the constructivist approach because they had been actively responsible for their own educational process. 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-based learning

involves students in exploration, theory building and experimentation. It encourages active thinking rather than rote learning (Herman & Knobloch, 2004).

There are several forms of inquiry ranging from confirmation to guided-inquiry. Scruggs and Mastropieri (2007) found a significantly high learning for an inquiry- oriented approach with students with learning disabilities.

Inquiry-oriented teaching has been found to give much benefit as opined by Triona and Klahl (2007) that students involved in inquiry-based programs increase their creativity, have better attitudes towards science. Have improved logic development, communication skills and reading readiness (Foley, 2008). Students who are exposed to inquiry approach to science express a more positive attitude to learning in all areas, show increased enjoyment of school and have increased skill proficiency in many areas, including independent thinking abilities than those students taught traditional ways (Anderson 2002). Another research finding showed that students taught using inquiry-based strategies show positive academic gains. (Aydeniz, Cihak, Graham, and Retinger, 2012; Lambert and Ariza 2008; Howitt, Upson and Lews 2011). According to them, this is true across various science topics even with the youngest of students.

1.4 Professional Development for Senior Secondary School Biology Teachers

Professional development of science teachers on inquiry-based teaching is meant to change the teacher's current teaching strategy of transmitting information to learners to that of a guide, through specialized continuing professional learning. For decades, teachers are used to teaching science by giving information from textbooks to the learners, emphazing mastery of content rather than the process, they need an opportunity to experience, understand and practice inquiry-based teaching if they are to develop the confidence and skills to change effectively teach using the strategy (Western AAAE Research conference proceedings, 2010). Change in teachers understanding of what is involved in helping students to learn through inquiry has implications for how professional development is conducted (Western AAAE, 2010). It takes time and effort for existing practices to be either replaced or modified and, unless underpinned by understanding and conviction of the value of new practices, or else it will be implemented only superficially and soon fades away (Western AAAE, 2010). Hence teacher learning and commitment must be that of continuous learning. The continuous professional training activities must include: increasing teacher's content knowledge and developing inquiry-based science education, pedagogy; opportunities for "learning through inquiry and learning about inquiry"; techniques and principles of new approaches (knowing how, knowing why) (NRC, 1996).

Professional development training programmes are mostly being affected by being piecemeal and fragmented (Jacquiline, 2003). Pre-service programmes are collection of courses, and there is a difference between science courses and education courses and between courses within both science and education. Unfortunately, new teachers are placed in difficult situation, of full load of teaching courses, with many preparations to make, with little or no support to ease the challenge of transiting from student to full-time professional teacher Crawford, 2007). Similarly, professional development for in-service teachers is equally fragmented, consisting primarily of short workshops that are neither connected to each other nor to the teacher's classroom work (National commission for teaching & America's future, 1996). Professional development programmes are supposed to offer teachers coherent opportunities to learn over time. Long-term comprehensive inquiry-based professional development is an absolute requirement for the success of standards-based reform (NRC, 1996: 56). Based on that, teachers, parents and even the community need to understand the concept, because they need evidence drawn from research to help them understand, justify and implement inquiry-based teaching and learning of biology. Many biology teachers, for example, may ask why they should reorient their teaching towards inquiry-based methods. School board may also want to know why they should support inquiry-based instruction and professional development. (NRC, 1996).

Hauck (2012) investigated the effects of sustained teacher professional development on classroom science instruction of elementary school teachers in Utah in the US. The result showed that sustained professional development improved the overall science instruction of the participants. The result is consistent with that of Supovitz and Tunner, 2000; Corcoran, McVay, and Riordan, 2003. Therefore, an expanded professional development programme for secondary school biology teachers on the use of inquiry-based learning cannot be overemphasized, because these teachers need Sufficient knowledge of the method, knowledge of how to design and implement the method (lesson) because this is what these teachers lack, therefore, professional development programme is the platform to offer them such help.

1.5 Consensus or Standards for Professional Development

To derive maximum benefits from biology teacher's professional development programme, certain standards are imperative. These standards include: learning science, learning to teach science and learning to learn (NRC, 1996).

Standard 1: Science learning experiences for teachers must:

i. Involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with current accepted scientific understanding.
ii. Address problem or topics significant in biology and of interest to the students.
iii. Build on the teacher's current biology understanding, ability, and attitudes.
iv. Encourage and support teachers to collaborate.

Standard 2: Knowledge of science teaching

i. Effective science teaching is more than science content and some teaching strategies.
ii. Learning to teach biology: Developing pedagogical content knowledge of science, have the opportunity to bring together the knowledge of science teaching and develop an integrated view of what it means to teach and learn biology.

Standard 3: Learning to learn

i. Changing emphasis
ii. For example, transmission of teaching knowledge and skills by lectures to inquiry into teaching and learning (NRC, 1996).

1.6 Researches on Professional Development

Several studies have been conducted on professional development of teachers on inquiry-based teaching. For example, Kazempour and Amirshokoohi (2014) examined Transitioning to Inquiry-Based Teaching: Exploring Science Teacher's Professional Development Experiences. The purpose of the study was to examine high school science teachers' experiences, cognitive beliefs and ideas on inquiry based method. The study took place in the Midwestern University USA. The participants of the study included 21 public high school science teachers from across the state, including 5 male and 16 female teachers. Results of the study revealed that collaboration was fruitful and effective in the identification and attempts to resolve student's bottle necks in learning some concepts. This suggests that professional development programme brings teachers together for collaboration which is important feature in inquiry teaching.

Nine different experimental research studies of teacher training programmes, were conducted and all the results revealed that greater duration of training were positively associated with teachers' change and improvements in student learning (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009). For better enhancement of the skills of inquiry-based teaching, longer training programmes are necessary. A study analyzed the impact of a science training

programme on teachers' practice, researchers found that teachers with 80 hours or more of training were significantly more likely to use the teaching practice they learned than teachers who had less than 80 hours of training (Corcoran, McVay & Riordan, 2003).

1.7 Impact of Professional Development

Results of professional development for teachers are reported in literature to have positive impacts, e.g (Darling- Hammond, Wei, Andree, Richardson & Orphanos, 2009). However, Supporting teachers at the point of implementation help teachers to be more successful with the method (Tuesdale, 2003). Workshops and coaching have also being found to be effective in helping teachers learn how to implement inquiry teaching strategy (Knight & Cornett, 2009) and improved instruction (Capps, Crawford, & Constras 2012). However, arguments have ensued to the use of self-report and direct observation in measuring teachers' implementation of inquiry teaching, Lee, Hart, Cuevas and Endner (2004) states that the use of both self-report and direct observation were conflicting but Jeanpierre, Oberhauser & Freeman (2005) argued that the use of the two approaches were consistent and reflected changes in teachers practice.

1.8 Challenges of Professional Development

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, 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.

2. Conclusion

Teachers are important figures in any learning situation. In inquiry-based teaching the teacher serves as a guide or facilitator of the process. However, a great number of these teachers are not well equipped with inquiry-based teaching knowledge and skills for implementation.

Reasons for these experiences stem from lack of adequate preparation of the teachers on inquiry-based strategy during pre-service training and professional training programmes which are usually presented piecemeal and fragmented being unable to build the teacher's capacity on inquiry teaching strategy (Jacquiline, 2003). Effective and longer professional development training progammes therefore, are needed in other to assist these teachers in building effective inquiry strategy skills to be used in the classroom.

Action Indicators

1. Comprehensive professional development programmes should be designed to last at least 8weeks, to offer teachers basic knowledge of the nature of inquiry learning/teaching.
2. The process of designing and implementation of inquiry teaching strategy be thoroughly taught to teachers.
3. Step-by-step procedure for implementing inquiry lesson be modeled before the teachers during professional development programmes for imitation by the teachers.
4. Short time workshops in inquiry teaching method that do not have many impacts and should therefore, be replaced with in-service training programmes.
5. Supervision, evaluation and monitoring of the trained teachers should be carried out 8weeks after the training to ensure sustainability.
6. Students should be encouraged to learn how to ask questions and seek process of investigating the questions to find answers.
7. Biology laboratory practical should be process oriented rather than product oriented.
8. Support and coaching should be provided to teachers at the point of implementing inquiry-based teaching.

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