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RESOURCEFULNESS IN SCIENCE TEACHING AND LEARNING IN THE COLLEGES OF EDUCATION IN GHANA: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Purpose: The focus of the study was to review existing literature on the resourcefulness of science teaching and learning in the colleges of education in Ghana and to make recommendations to the government of Ghana and the science tutors on the teaching and learning of science in the colleges of education. The study strived to ascertain the right state of resourcefulness in science teaching and learning, nature of preparation given to pre-service science teachers and the kind of in-service training programmes science tutors receive.

Methodology: Systematic literature search approach was adopted in selecting, screening and extraction of important and related documents. These processes included defining the question(s) that the review aimed to answer, establishing inclusion and exclusion criteria, carrying out the search for literature, reviewing the process and evaluating the studies, extracting relevant documents or data and then synthesizing, analyzing and presenting data. The criteria involved identifying journals, articles, policy documents, official reports, training modules, scholarly work from both print and electronic media; identifying goal, scope and focus of the review; presenting outline of procedure for selecting journals; deciding on source selection process; selecting sources; calibration of the content extraction process and picking relevant content materials.

Results: From the analysis of the contents of the various documents gathered, it was revealed that a lot of colleges of education in Ghana have inadequate infrastructure, well-equipped science and ICT laboratories, human resource capacities and material resources that befit their status as tertiary institutions for effective delivery of science lessons by the tutors.

Recommendation: It was recommended that the government of Ghana should adequately resource the colleges of education and the science tutors should take advantage of the Professional Development Sessions to sharpen their knowledge and skills for effective delivery of science concepts to learners.

Keywords: *Colleges of education, In-service training, Resourcefulness, Science, Teaching and learning.*

INTRODUCTION

Teacher education is a driving force responsible for preparing a cadre of professionals whose core duty is to prepare the larger majority of growing individuals to adjust and cope with the rapid changes coming along with the new social, economic and technological environment with the intent to developing the needed human capital for the betterment of the society. Teacher education is very essential based on the fact that its effect on producing quality teachers cannot be measured (Musset, 2010). The core mandate of teacher education is to churn out high quality and effective classroom practitioners (Ministry of Education, 2018). This is because effective teachers are academically and professionally competent and employ appropriate pedagogies to guide the process of teaching and learning for greater student academic achievements (Alami, 2016). One burning concern on the minds of worldwide teacher educators for sometimes now is how to properly prepare teacher trainees to be versatile in their skill, knowledge base and pedagogic practices (McNamara, Murray & Phillips, 2017).

In line with the preparation of more effective teachers to satisfy future pressing needs of the increasing society as education is perceived as a fundamental human right of every child, it has become necessary for countries to implement Education For All (EFA) policies adopted at World Declaration of Education for All in Jomtien, 1990 and Dakar Framework for Action adopted at the World Education Forum in Senegal to meet the need of expansion in education (UNESCO, 2000). In Ghana, the desire to produce quality and effective teachers to teach in the country's educational institutions had culminated in a series of educational reforms.

One of these reforms is the 2007 Educational Reforms following the recommendations made by the Report of the President's Committee on Review of Education Reforms in Ghana (2002). Accordingly, the then teacher training colleges were to be upgraded to Colleges of Education to offer programmes leading to the award of diploma certificates in education (Mereku, 2019; Report of the President's Committee on Review of Education Reforms in Ghana, 2002) in order to improve on the content knowledge and pedagogical content knowledge of pre-service teachers for effective delivery of lessons to their learners. In recognition of the major roles that teachers play to drive development through the provision of skilled human resource, the Government of Ghana indicated that the goal of teacher education is to prepare effective teachers who will be resourceful, competent, committed and dedicated to apply various forms of knowledge for effective instructional facilitation in schools (Report of the President's Committee on Review of Education Reforms in Ghana, 2002).

Teaching is a complicated and intellectually tasking activity that demands adequate preparation before executing it (Musset, 2010). Teacher education activities must be geared towards furnishing teachers with adequate knowledge, skills and values that will inure to the benefits of their learners (Asare & Nti, 2014). Because the synergy between education and society is that the needs of society are reflected in the curriculum and school curriculum should therefore equip learners with knowledge, skills and values that will make them self-reliant and to prepare them adequately to enter the job market (Nkechi, 2012). Since 20th century, higher educational institutions of which colleges are of no exception have been devoted to training the minds of individuals to think critically and to solve the problems of society (Alemu, 2018). Colleges of Education should therefore take a second look at their programmes of study and practices to ensure that pre-service teachers are made to polish their pedagogical skills effectively (Mereku, 2019).

All these realizations necessitated the review of curricula of colleges of education in Ghana with the help of the mentoring universities in partnership with Transforming Teacher Education and Learning (T-TEL) which is an UKaid support programme from the government of Britain. This review has placed so much emphasis on the need to train teachers with requisite knowledge and skills which should be fashioned at improving the teaching and learning of the various disciplines in schools. Thus, the reviewed curriculum had included innovative and learner-centered approaches such as group work, talk for learning, think-pair-share, problem-based learning, inquiry approach, concept maps, games, differentiation as well as core and transferrable skills such as equity, inclusion, critical thinking and problem-solving, reflection, creativity, collaboration/team work and development of science process skills (Ministry of Education, 2016: Themes 3, 4 & 5; Ministry of Education, 2018). These innovative and child-centered approaches are to make the students active in the teaching and learning process and therefore be able to construct knowledge and to make learning meaningful.

For that matter, from the onset, colleges and universities should create the necessary friendly environment that will enable trainee teachers to acquaint themselves with all the resources that will be made available during training so as to get them to be innovative, resourceful and to adopt differentiated instructional approach to achieve high learning outcomes on completion (Bonney, 2019). Unlike the didactic instructional strategy that was practiced in schools and colleges where the students became passive learners and the teachers served as a repository of knowledge, an active and child-centered method of delivery was needed to implement the new curriculum with the intent of promoting critical thinking and problem-solving among learners instead of encouraging rote learning (Davidson, 2010).

For effective implementation of the reviewed curriculum which is student-centered and innovative in approach, tutors in the colleges of education especially science tutors must be well equipped with the relevant content knowledge, pedagogical content knowledge and adequate resources to enable them deliver on the mandate of the new curriculum. According to Bonney, Amoah, Micah, Ahiamenyo and Lemaire (2015), the teacher's qualification is an important factor in promoting higher academic work. A teacher should thus possess the requisite qualifications in both the content knowledge and pedagogical knowledge. This is because a blend of good content and pedagogical knowledge of the teacher promotes the teaching and learning process (Jones & Moreland, 2003).

One major responsibility that is placed on the shoulders of teachers in an attempt to promote teaching and learning of science in colleges of education in Ghana is to aid instructional delivery as they use enough resources. Recently, a lot of resources are available for science teaching and learning and these resources are put to good use by skillful teachers. It is good to have a cadre of qualified and competent science teachers in the classroom, it is equally important to ensure that adequate and functional resources such as computers, good textbooks, interactive boards, science laboratories, Information and Communication Technology (ICT) tools and other forms of technology, internet facilities, local resources in the environment and many others are available for use by teachers to facilitate the teaching and learning situation (Oludeyi, Adekalu & Shittu, 2015).

According to Awolola (2000), teaching and learning resources are those human and material inputs needed for promoting and achieving aims and objectives of concepts to be taught. It is the

aggregate of all the inputs employed directly or indirectly with the primary aim of facilitating educational training or promoting the acquisition of knowledge and, skills (Akinsola as cited in Okeke & Okoye, 2013). According to Adeoye and Papoola (as cited in Mucai, 2013), in order to promote learning, the learner must be made to access all the requisite information, relevant materials and resources. For performance drive, learners interact with tangible and intangible resources. This assertion agrees with Mutai (2006) who notes that provision of enough materials such as textbooks, exercise books, teaching aids and classrooms promote teaching and learning.

Making science teaching and learning resources available at the colleges, therefore, facilitates effective science teaching as it is these basic resources that promote academic excellence in the students. As indicated by Chiriswa (2002), effective teaching and learning which includes science has a lot to do with adequate provision of suitable resources such as books, laboratories, library materials and host of other visual and audio teaching aids which promotes good performance in the national examination. Akungu (2014), emphasized that resources including material resources, human resources such as teachers and support staff and physical facilities such as laboratories, libraries and classrooms should be provided in order to facilitate effective and meaningful teaching and learning.

Proper utilization of teaching and learning materials supports classroom instruction and encourages active and adequate participation of learners. Olagunju and Abiona (2008) state that use of school resources in science teaching results in meaningful learning because it arouses students' interest at the same time motivates learners. They came to the basic conclusion that students do not perform well due to lack of resources. Because there is a considerable correlation between availability and use of laboratory apparatus and academic performance of science students (Adeyemo, 2013). Thus, if resources are effectively utilized in the teaching and learning of science, it increases the achievement levels of students, helps them to construct and consolidate knowledge, acquire science process skills and makes them learn science meaningfully (Abungu, Okere & Wachanga, 2014; Agyei, 2011, Babalola, Lambourne & Swithenby, 2019; Boateng, 2014; Chebii, 2011; Dah, 2020; Hofstein & Mamlok-Naaman, 2007; Idiege, Nja & Ugwu, 2017; Okeke & Okoye, 2013; Opara, 2015)

Science teaching and learning has been of so much interest to many governments and researchers for some time now. Most governments in one way or the other focus on improving the teaching and learning of science to change their economy (Adu-Gyamfi, 2014). Science education should therefore aim at equipping the learners with appropriate scientific concepts and skills that could encourage them to explore their surroundings and to become more creative and self-reliant (Nkechi, 2012). Nkechi further stated that effective teaching and learning outcomes in science can only be realized if the necessary resources are provided and utilized during the teaching and learning process. Because availability and utilization of resources facilitates and ensures active involvement of the students in the teaching and learning process and thus improves learning (Opara, 2015) as one of the major factors responsible for low academic achievement in our schools is unavailability of resources (Ministry of Education, 2014). Science teachers must therefore be resourceful and innovative (Adu-Gyamfi, 2014; Miyoba & Banja, 2018) in order to provide a student-centred learning environment that will meet the needs of individual students (Parker, Osei-Himah, Asare & Ackah, 2018). This is because in a student-centred environment, students usually collaborate with one another, solve realistic problems, manipulate and interact with equipment and

materials in the teaching and learning process which facilitates the grasping of the scientific concepts by students (Dah, 2020).

Nevertheless, science teachers in a bid to make teaching and learning of science child-centered and to allow learners actively construct knowledge, encounter a number of challenges in this regard. Anderman, Sinatra and Gray (2012) assert that matters surrounding provision of appropriate science textbooks and classroom resources, preparation and training of pre-service and in-service science teachers are some of the challenges confronting the teaching and learning of science. However, research findings reveal that schools including colleges of education either lack or has inadequate resources including textbooks, laboratory materials and equipment, spacious lecture theatres and internet facilities for effective teaching and learning of science (Adu-Gyamfi, 2014; Alshammari, 2013; Amoah, 2018; Boakye & Ampiah, 2017; Bonney, 2019; Kadbey, Dickson & McMinn, 2015; Ministry of Education, 2014; Miyoba & Banja, 2018; Okori & Omenka, 2017; Otieno, 2012). Meanwhile material resources play an integral part in the teaching and learning of science by stimulating critical thinking, making learning enjoyable, interesting and meaningful (Nkechi, 2012) as their availability and effective utilization ensures active involvement of students in the teaching and learning process which makes learning meaningful (Nkechi, 2012; Okeke & Okoye, 2013; Opara, 2015). Schools must thus have enough resources that could get teachers and learners to pursue and achieve the targeted objectives at the end of the course (Mogaka, 2019).

Adequate content and pedagogical content knowledge of science teachers are essential for effective delivery of science concepts to learners. For science teachers to meet the innovative science curriculum in schools, they are required to be given thorough professional development that would effect these changes in the curriculum (Adu-Gyamfi, 2014). However, it was observed that insufficient professional knowledge and content knowledge are the struggles of some beginning science teachers (Alsharari, 2016; McMinn, Kadbey & Dickson, 2015) because they were not rigorously prepared during their pre-service training course. Policy implementers should therefore ensure that newly trained teachers are up to task in their professional practices (McNamara, Murray & Phillips, 2017).

Not only must the pre-service teachers be thoroughly prepared but they must also regularly update and upgrade their content knowledge and pedagogical content knowledge. Musset (2010) stated that, continuous training of teachers is a great practice and approach directed at developing the requisite knowledge and skills for achievement of greater student performance. Okeke and Okoye (2013) asserted that there is lack of opportunities for in-service training on how to properly use new tools, equipment and materials and this had resulted in the inability of some science teachers to use the instructional resources for effective delivery of lessons to students (Opara, 2015). Anthony-Krueger (2007) stated that majority of science teachers in Ghana did not have the opportunity to undergo in-service programmes and this would result in their content knowledge and professional skills remaining dormant or degenerate with time. Meanwhile, science teachers need to constantly develop their knowledge and practical organizing skills through in-service programmes in order to be competent in the classroom (Khatoon, Alam, Bukhari & Mushtaq, 2014) as there is documentary evidence that in-service training programmes lead to improvement in the professional competencies of teachers' knowledge and skills for effective delivery of lessons to students (Cossa & Vamusse, 2015; Rahman, Jumani, Akhter, Chisthi & Ajmal, 2011).

Apart from availability of classroom resources and training of science teachers, there are other host of challenges that are faced by science teachers. These difficulties include heavy overloaded science curriculum, inadequate time to teach science and large science classes. According to Okeke and Okoye (2013), because of inadequate time allocation to science subjects on the teaching time table, most teachers rush through the science subject matter without giving chance to students to engage in practical activities for effective utilization of science resources. Meanwhile, effective utilization of resources ensures active involvement of pupils in the teaching and learning process and thus improves learning (Opara, 2015) and acquisition of science process skills (Abungu, Okere & Wachanga, 2014; Agyei, 2011, Babalola, Lambourne & Swithenby, 2019; Chebii, 2011).

Another difficulty that teachers face is the overloaded science curriculum that learners are supposed to undergo. Because of the extensive nature of the science syllabus, many science teachers concentrate on teaching science theoretically for the early completion of the syllabus to the detriment of practical activities (Abdul-Mumuni, 2005; Ampiah, 2004; Dah, 2020) which results in teachers serving as repositories of knowledge and students acting as passive recipients of knowledge (Okeke & Okoye, 2013) rather than active participants in the teaching and learning process. Because in active learning situations, students will be required to undergo practical activities in order to generate scientific knowledge and acquire science process skills (Abungu, Okere & Wachanga, 2014; Eshun, 2011; Jack, 2018; Musasia, Abacha & Biyoyo, 2012; Nkechi, 2012; Ongowo & Indoshi, 2013).

The increasing numbers of students is another factor that militates against effective teaching of science. Okori and Omenka (2017) asserted that the Nigerian school system today is experiencing an upsurge in the population of students with much demand for classroom space and laboratory facilities. This situation is not different in Ghana. According to Alshammari (2013), management of large science classes was a challenge to science teachers. This is because adequate teaching and learning materials must be provided for the students to manipulate in order to acquire science process skills and to learn science meaningfully. Subsequently, many science teachers organize practical activities in groups due to large class size and insufficient laboratory equipment (Awuku, 2014; Kasiyo, Denuga & Mukwambo, 2017; Mwangu, & Sibanda, 2017; Said, Friesen & Al-Ezzah, 2014). When practical activities are organized in groups because of large class size and inadequate science apparatus, the members in the groups should not be too many to prevent overcrowding around the apparatus and to give every student ample chance and time to manipulate the equipment and to go through the experimental procedures to acquire science process skills and to effectively understand the scientific concepts (Dah, 2020).

Subsequently, studies conducted by Alshammari (2013) and Sengul, Cetin and Gur (2008) indicated that teachers' professional duties are characterized by a number of challenges, among them are; content difficulty; class control issues as a result of large class sizes; excessive workload; shortage of teaching tools and physical resources; inadequate pedagogy and lack of professional development opportunities.

Statement of the Problem

Education plays pivotal role in developing nations since it provides the requisite human resources (Asare-Danso, 2014). Tertiary institutions are very paramount in providing the quality human resources that countries need to perpetuate their developmental agenda. It was in this vein that the government of Ghana upgraded the erstwhile teacher training colleges into the present colleges of

education for them to award higher degrees to teacher trainees (Asare-Danso, 2014) with a legal backing of the Colleges of Education Act (Act 847) in 2012 (National Council for Tertiary Education [NCTE], 2013).

However, with the upgrading of the colleges into tertiary status, science teachers continue to experience most of the challenges they faced during the era of teacher training colleges. Some of these challenges include inadequate human resource capacity, unavailability of science textbooks and classroom resources, preparation and training of pre-service and in-service science teachers, large class sizes, insufficient instructional time, limited physical space, inadequate laboratory equipment and materials, and infrastructure to meet the standards required of tertiary status (Adu-Gyamfi, 2014; Al Ghamdi & Al Salouli, 2012; Alshammari, 2013; Anderman, Sinatra & Gray, 2012; Effah, 2018; Mereku, 2019; NAB, 2007; NCTE, 2013; NCTE, 2015; Nkechi, 2012).

This state of affairs had defeated the purpose for which the colleges were upgraded to the tertiary status. As the core mandate of the colleges of education is to teach, undertake research and provide services to the community for the government to address its challenges as the knowledge, skills and desirable values obtained from these institutions would help in solving the problems of the society (Bingab, Forson, Mmbali & Baah-Ennumh, 2016; Effah, 2018). For science teachers to effectively deliver on this mandate, they must possess the requisite academic and professional qualifications, be well resourced, undergo regular in-service programmes and use student-centred approaches to adequately prepare the teacher trainees for the world that is constantly reinventing itself in order to solve challenging problems (Abungu, Okere & Wachanga, 2014; Aydogdu, 2015; Bonney, Amoah, Micah, Ahiamenyo & Lemaire 2015; Dah, 2020; Miyoba & Banja, 2018; Nkechi, 2012; Okeke & Okoye, 2013; Opara, 2015; Osamwonyi, 2016; Parker, Osei-Himah, Asare & Ackah, 2018; Sellars, 2012). It is therefore worthy to review data on the resourcefulness of science teaching and learning in the colleges of education in Ghana.

Purpose of the Study

The purpose of the study was to review existing literature on the resourcefulness of science teaching and learning in the colleges of education and to make recommendations to the government of Ghana and the science tutors in the colleges of education.

Review Questions

The review was guided by the following questions.

1. How resourceful are the colleges of education in terms of science teaching and learning in Ghana?
2. How are the pre-service science teachers prepared in Ghana?
3. How are in-service training programmes organized for science tutors in the colleges of education in Ghana?

LITERATURE REVIEW

Resourcefulness of science teaching and learning in the colleges of education

Many governments and researchers have for some time now shown appreciable amount of interest in the teaching and learning of science. Most governments in one way or the other focus on improving the teaching and learning of science to change their economy (Adu-Gyamfi, 2014). The

objective of teaching Science at the college of education level is to create learner friendly environment that supports individual students as they adopt differentiated instructional approach to produce high learning outcome (Bonney, 2019) not like the conventional method that was practised in schools and colleges where teachers serve as possessors of knowledge while students act as passive recipients of knowledge from teachers (Okeke & Okoye, 2013; Shah, 2017) as colleges of education are shifting away from theoretical transmission of knowledge to a more constructivist paradigm of teaching and learning which believes in learning by practice (Miyoba & Banja, 2018).

Viable and child-centered approaches are needed to implement the new curriculum with the intent of promoting critical thinking and problem-solving among learners instead of encouraging rote learning (Davidson, 2010). This is because when learners get actively involved in science-based classroom activities, they are able to construct their own knowledge, acquire science process skills, learn meaningfully, retain knowledge acquired, it demystifies the study of science, are motivated to learn science and can use the knowledge, skills and values acquired to solve their daily problems (Abungu, Okere & Wachanga, 2014; Adu-Gyamfi, 2013; Aydogdu, 2015; Babalola, Lambourne & Swithenby, 2019; Boateng, 2014; Dah, 2020; Hofstein & Mamlok-Naaman, 2007; Miyoba & Banja, 2018).

For the colleges of education to be adequately positioned to train high quality of science teachers that the country yearns for through student-centred approaches, they must be well provided in terms of quality human resource, classroom resources, laboratory equipment and materials, infrastructure and internet facilities. However, research findings revealed that the colleges of education in Ghana are not sufficiently resourced to carry out the mandate for which they were upgraded into tertiary institutions (Bingab, Forson, Mmbali & Baah-Ennumh, 2016; Effah, 2018; Ministry of Education, 2014; National Accreditation Board [NAB], 2007; National Council for Tertiary Education [NCTE] as cited in Newman, 2013; The World Bank, 2000). As such tutors will have to use innovative ways of teaching to enhance the understanding of teacher trainees.

According to Effah (2018) and National Council for Tertiary Education (2015), faculty members in the colleges of education are required to teach, set and mark assignments/quizzes/examinations, undertake research work and publish their findings, supervise students on internship and their project works, assist in the administration of the college and provide services to the community and the nation at large. If faculty members are to perform these tasks efficiently, they must possess the requisite academic and professional qualifications. Thus, the minimum qualification for a tutor in the colleges of education is pegged at research masters which should be in alignment with the area of study in the first degree by the staff (NCTE, 2015) to enable him/her possess an in-depth knowledge in content and pedagogy to be able to perform his/her duties effectively.

However, with the upgrading of the teacher training colleges into colleges of education, one of the major challenges they continued to battle with was inadequate human resource capacity (Effah, 2018). Subsequently, Newman (2013) affirmed that only about 37.55% of faculty members in the colleges of education in Ghana have research masters' degree or PhD in the relevant fields. It is therefore not surprising that tertiary institutions including the colleges of education have a challenge of recruiting and retaining highly qualified academic staff (Bingab, Forson, Mmbali, & Baah-Ennumh, 2016). According to Bonney, Amoah, Micah, Ahiamenyo and Lemaire (2015), the teacher's qualification is an important factor in promoting higher academic work. A teacher

should possess the requisite qualifications in both the content knowledge and pedagogical knowledge. This is because a blend of good content and pedagogical knowledge of the teacher promotes the teaching and learning process (Jones & Moreland, 2003) as there was a positive relationship between the teacher's content knowledge and pedagogical skills and the performance of the pupils which meant that increase in the content and pedagogical skills of the teachers resulted in higher academic performance of the pupils (Bonney, Amoah, Micah, Ahiamenyo & Lemaire, 2015). Because pedagogical content knowledge is a skillful combination of pedagogy and subject matter knowledge which consists an aspect relating to an understanding of what is to be taught, learnt and assessed, how to blend content and pedagogy to organize particular topic for learners (Jones & Moreland, 2003). However, pre-service science teachers may lack subject matter knowledge and pedagogical content knowledge (Alsharari, 2016; Boakye & Ampiah, 2017) due to lack of adequate preparation in the content knowledge and pedagogical content knowledge in the course of their training (Alsharari, 2016).

Classroom resources such as models, charts, projectors, slides, realia and other teaching and learning materials that are used to facilitate teaching and learning in the classroom are very paramount in the preparation of teachers. This is because teacher trainees who are undergoing the rudiments of teaching and learning must act as apprentices learning from the master craftsmen who are their tutors. Since they will be required to exhibit the knowledge and skills they have acquired in the course of their training when they become fully fledged teachers. According to Asare and Nti (2014), it is common to hear people say that teachers teach the way they were taught to become teachers. Adequate classroom resources must therefore be provided and used effectively in the training of teachers in order to make the teaching and learning process student-centred which will be replicated by the student teachers upon completion of their course. Thus, teacher education efforts must aim at ways of equipping teachers with knowledge, skills and values that are critical to the development of their learners (Asare & Nti, 2014) since teaching is a complex and demanding intellectual activity that cannot be accomplished without adequate preparation (Musset, 2010).

Nkechi (2012) asserted that material resources play an integral part in the teaching and learning of science as they stimulate critical thinking processes in students, make learning interesting and meaningful. Okeke and Okoye (2013) stated that the extent of acquisition of knowledge, skills and values by science students depends on the quality of teaching and learning that takes place in the classroom as a result of effective interaction with teaching and learning resources. Availability and effective use of resources facilitates active involvement of students in the teaching and learning process and therefore improves learning (Opara, 2015). Nevertheless, the colleges of education experience the challenge of inadequate resources that befits the standards required of them as tertiary institutions (Effah, 2018; Ministry of Education, 2014). Meanwhile the government of Ghana had identified tertiary education as one of the major ways to address its challenges as the knowledge, skills and values attained from these institutions will help in solving the problems of society (Bingab, Forson, Mmbali & Baah-Ennumh, 2016). Having identified the deficit in material resources in the colleges of education, the government of Ghana is making frantic efforts to supply the colleges of education with the resources that they need for effective teaching of science (Ministry of Education, 2014).

Science entails both processes and products in nature and therefore science education must focus on activities that will enable students see the processes and products of science as interdependent and geared towards promoting scientific literacy of the nation in this 21st century (Abungu, Okere & Wachanga, 2014; Dzidzinyo, 2011; Ministry of Education Youth and Sports, 2004; Ogunmade, 2005; Sadhana, 2017). Practical activities are therefore indispensable when students are to actively apply the science processes in order to generate scientific knowledge (Musasia, Abacha & Biyoyo, 2012; Ongowo & Indoshi, 2013) as this makes learning meaningful (Idiege, Nja & Ugwu, 2017; Rauf, Rasul, Mansor, Othman & Lyndon, 2013). Practical activities are mostly carried out in the laboratories where students are allowed to go through the processes of science in order to produce scientific knowledge (Abungu, Okere & Wachanga, 2014; Jack, 2018; Kasiyo, Denuga & Mukwambo, 2017). If teacher trainees are, therefore, to learn science meaningfully by applying the processes of science to generate the products of science which they will later transfer to their learners by coaching them, then there is the need for availability of well-equipped science laboratory for the students to go through experimental procedures in order to create scientific knowledge.

Nevertheless, the colleges of education in Ghana lack well-equipped science laboratories and as a result, science is taught theoretically (Ministry of Education, 2014). Also, the report of the National Accreditation Board (2007) revealed that in the colleges of education in Ghana, the laboratory equipment and materials were obsolete, inadequate and poorly maintained. This finding of the National Accreditation Board was buttressed by NCTE as cited in Newman (2013) that the furnishing in the laboratories of colleges of education is very poor and equipment is not only scanty and paltry but out of date. Meanwhile, teacher trainees need to effectively manipulate science equipment and materials in order to be active learners in the teaching and learning process for acquisition of science process skills and understanding of the scientific concepts (Abungu, Okere & Wachanga, 2014; Nkechi, 2012; Opara, 2015) because when learners actively engage themselves in learning a scientific concept, many of their senses are employed and this results in the retention of the concepts (Miyoba & Banja, 2018).

Facilities such as auditorium, spacious lecture blocks, and library blocks are expected to aid the teaching and learning process. For instance, a library that is well stocked with relevant and modern books will assist both faculty members and students to undergo research activities. Spacious lecture blocks fitted with loudspeakers will help accommodate the increasing number of students and help in the teaching and learning process. The presence of an auditorium can help in organizing professional development sessions, symposia, conferences and scholarly presentations by faculty members and students. With the upgrading of the colleges of education into tertiary status by Act 847, it had provided accessibility to more senior high school graduates to enroll as pre-service teachers (Bingab, Forson, Mmbali & Baah-Ennumh, 2016). This calls for the expansion in the existing infrastructure of the colleges of education in order to cope with the increasing numbers of students. However, the colleges of education are still facing a challenge of inadequate infrastructure that befits their status as a tertiary institution (Bawakyillenuo, Akoto, Ahiadeke, Aryeetey & Agbe, 2013; Bingab, Forson, Mmbali & Baah-Ennumh, 2016; Effah, 2018). This state of affairs will not permit the colleges of education to deliver on the mandate of being elevated to the tertiary status. The government of Ghana must therefore be committed to funding colleges of education in terms of infrastructural development (Bawakyillenuo, Akoto, Ahiadeke, Aryeetey & Agbe, 2013) to enable them carry out their functions effectively.

In this 21st century, science education must be geared towards promoting scientific literacy and technological advancement of the nation (Dzidzinyo, 2011; Ogunmade, 2005). In view of this, teaching and learning in the colleges of education should incorporate the use of technology such as projectors, tablets, android phones, laptops, desktop computers, spacious Information and Communication Technology (ICT) laboratories with accessibility to the internet for the students and tutors to surf the internet for relevant information to facilitate teaching and learning by the students. According to the Ministry of Education (2014), the availability of laptops, desktop computers, android phones and internet connectivity provides easy access to Open Educational Resources (OERs) in science for both teachers and students for effective teaching and learning of science. For instance, if there is lack of a particular laboratory apparatus in a school and thus makes it difficult for the teacher to use it during teaching and learning activities, the students could be asked to surf the net to effectively learn about this apparatus if they possess the technological tools and a stable internet connectivity. However, many teachers at the second cycle institutions lack the capacity to integrate technology into the teaching of science in the classroom (Ministry of Education, 2014). This situation is not different to tutors in the colleges of education and can be attributed to lack of or inadequate technological tools, absence of stable internet connectivity and lack of in-service training on how to effectively integrate technology into the teaching and learning process to promote the learning of science.

Meanwhile, by integrating technology into the teaching and learning of science will enhance both the content knowledge and the pedagogical content knowledge of the teacher and therefore promote understanding of the scientific concepts by the learners. Fortunately, the government of Ghana had initiated steps to expand ICT facilities in schools to strengthen the teaching of Mathematics and Science and other subjects through digital content for teachers and students through the Ministry of Education Sector Plan (ESP) for second cycle schools (Ministry of Education, 2014). If this laudable initiative could be timely and extended to the colleges of education, it will help to ameliorate the existing state of technology facilities and internet connectivity in the colleges of education for improved academic work.

Preparation of pre-service science teachers in Ghana

Before 2007, the pre-service science teachers in the basic schools in Ghana mainly underwent a 3-Year Post Secondary Generalist Programme across all the then teacher training colleges being mentored by the University of Cape Coast (Mereku, 2019). However, with the upgrading of the former teacher training colleges into colleges of education by Act 847, they were elevated to diploma awarding institutions to commensurate with their status as tertiary institutions (Mereku, 2019; NCTE, 2013) to run a 3-year generalist and specialist programmes with the "IN-IN-OUT" component where teacher trainees were required to spend two years of their training in college and the last year outside the college in their schools of attachment to be mentored by the schools in which they were attached (Mereku, 2019).

This restructuring of the curriculum from that of post-secondary to a diploma awarding one was due to the fact that concerns have been raised about the quality of the products of teacher training colleges in terms of their generic and subject-specific competencies as required by the basic school teacher and the fact that teacher trainees need to be trained holistically in order to be innovative, adaptive and have the capacity to apply the knowledge and skills acquired to solve problems in their daily lives (Mereku, 2019). However, because of the weak qualifications of the entrants into

the colleges of education as compared to that of the universities coupled with inadequate human and material resources, many of the diplomates from the colleges of education still perform poorly in their final assessments and appeared unprepared to teach during their internship programmes due to the absence of the requisite knowledge and skills for effective delivery of lessons to learners (Effah, 2018; Mereku, 2019; NAB, 2007; NCTE, 2013; NCTE, 2015; Nkechi, 2012; Ossei-Anto, Annang-Nunoo & Korankye cited in Mereku, 2019). There is therefore the need for a change in the academic qualifications of teachers towards effective delivery of lessons to learners (Hosgorur, 2016). Since teachers are the most important resource in schools and therefore important to focus on them (Musset, 2010).

Subsequently, the curricula of colleges of education had been modified with the help of the mentoring universities and Transforming Teacher Education and Learning (T-TEL) which is an UKaid support programme from the government of Britain to award degrees to the products of the colleges of education. In this modification, the duration for completion of the degree programme is four years as pertaining to the universities, constructivist teaching strategies such as problem-based learning, inquiry-based learning and collaborative learning have been introduced into the curriculum, the school attachment programme that diplomates undergo in their third year had also been changed into Supported Teaching in Schools where trainees visit their schools of attachment right from the first year and write reflective journals on their observations. Moreover, the forty-six colleges of education have been shared among the five public universities for mentoring purposes and the students are required to undergo programmes in Early Childhood Education, Primary Education and Junior High School Education with their specialisms. These modifications have become necessary because concerns have been raised about the quality of teachers being produced by the colleges of education, the fact that the educational system is not static and must change in response to national plans and the need for the curriculum in the colleges to incorporate changes in order to turn out teachers that meet the standards of adequate professional knowledge, practice and values (Amakyi & Ampah-Mensah, 2014; Mereku, 2019; Republic of Ghana, 2017). According to Amakyi and Ampah-Mensah (2014), teacher education in Ghana had undergone several reforms and as changing needs of basic education demands that teachers embark on more institutional training to be more competent academically and professionally in the classroom.

Thus, under the current dispensation, the colleges are to produce generalist science teachers for the primary schools and specialist science teachers for the junior high schools. The trainees offering Early Childhood Education and Primary Education programmes will end up being science teachers at the lower and upper primary respectively. Students studying Science as elective courses under the Junior High School Education programmes will be eligible to teach science at the junior high school level.

Organization of in-service programmes for science tutors in the colleges of education in Ghana

In-service training programmes are very essential for science teachers to upgrade and update their knowledge and skills for effective delivery of lessons to learners. According to Osamwonyi (2016), teachers must be provided with opportunities through in-service programmes to update their knowledge, skills and experiences for their professional competence in the classroom because there is documentary evidence that in-service training programmes lead to improvement in the professional competencies of teachers in terms of knowledge and skills for effective delivery of

lessons to students (Cossa & Vamusse, 2015; Rahman, Jumani, Akhter, Chisthi & Ajmal, 2011). However, in-service programmes were not a regular feature in the colleges of education before 2015. With a collaboration from the government of Ghana and Transforming Teacher Education and Learning (T-TEL) which is a UKaid support programme from the government of Britain, Professional Development Sessions (PDS) which is an in-service programme had been institutionalized in the colleges of education to enable science tutors to update and upgrade their knowledge and skills towards effective delivery of lessons to their students. Because teacher professional interventions are designed to increase teachers content knowledge and pedagogical content knowledge (Schieb & Karabenick, 2011). According to Anthony-Krueger (2007), if science teachers do not constantly benefit from in-service training programmes, the knowledge and skills they have acquired from the universities will remain dormant or even degenerate with time and this may result in their inability to effectively present scientific concepts to students.

Subsequently, in a bid to produce qualified science teachers who will be adaptable in their skill set, knowledge base and pedagogic practices (McNamara, Murray & Phillips, 2017), the government of Ghana in collaboration with T-TEL had instituted professional development programmes for science teachers to update and upgrade their knowledge and skills in order to effectively deliver science concepts to their learners. Thus, the science tutors at the colleges of education had undergone professional training programmes under innovative themes such as creative approaches to teaching, talk for learning, group work, teaching and learning materials, assessing trainee teachers, the tutor as a researcher (Ministry of Education, 2015: Themes 1; Ministry of Education, 2016: Themes 3, 4 & 5; Ministry of Education, 2017: Themes 7 & 8).

Thus, science tutors in the colleges of education had updated their pedagogical knowledge and pedagogical content knowledge on using innovative strategies such as games, story-telling, role play, songs, modelling, concept maps, concept cartoons and mind maps to help learners construct knowledge during the teaching and learning process (Ministry of Education, 2015: Themes 1 & 3). This will help them retain knowledge, demystifies science as a difficult subject and thus learn meaningfully. According to Dah (2020), if students are to learn science meaningfully, science teachers must be innovative and adopt student-centred approaches in the delivery of science concepts to learners. This is because in a student-centred approach, students are active participants in the learning process, they learn at their own pace, use their own strategies and approach to learning and are more intrinsically than extrinsically motivated to learn (Mido, 2017).

Also, science tutors in the colleges of education had upgraded their knowledge and skills in organizing students for group work and improvisation of teaching and learning materials using low-cost materials available in the environment (Ministry of Education, 2016: Themes 4 & 5). They are now better placed to effectively adopt the different types of groups and improvise teaching and learning materials to enhance delivery of their lessons. This is because by employing group work during the teaching and learning of science enables the participants to collaborate, interact and share information which results in improved learning of science. And if teachers can improvise teaching and learning materials, it will facilitate the learning of science. During collaborative group work, members are provided with opportunities to interact with their peers for the purposes of generating, discussing and sharing knowledge and if the students interact with improvised materials provided to them by a good creative, innovative and productive science teacher, it facilitates learning of science (Opara, 2015; Roessingh & Chambers, 2011).

According to Effah (2018), the core purpose of tertiary education is to teach, undertake research and provide service to the community. Staff members are responsible for the implementation of this purpose of education (Sellars, 2012). Science tutors are, therefore, supposed to teach, assess the outcomes of their learners and supervise the project works of their students on internship in the schools of attachment and also undertake their own research activities and publish their findings (NCTE, 2015). For the science teachers to perform these duties effectively, they must constantly be reinforced in the skills related to these activities which they have acquired from the universities if not they will remain dormant and even degenerate with time (Anthony-Krueger, 2007). Consequently, the upgrading and updating of the knowledge and skills of science tutors on the rudiments of undertaking a research work and effective strategies that can be adopted in assessing students learning outcomes (Ministry of Education, 2017). This organization of professional development programme for science tutors by the government of Ghana in collaboration with Transforming Teacher Education (T-TEL) and the various colleges had boosted the morale of the teachers and made them adequately prepared to efficiently assess both lower and higher order learning outcomes and also supervise the action research projects by their students on school attachment programmes.

METHODOLOGY

The approach adopted in this study is systematic literature search. A systematic literature search of academic articles was carried out to gain an insight into issues surrounding the resourcefulness of science teaching and learning as well as matters related to it. According to Ferraras-Femandez, Martin-Rodero, Garcia-Penavlo and Merlo-Vega (2016), systematic reviews are a type of scientific research that aims to integrate in an objective and systematic manner the results of empirical studies on a particular research problem in order to determine the state of the problem in its field of study. There are several approaches to conducting literature review (Fisch & Block, 2018), among it is the systematic literature review which has been employed in this study. The processes involved in carrying out systematic literature review as indicated by Ferraras-Femandez, Martin-Rodero, Garcia-Penavlo and Merlo-Vega (2016) were followed to identify electronic journals, articles, books and other scholarly materials and books. These processes included defining the question(s) that the review aimed to answer, establishing inclusion and exclusion criteria, carrying out the search for literature, reviewing the process and evaluating the studies, extracting relevant documents or data and then synthesizing, analysing and presenting data.

At the beginning of the review, the researchers specified clearly the questions that the review sought to answer and they include the resourcefulness of the colleges of education in terms of science teaching and learning, the preparation of pre-service science teachers and the organization of in-service programmes for science tutors in the colleges of education. The inclusion and exclusion criteria of articles, journals, books, theses, congress and conference papers, and training modules were then established with respect to the objectives of the study. The inclusion criteria include: the document must be written in English, article must be on resourcefulness of teaching and learning science, journals, articles and books must be on preparation of pre-service science teachers and in-service training for science tutors, the scholarly work must be current or an updated work. Contents that were not written in English and deviate from the research questions/objectives were excluded from the search.

After conveniently establishing the research questions, the inclusion and the exclusion criteria, a comprehensive literature search was carried out to locate relevant data using Google, Google Scholar, Web of Science, ERIC, for electronic data and library catalogues for training manuals and other unpublished scholarly work such as theses in the library. After the search for relevant data, the assessment of the relevance of the documents was done thoroughly and independently by the reviewers following the analysis of the titles, abstracts and in some instances the contents of the articles. The relevant information that met all the inclusion criteria were extracted after the screening process. The data collected were then analyzed, synthesized and presented qualitatively according to the research objectives.

The search for these literature and documents started in early 2020 and was fashioned to cover academic research, professional literature together with policy documents, official reports, training modules, databases and electronic publications in English within the period of 2000 to 2020. These sources were chosen based on the understanding that they have a lot of information from many databases and were able to give a very broad spectrum of existing literature with respect to the topic under study. Some keywords such as 'resourcefulness', 'science teaching and learning', 'colleges of education' were used in search of the full texts, and forty-two (42) documents were retrieved and used in this systematic literature review after sorting the unrelated ones out. Relevant articles published in a peer-reviewed academic journal were chosen over others to ensure credibility.

Systematic manual approach to selecting these articles was designed by using keywords and titles and in some cases, both abstracts and full texts were read to determine the relevance of the article to the topic under study. Three science education tutors and researchers independently screened these articles to assess their eligibility. The selected articles and the reasons for rejecting others were discussed at a meeting. The outcome of the discussion influenced the inclusion criteria so as to reduce ambiguities, after which the refined and final set of criteria was applied to the whole body of 42 articles selected.

DISCUSSION

National educational systems are not static as they have changed in response to national agenda (Mereku, 2019). Since teachers are the most powerful and effective agents of educational change and the fact that teaching is a complicated and intellectually demanding task, teachers must be adequately prepared to accomplish this task (Hosgorur, 2016; Musset, 2010; Sellars, 2012). Subsequently, when concerns are being raised about the quality of the products from the training colleges in terms of their generic and subject-specific competencies as required by the basic school teacher (Mereku, 2019), the government of Ghana had upgraded the colleges of education by Act 847 into tertiary status (NCTE, 2013) since it had identified tertiary education as one of the major ways to address its challenges as the knowledge, skills and desirable attitudes obtained from these institutions can help in solving the problems of society and to produce qualified teachers who will be versatile in their skill set, knowledge base and pedagogic practices (Bingab, Forson, Mmbali & Baah-Ennumh, 2016; McNamara, Murray & Phillips, 2017).

Nevertheless, with the upgrading of the colleges of education into tertiary status, they continue to face challenges such as inadequate human resource capacity, insufficient infrastructure and material resources to meet the standards required of tertiary status (Bingab, Forson, Mmbali & Baah-Ennumh, 2016; Effah, 2018; NAB, 2007). According to Effah (2018), the core purpose of

tertiary education is to teach, undertake research and provide service to the community. Staff members are responsible for the implementation of this purpose of education (Sellars, 2012). Thus, for effective implementation of the reviewed curriculum which is student-centred and innovative in approach, tutors in the colleges of education especially science tutors must be well equipped with the relevant content knowledge, pedagogical content knowledge and adequate resources to enable them deliver on the mandate of the new curriculum. According to Bonney, Amoah, Micah, Ahiamenyo and Lemaire (2015), the teacher's qualification is an important factor in promoting higher academic work. A teacher should thus possess the requisite qualifications in both the content knowledge and pedagogical knowledge. This is because a blend of good content and pedagogical knowledge of the teacher promotes the teaching and learning process (Jones & Moreland, 2003). Consequently, according to the National Council for Tertiary Education (2015), faculty members are to acquire a minimum of a researchable master's degree in the area of the faculty's specialization at the degree level.

Also, to further boost the pedagogical content knowledge of science tutors, the government of Ghana in collaboration with T-TEL had instituted professional development programmes for the tutors to make them more effective in the presentation and assessment of students' learning outcomes. For instance, this in-service training programmes had updated the science tutors' knowledge and skills in employing innovative and student-centred approaches, improvising teaching and learning materials for teaching of science, supervision of project work and effective ways to assess both lower and higher order learning outcomes (Ministry of Education, 2015; Ministry of Education, 2016: Themes 4 & 5). This had boosted the morale of science tutors in the colleges to effectively teach science as lack or insufficient professional development was perceived as an obstacle to teaching and learning science (McMinn, Kadbey & Dickson, 2015). The professional development programme instituted by T-TEL in collaboration with the colleges coupled with the innovative curriculum of the colleges of education will enable science teachers to train students that will be well prepared to adopt creative and child-centred approaches in the presentation of their lessons, improvise teaching and learning materials, assess the learning outcomes of their pupils using alternative assessment modes and also be reflective teachers.

It is good to have a team of qualified and competent science teachers in the classroom, it is equally important to ensure that adequate and functional resources such as computers, good textbooks, interactive boards, science laboratories, Information and Communication Technology (ICT) tools and other forms of technology, internet facilities, local resources in the environment and many others are available for use by teachers to facilitate the teaching and learning situation (Oludeyi, Adekalu & Shittu, 2015). Nkechi (2012) asserted that material resources play an integral part in the teaching and learning of science as they stimulate critical thinking processes in students, make learning interesting and meaningful. Thus, the availability and effective utilization of resources ensures active involvement of learners in the teaching and learning process, helps them to construct knowledge, acquire science process skills, and motivates them which results in an improved learning (Abungu, Okere & Wachanga, 2014; Ministry of Education, 2014; Nkechi, 2012; Okeke & Okoye, 2013; Olagunju & Abiona, 2008; Opara, 2015).

Because teaching science through constructivist learning strategies excites students to learn the concept meaningfully, teachers must make their lessons practical by employing enough teaching and learning materials in the delivery of lessons and guide students to make their own

generalizations instead of encouraging them to memorize formulae and definitions (Ministry of Education). Nonetheless, the colleges of education experience the challenge of inadequate resources such as laboratory equipment and materials, internet facilities that befit the standards required of them as tertiary institutions (Effah, 2018; Ministry of Education, 2014; NAB, 2007, NCTE as cited in Newman, 2013). Meanwhile, science teachers at the colleges of education need adequate resources in terms of laboratory equipment and materials as well as stable internet facilities in order to train the prospective science teachers by adopting child-centred approaches for meaningful learning of the concepts. According to the Ministry of Education (2014) and NCTE as cited in Newman (2013), the colleges of education do not have enough of well-equipped science laboratories hence, science teaching is more abstract and theoretical than practical. If we are to ensure that newly qualified science teachers are up to task about their profession (McNamara, Murray & Phillips, 2017), then adequate resources must be provided for the students to interact with in the teaching and learning process for them to construct knowledge, acquire science process skills, demystify science as a difficult subject and be motivated intrinsically to learn science meaningfully.

This is because when students actively participate in the teaching and learning process of science, they are able to construct their own knowledge, acquire science process skills, learn meaningfully, retain knowledge acquired, demystify the study of science, are motivated to learn science and can use the knowledge, skills and values acquired to solve their daily problems (Abungu, Okere & Wachanga, 2014; Adu-Gyamfi, 2013; Aydogdu, 2015; Babalola, Lambourne & Swithenby, 2019; Boateng, 2014; Dah, 2020; Hofstein & Mamlok-Naaman, 2007; Miyoba & Banja, 2018) this will enable them to meet the objective of teaching science at the college of education level which is to create learner friendly environment that supports individual students as they adopt differentiated instructional approach to produce high learning outcome (Bonney, 2019; Parker, Osei-Himah, Asare & Ackah, 2018) instead of encouraging rote learning of concepts (Davidson, 2010).

Science tutors should therefore employ adequate instructional materials so as to ensure child-centred instructional strategy which can facilitate learning of science and for the students to replicate this good practice when they become fully fledged teachers because they are apprentices learning from master craftsmen. Even though, a good, creative and innovative science teacher should be able to improvise some instructional materials to make him/her resourceful for the delivery of science lessons (Adu-Gyamfi, 2014; Oginni, Awobodu, Alaka & Saibu, 2013; Opara, 2015), equipment such as microscope, thermometer, hand lens (Adu-Gyamfi, 2014; Dah, 2020) and internet facilities cannot be improvised and effectively used for the teaching and learning of science. Therefore, conventional science apparatus must be provided to the colleges of education by the government, stakeholders in education, Non-Governmental Organizations (NGOs) and philanthropists for the tutors and students to use for effective teaching and learning of science. Fortunately, the government of Ghana had initiated steps to improve ICT facilities in schools to strengthen the teaching of science and other subjects (Ministry of Education, 2014).

CONCLUSION

Teaching and learning resources have a significant role to play in training prospective science teachers for this country. When these resources are adequately provided for the students to manipulate during the teaching and learning process, it facilitates acquisition of science process skills, makes the lesson student-centered, demystifies science as a difficult subject, motivates

learners, helps them to learn meaningfully and thereby retain the concept learnt. Since teacher trainees are undergoing training, they serve as apprentices who must learn the best practices of the teaching profession from the master craftsmen who are their teachers because they will replicate what they have learnt as teachers on the field. Sufficient teaching and learning materials must therefore be provided and effectively utilized in the teaching and learning process of teacher trainees. However, literature had revealed that the colleges of education either lack or have inadequate resources for effective training of teacher trainees. Even though, creative, dedicated and innovative teachers can improvise some science apparatus for the teaching and learning of science, not all equipment can be improvised for effective study of science. Also, with the increasing numbers of entrants into the colleges of education, the science teacher who has the mandate to improvise science apparatus in the absence of conventional ones will not be able to improvise science apparatus to adequately cater for the large class sizes being experienced in the colleges of education in Ghana. Consequently, there is the need for adequate resources to be provided in the colleges of education for the effective training of future science teachers.

Moreover, the professional development sessions instituted by T-TEL and the colleges in collaboration with the government of Ghana is of immense benefit to the science tutors in the colleges of education. This is because it has updated and upgraded their knowledge and skills on creative and innovative ways to present science concepts to learners for them to learn meaningfully. Additionally, it has provided effective ways of assessing both lower and higher order learning outcomes by learners as well as enhanced their prowess in the supervision of project works of their students on attachment programmes. Finally, the modifications in the curriculum to include constructivist strategies such as problem-based learning, inquiry-based learning and collaborative learning as well as Supported Teaching in Schools were of paramount significance. As the Supported Teaching in Schools has enabled trainees to observe lessons by their mentors and write reflective journals on these lessons. The constructivist learning strategies have also helped the pre-service teachers to understand science concepts better and to be able to apply them to solve the problems of society.

RECOMMENDATIONS

1. Since the colleges have been upgraded to tertiary status, the government of Ghana should adequately resource the colleges for effective training of the prospective teachers for the country and to also serve as centres of excellence for providing in-service training to basic school teachers in their catchment areas.
2. Science tutors in the colleges of education should take advantage of the Professional Development Sessions to sharpen their knowledge and skills for effective delivery of science concepts to learners.

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