Transatlantic Journal of Multidisciplinary Research(TJMR)
p-ISSN: 2672-5371
e-ISSN:2735-9808
Journal Homepage: https://tjmr.org

A Meta-Analysis Of The Influence Of Incorporating Practical Activities Into Physics Lessons In Senior High Schools In Ghana

Donusem Yao Asamoah.[1] **Ebenezer Ekow Mensah** [2] **Shemmira Yunus** [3]

[1,2,&3] Department of Integrated Science Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) Ghana.

Corresponding Author: Donusem Yao Asamoah E-mail: yaoasamoah@aamusted.edu.gh

ARTICLE INFORMATION

Volume: 4
Issue: 2 | 2022
DOI:10.5281/zenodo.7301735

KEYWORDS

Incorporation, physics teachers, practical activities, science teaching.

ABSTRACT

Nurturing scientific curiosities in learners is inconceivable if theory is not linked to practice in the teaching and learning process as enshrined in the physics teaching syllabus for Ghanaian senior high schools. Undeniably, practical activities facilitate how learners generate, acquire, and become proficient of scientific knowledge, competencies, processes and values in well-organised and productive ways. This work is guided by research questions: "Why do physics teachers incorporate practical activities into their lessons in senior high schools?" and "What are the impacts of incorporating practical activities into physics lessons in senior high schools?" As a result, a meta-analytical assessment of related literature was carried out to provide refreshing insight on the influence of incorporating practical activities into physics lessons. Important issues emanating from the review of related literature include need for pedagogical practical experiences, adoption of appropriate pedagogical strategies linking theory and practice, and impact of practical activities on learning outcomes.

Introduction

There have been major shifts from teaching natural science as a body of knowledge towards increasing emphasis on experiences of the processes and procedures (Fadaei, 2012; Hodson, 1990) because knowledge, hands-on experiences, and competencies are key components of the teaching and learning process. Many researchers (Hofstein & Lunetta, 2004; Hofstein, 2004; Lunetta, Hofstein, & Clough, 2007) suggest that learning science is heightened with ease when learners are involved in practical activities. Practical experiences are acquired through engaging learners in any science pedagogy and practical activities be it collaborative or not, handling and observing tools and materials [Science Community Representing Education (SCORE), 2008] as an indispensable aspect of science education.

Considering the various aspects of natural science, a fundamental subject among it is Physics which is central to the existing and future progress of mankind (Wenham, Dorling, Snell, & Taylor, 1984). Being an essential subject, physics is ground on experiences and empirical facts finding (Michael & Möllmann, 2012) and thus calls for constructive approach (Bybee, 2000; Wellington, 1989). The effect is to equip learners with requisite knowledge, competencies, values, and attitudes with targeted learning support for problem solving. Fadaei (2012) indicated that one of the key methodologies by which learners are made to be actively engaged in meaning generation between experiences and ideas in physics is via constructive approach to teaching and learning of physics involving practical activities (Fadaei, 2012). Physics practical activities are learner-centred and it enables a learner to process physics concepts in a systematic manner. The usefulness of practical activities in pedagogy and studying physics is seen to be very crucial (Okebukola, 1986) and vital. Learning through practical experience is very important since it provides learners with the opportunity to engender knowledge and understanding from an interaction between their practices, ideas, and the natural environment which is central to science in general and specifically physics. Furthermore, the efficacy of physics lessons is largely dependent on how teachers and students are carrying out practical activities (Oyoo, 2004). Practical activity being an exclusive feature of science education aids learners to meaningfully understand concepts in science coupled with enhanced learners' enthusiasm to learning science (Hofstein & Lunetta, 2004; Lunetta, Hofstein & Clough, 2007), and specifically a positive attitude towards physics is developed which stimulates permanence of knowledge (Azar & Şengülec, 2011). Involving learners in practical activities embosses a long-lasting impression on their minds. Learners can easily link theory to practice if facts and philosophies concerning science are developed and incorporated logically (Van Driel, Beijaard, & Verloop, 2001). Also, well-organised practical activities entice learners into studying science programmes (National Council of Educational Research and Training [NCERT], 2013). Providing constructivist teaching and learning settings wet learners' appetite for enquiry, arouse and sustain their interests to practice science in a meaningful way (Asamoah, & Aboagye, 2019).

Owing to the prominence of practical activities, the physics teaching syllabus designed for senior high schools (SHS) in Ghana by the Curriculum Research and Development Division (CRDD) of the Ministry of Education (MoE) laid emphasis on practical activities, and the obvious roles they play in students' acquisition of scientific enquiry competencies, values and attitudes needed to practice science and technology in well-organised and cost-effective way. Importance placed in the syllabus on practical activities include portfolios, demonstrations, experiments, interactive hands-on activities, and enquiry abilities calculated to unearth innovativeness and creativity in physics students (MoE, 2010). Indeed, when students are involved in practical activities, knowledge acquisition and understanding of concepts in physics are enhanced. For these reasons, physics teachers have to be familiar with pedagogical techniques, practical activities, scientific problem-solving, and learners' presumptions and models (Asikainen & Hirvonen, 2010).

The success of practical activities depend to a great extent on the commitment of the teacher(s) responsible, knowledge of instructional approaches and how he/she effectively integrates practical activities into instructional time (Millar, 2004). However, a large number of students in Ghana perceive physics difficult to conceptualise, abstract and theoretical in nature (Buabeng & Ntow, 2010) which has led to an increase in lack of comprehension and assimilation. The alleged difficulty of physics alluded to by students call for a methodological framework appraisal with reinforced emphasis on the need to incorporate practical activities into physics lessons to serve as an anchor of demystifying concepts in physics (Asamoah, & Aboagye, 2019). This meta-analysis is guided by the research question: "Why do physics teachers incorporate practical activities into their lessons in senior high schools?" and "What are the impacts of incorporating practical activities into physics lessons?" In view of this, effort was made to review related literature to address issues of concern.

Materials and Method

Due to the significance of catalogues from archives (Cozby & Bates, 2012; Creswell, 2014), assessment and review of related literature from different scholars were undertaken on the physics teaching syllabus of senior high schools in Ghana, teaching and learning physics as a science subject, need for practical experiences, incorporating practical activities with theory, and impacts of practical activities. Various related literature were studied to point out the influences of incorporating practical activities into physics lessons. In consonance with Creswell (2014)'s submission on important roles archival materials play in information enhancement of research works, remarks made by various authors from literature were thematically presented in this study. Information obtained for this study on specific key words in relation to the influence of incorporating practical activities into physics lessons was from secondary sources. The secondary information was grounded mainly on analysis of related literature accessible online (Researchgate.net, Academia.edu, Google, and Google Scholar), documents from the Ghanaian Ministry of Education, unpublished thesis and published works related to practical activities due to their relevance. The rest were general issues on findings accessed from collected works which were synthesised to gain insight into specific issues relevant to practical experiences, and impacts of incorporating theory and practice during instructional time. These actions are expected to improve the delivery of physics lessons in a more interesting and stimulating way.

The Physics Teaching Syllabus of Senior High Schools in Ghana

The rationale for teaching physics in Ghanaian SHS is to help students gain and apply the requisite scientific knowledge, abilities, principles and talents to self-actualise and for the social, economic and political shift of Ghana [Ministry of Education (MoE), 2010]. The aims of the SHS Physics are to:

i. Provide through well designed studies of experimental and practical physics a worthwhile hands-on educational experience to become well informed and productive citizens;

ii. Enable the Ghanaian society function effectively in a scientific and technological era where many utilities require basic physics knowledge, skills and appropriate attitudes for operations;

iii. Recognise the usefulness, utilisation and limitations of the scientific methods in all spheres of life;

iv. Raise the awareness of inter-relationships between physics and industry, information and communication technology (ICT), agriculture, health and other daily experiences;

v. Develop in students, skills and attitudes that will enable them to practise science in the most efficient and cost effective way;

vi. Develop in students, desirable attitudes and values such as precision, honesty, objectivity, accuracy, perseverance, flexibility, curiosity and creativity; and

vii. Stimulate and sustain students' interest in physics as a useful tool for the transformation of society (MoE, 2010).

The teaching syllabus for physics designed for SHS by the CRDD of the MoE makes provision for fundamental conducts for pedagogy, learning and appraisal known as profile dimensions which include knowledge and understanding (KU), application of knowledge (AK) as well as practical and experimental skills (PES) with percentage weights of 30%, 40% and 30% respectively (MoE, 2010). The principal aim of the syllabus is to encourage and orient students not only in acquiring knowledge but to comprehend what have been taught, learnt and as such apply them practically. Combining the profile dimensions ensures that physics is imparted not only at the factual knowledge-level but in learners' acquisition of abilities, which can effectively be applied to concerns and problems, as well as aptitude for PES needed for problem-solving and enriching competencies.

Teaching and Learning of Physics as a Science Subject

Physics is a natural science concerned with the study of matter, energy and interactions amongst them (Chiu & Lin, 2002) as well as measurement. These interactions are necessary for the technological needs of the ever dynamic society (Juceviciene & Karenauskaite, 2004; Zhaoyao, 2002). Millar (2004) categorised the objectives of science education into two-fold: (1) aid learners to comprehend science subject-matter knowledge in relation to necessities, well-being and capabilities; and (2) develop learners' intellect of available techniques which can help achieve this knowledge. Adopting appropriate pedagogical techniques is seen to be a requirement for effective pedagogy (Klafki, 2000). The probability of a teacher to underperform in his/her field or discipline is very high with inadequacy of subject-matter knowledge (Boz & Boz, 2008). Subject-matter knowledge is a prerequisite to successfully implement pedagogical strategies since teachers are required to assist learners overcome learning difficulties (Klafki, 2000; Van Driel, Verloop, & de Vos, 1998).

It is very important to have pre-service teachers' knowledge about content and practices examined as significant spheres of professional advancement (Asikainen & Hirvonen, 2010). Findings from a qualitative research conducted by Taylor and Dana (2003) with one student teacher and two in-service high school physics instructors as participants reveals that high school physics instructors' capability to meticulously appraise scientific facts is complex. Taylor and Dana added that science instructors need to have appropriate conceptual knowledge and facts to firmly position them to aid learners develop and comprehend analogous concepts. They thus recommended that emphasis must be laid on scientific knowledge required to appraise engendered scientific facts in high schools. Likewise, science instructors must lay emphasises on scientific knowledge and facts, and adopt pedagogy well-tailored to aid learners develop suitable scientific competencies (Taylor & Dana, 2003).

In a study on the development of science instructors' experiential knowledge and practices, Van Driel, Beijaard and Verloop (2001) explained that experiential knowledge of instructors and philosophies correlate to their practices in the classroom. If experiential knowledge of teachers comprises features which are not well linked and incorporated, they often encounter contradictions between their personal philosophies about science and science pedagogy and their actual pedagogical practices. Developing a conceptual structure which effectively and logically blends scientific knowledge and philosophies, subject-matter, pedagogies and learning is expected to aid teachers and learners to connect theory to practices (Van Driel et al., 2001). One of the core mandates of teachers is to popularise science education at the high school level hence their comprehensive knowledge, which include but not limited to factual, conceptual, procedural and strategic, should be equivalent or go beyond the requisite knowledge to instruct (Kasanda, 2008) and institute appropriate instructional strategies which links theory to practice.

Need of Practical Experiences for Physics Teachers

Prominence have been placed on the positive role practical activities play in science pedagogy, and the need of practical experiences for learners (Hofstein & Cohen, 1996; Hofstein & Lunetta 2004; Lunetta, Hofstein & Clough, 2007; Millar, 2004; Tamir, 1991; Thair & Treagust, 1999). Commenting on the need of practical experiences, researchers (Garnet & Hackling, 1995; Hofstein & Lunetta, 2004; Lunetta, 1998; Tobin, 1990) pointed out that practical activities have a distinguishing and unique role in science education, and as such educators of science have advocated that a lot of advantages ensue from involving students in practical activities. Observations made by Jarrett, Takacs and Ferryet (2010) on physics practical activities suggest that these activities lay the needed basis of concept assimilation by many learners and hence the quality of their conceptual assimilation is of ultimate importance. Furthermore, there is the need to recognise the effectiveness of practical activities in science in order to insightfully understand what is learnt; and how students' meaningfully process information in their minds concerning procedural actions and methodologies in the development of models and theories (Dillon, 2008) which in the long run give rise to an enriched image of science as well as quest for its study.

Research also revealed that involving students in practical activities can surge their sense of ownership and learning outcomes and can equally surge their enthusiasm (Johnstone & Al-Shuaili, 2001). Any science teaching and learning setting whereby learners are stimulated to practice science in effective ways as scientists such as enquiring, exploring, analysing, synthesising, appraising, and providing justifications is seen to be an ideal type.

Incorporating Practical Activities and Theory

This is one of the most important issues the study sought to address. According to Scanlon, Morris, Terry and Cooper (2002), science students find it difficult to construct knowledge mainly because of the need to develop both conceptual and procedural knowledge coupled with suitable activities. Wellington (2002) hinted that fundamental skills of science instructors to mediate concepts for high school students lie in accepting and transmitting a multifaceted and captivating subject such as physics and thus physics teachers must employ pedagogical techniques that links concepts and models (Asikainen & Hirvonen, 2010).

There is a global concern over the steady decline of practical activities being conducted in secondary or high schools and post-secondary stages as the battle for activity or project-based teaching is yet to fully materialise in our basic schools (Institute of Physics, 2014; NCERT, 2006). There have been countless recommendations of the need for teachers not to divorce practical activities from theory, yet this has not been achieved due seeming inadequacy of facilities, skilled teachers and experiences in teaching in most schools (Institute of Physics, 2014; NCERT, 2006). The National Research Council [NRC] in 2006 instituted an integrated laboratory programme which is enquiry process-based meant to encourage a cocktail of capabilities correlated with scientific cognition. They comprise but not limited to the ability to:

i. ascertain problems and ideas guiding scientific enquiries;

ii. design and carry out scientific enquiries;

iii. develop and review scientific explanations and prototypes;

iv. identify and scrutinise alternate explanations and prototypes; and

v. initiate and sound convincing during a scientific argument, including write-ups, review of information, use of appropriate scientific hermeneutics, constructive arguments, and respond to critiques (NRC, 2006).

Provision of learner support through complex and ambiguous forms of practical activities involving verification calls for in-depth knowledge of detailed scientific ideas and procedural actions in such activities (Millar, 2004). Relating learner's practical experiences with scientific concepts, models, principles, and daily life status quo ought to be learnt. A number of researchers (Aufschnaiter & Aufschnaiter, 2007; Domin, 2007; Mestre, 2001) revealed that meaningful learners' communication and discussion are mostly not encouraged during learning science and when carrying out physics practical activities. They added that students often are made to focus on carrying out a number of activities without certainly comprehending them; and also fail to connect practical experiences to main theory on same concepts. The next section takes a look at another salient subject matter for the study.

Impacts of Practical Activities on Learning Outcomes

One of the extensively and commonly used procedural techniques used in science pedagogy in English high schools is practical activity (Bennett, 2003; Millar, 2004). Teachers view practical activity as a technique that arouses learner's interest in science as pointed out by a lot of empirical data (Holstermann, Grube, & Bögeholz, 2009). Practical activities essentially play an important role in learning science, a very strong opinion shared by numerous educational researchers, science educators, teachers and students (Dillon, 2008; Hofstein & Cohen, 1996; Tamir, 1991; Thair & Treagust, 1999). As ascribed by Barron, Schwartz, Vye, Moore, Petrosino, Zech, and Bransford (1998), practical activities have four (4) design doctrines that positively affect students' learning outcomes: (i) outlining learning-appropriate goals that lead to in-depth comprehension; (ii) provision of frameworks such as 'embedded pedagogy', 'pedagogical tools', groups of 'antagonistic cases', and commencing problem-based learning events before instituting projects; (iii) make certain several prospects for formative self-assessment and evaluation; and (iv) develop social frameworks that stimulate collaboration and a sense of urgency.

The need for novelty assisted by class focused tutoring and modelling are approaches that make available prospects for instructors to involve learners in activities which are minds-on and hands-on (Gunstone, 1991). In a study by Cerini, Murray and Reiss (2003) of over 1400 students of varying ages in England revealed that seventy-one percent (71%) indicated 'doing an experiment in class' as one of the three techniques they find 'most enjoyable' and thirty-eight percent (38%) asserted that it is 'most useful and effective'. This implies that students see their involvement in practical activities as being both affective and effective in relation to their learning and enjoying scientific practices. These outcomes suggest that practical activities which have no contextual use and are merely set-up to be carried out by students or for appraisal intents may result into lesser learning outcomes than activities connected to real experiences and day-to-day lives.

Practical activities provide opportunities for learners to discuss and argument views as well as share peculiar know-hows. Instructors are expected to help learners to assess results with those of their cohorts and with the broader science society is very important (Driver, 1995). This will generate a 'cognitive conflict' which is essential for intellectual advancement. In order to foster 'cognitive conflict' learners should be provided with an enabling environment and conditions to enable them pose scientific problems, to work collaboratively, to carry-out enquiries, administer and put up ideological defence, results, and discoveries, and examine their own and other learners' cognition (Pope & Gilbert, 1983). The worth of 'cognitive conflict', cognition and bridging conceptual frameworks to new circumstances provide considerable signals of the effect of cognitive speeding up via possible science learning outcomes and attainment (Adey, Hewitt, Hewitt, & Landau, 2004). In-depth meaning can merely be generated on the minds of learners via their own vigorous determinations (Saunders, 1992). This suggests that learners are not just impassive receivers of facts from instructors, technological devices, textbooks, or any source of facts during cognition; they have to grapple with thoughts in their own mental faculty until it becomes purposeful to them. This can only be achieved by exposing them to practical activities. Learners need to comprehend to some degree the characteristics of science if they are to fully accept the parameters and worth of practical activities (Abd-El-Khalick & Lederman, 2000; Duschl, 2000; Lunetta, 1998; Matthews, 1994; Wolpert, 1992).

Studies on the influence of practical activities or enquiry learning on learners' performance, attainment and attitudes have shown positive correlations. One of such studies is that of Freedman (1997) who reported that students aged fourteen to fifteen who had frequent practical lessons: (a) recorded considerably higher ($p < .01$) on the objective-examination of science knowledge attainment than those who had no practical experiences; (b) showed an average positive relationship ($r = .406$) between their attitudes toward science and their accomplishing learning outcomes; and (c) recorded considerably higher ($p < .01$) on accomplishment of knowledge in science after these scores were aligned on the scientific attitudes' co-variable. Also, a survey research conducted by National Endowment for Science, Technology and the Arts [NESTA] (2005a) revealed that 99% of science-teachers sampled believe that learning via enquiry had an (83% - 'very'; 16% - 'a little') effect on students' performance. Moreover, the purpose of enquiry-learning in science education has been articulated by a number of science educators that practical activities aid students to appreciate how scientists work while others indicated that experimental skills focused approach help learners to gain a very good understanding of scientific concepts (Donnelly, Buchan, Jenkins, Laws, & Welford, 1996). Besides, practical activities can both upsurge learners' awareness of their learning outcomes and enthusiasm (Johnstone & Al-Shuaili, 2001). According Millar (2004), there is some evidence (Jakeways, 1986; Woolnough, 1994) that carrying out prolonged practical activities enable learners to have acumen of scientific practises and upsurges there curiosity and enthusiasm to further their studies in science. The value of practical activities in school science as acknowledged by Millar (2004) are indispensable since it provides learners the opportunity to appreciate, for instance, the problematic aspects of measurement and existence of uncertainties (or measurement error); and also as an essential experimental pedagogical technique. Of course, research suggests that learners plan and implement enquiry processes effectively when they are directly involved in a scientific activity than when only requested to write a plan and as such critical assessment of experiential response advances design (Kannari & Millar, 2004; Millar, 2004).

Effectively involving students in practical activities enable them to explore thoughts as well as schools' laboratory apparatus (White & Gunstone, 1992). Lunetta et al. (2007)'s study offers a succinct conclusion on practical activities. They remarked that when practical activities are well planned and implemented in science education, they significantly influence learning outcomes in many ways since various stages of enquiry engage learners cognitively and tangibly via means which are not conceivable in other science education involvements. They further assert that well planned and executed practical activities enhance learning outcomes, shaping and puzzling learners' deeply held views about natural phenomena and fashioning and modernising their beliefs. Commenting on a pedagogical approach, they were of the view that social learning theory makes clear the need to promote practical activities so that expressive conceptually focused discourse can occur between the instructor and learners (Lunetta et al., 2007).

Research on outdoor education by Rickinson, Dillon, Teamey, Morris, Choi, Sanders and Benefield (2004) established that (i) practical activities suitably considered, effectively planned and designed, well thought of and executed offer learners with prospects to develop their knowledge and capabilities in ways that add value to their every-day know-hows in the classroom; (ii) specially, practical activities positively contributes to long-term cognition due to the extraordinary nature; and (iii) effective practical activities can lead to individual growth and development because it reinforces the relationship between the affective and cognitive domains and serves as a bridge to higher order learning.

Discussion

In the light of the above observations, the researcher suggests that physics teachers accept practical activities as hands-on and minds-on activities to help students develop requisite skills, knowledge and understanding of physics concepts. Incorporating practical activities during instructional time ensures that contents in SHS physics are instructed not only at the meta-cognitive, factual, and conceptual level of knowledge but also at the procedural level of knowledge which enables students to utilise a combination of these knowledge set to solve daily problems, and as such enhance their skill acquisition and philosophies.

Literature alluded to the fact that incorporating theory and practice promote active learning where students practice more than listening, emphasis on skill development than knowledge transmission, and engagement in higher order thinking and enquiry (Wrenn & Wrenn, 2009). Incorporating theory and practice is, therefore, essential in learning physics and other science related subjects since it promotes students' cognitive processes needed to function effectively in today's world. Besides, science teachers are entreated to employ active engagement strategies to aid the development of cognitive, affective and psychomotor domains of students. By this, students not only acquire procedural understanding of concepts but learn meaningfully through active involvement and participation (Al-Naqbi & Tairab, 2005). Furthermore, practical activities most importantly, enhances students' acquisition of scientific skills and attitudes, promotes understanding and demystifies scientific theories, concepts and principles taught to enable them practice science in the utmost and proficient way. The incorporation sharpens students' powers of observation, stimulate enquiries and help develop new scientific understanding and vocabulary. These findings are in consonance with Ottander and Grelsson (2006), and Perkins-Gough (2007) who reported that practical activities enable students to acquire and practice procedural skills, engendered the mastery of subject and scientific knowledge. Similarly, Millar (2004), Millar and Abrahams (2009), and Tiberghien (2000) found that practical activities motivate students by stimulating interest, enrich their acquisition of experiential skills and scientific knowledge.

The syllabus implemented by teachers in SHS in Ghana clearly recognises the importance of scientific practical activities, and for that matter, the acquisition of enquiry processes, practical and experimental skills, values and aptitudes in science by students needed for problem solving and innovativeness. Engaging students in practical activities improves their knowledge, understanding and connection of what happens, how it happens, and why it happens. As remarked by Tamir (1991), practical activities in science education induces learners with scientific attitudes, problem solving skills and enhances assimilation of concepts. When students are undertaking practical activities, they are made to be actively involved in the learning process as they work cooperatively or individually and interact in solving problems. Hence, the worth of practical activities cannot be underestimated in any science curriculum.

Millar (2004) pointed out that teachers find it challenging to conceive or aid learners to engender sufficient project-base ideas, year-on-year. It is not uncommon for practical activities to become subjects of routine and to some degree very different from what was initially in the curriculum. This suggest that a practical activity is an effective tool in getting students to assimilate, understand and connect science concepts, theories, practices and the ideas behind phenomena in physics. Practical activities aid and motivate students by providing them with the requisite acquaintance, enquiry and experimental skills for continuation in the study of science.

Besides, practical activities enhance students' comprehension processes of scientific investigation and conceptual development. Given that practical activities should be incorporated with theory, its impact via promoting teaching and learning of physics concepts is imperative. It is expected that practical activities should promote cognitive, social competencies, behavioural, affective and the psychomotor dispositions of students. Teaching and learning can be improved by ways in which science explanatory and experimental models of teaching are designed and carried out, either in or outside the physics classroom. This is the more reason why practical activities have become an obvious and significant feature which distinguishes science in general and physics in particular from other subjects in senior high schools in Ghana.

Conclusions

Incorporating practical activities into physics lessons both in and outside the classroom is a crucial element of effective science pedagogy, and it is inconceivable the possibility of teaching physics without practical activities because it affords students with knowledge, content, practical and experimental experiences. Incorporating practical activities into physics lessons is a good strategy for students of all abilities since it aids strategically the development of students' knowledge, skills and attitudes. Also, incorporating physics practical activities during instructions challenge students to observe, explain and utilise scientific principles.

There is the need for physics teachers to accept and implement practical activities as an integral part of lessons. It is of utmost importance that instead of isolating practical activities or as additional experiences, it should be meticulously incorporated with theory. Time and again, there is a lag of more than a few months between concepts taught in theory and practical activities conducted on same concepts. This calls for an imperative need of letting go of this disjointed approach to science education.

Researchers have chatted issues on the effectiveness of incorporating practical activities during lessons. Remarks include debrief of the physics teaching syllabus of SHS in Ghana, teaching and learning of physics, recognising the essence of practical activities from pedagogical perspective; incorporating practical activities and theory, and the impacts of practical activities on learning outcomes. In reference to this qualitative review of literature, it is proposed that physics teachers should regularly involve students in practical activities in order to instil the culture of procedural learning in them. It is imperative for physics teachers to incorporate practical activities with theory in the teaching and learning process which can result in broadening scientific knowledge base of students. Being conversant with a number of practical activities is expected to facilitate physics teacher's plan, design, teaching approaches, and learning experiences tailored to meet students' scientific requirements.

Funding: "This research received no external funding"

Conflicts of Interest: "The authors declare no conflict of interest."

References

Abd-El-Khalick, F., & Lederman, N. G. (2000). Improving science teachers' conceptions of nature of science: A critical review of the literature. International Journal of Science Education, 22(7), 665-701.

Adey, P., Hewitt, G., Hewitt, J., & Landau, N. (2004). The Professional Development of Teachers: Practice and Theory. Dordrecht: Kluwer.

Al-Naqbi, A. K., & Tairab, H. H. (2005). The role of laboratory work in school science: Educators' and students' perspectives. Journal of Faculty of Education, 18(22), 19 - 35.

Asamoah, Y. D., Aboagye, K. G. (2019). Integration of practical work into teaching and learning of physics at the senior high school level. The Oguaa Educator, 13, 52 - 69.

Asikainen, M. A., & Hirvonen, P. E. (2010). Finnish cooperating physics teachers' conceptions of physics teachers' teacher knowledge. Journal of Science Teacher Education, 21(4), 431-450.

Aufschnaiter, C., & Aufschnaiter, S. (2007). University students' activities, thinking and learning during laboratory work. European Journal of Physics, 28, 51-60.

Azar, A., & Şengülec, Ö. A. (2011). Computer-Assisted and Laboratory Assisted teaching methods in physics teaching: The effect on student achievement and attitude towards physics. Eurasian Journal of Physics and Chemistry Education (Special Issue), 43-50.

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., & Bransford, D. J. (1998). Doing with understanding: lessons from research on problem and project-based learning. The Journal of the Learning Sciences, 7, 271-311.

Bennett, J. (2003). Teaching and learning science: A guide to recent research and its applications. London: Continuum.

Boz, N., & Boz, Y. (2008). A qualitative case study of prospective chemistry teachers' knowledge about instructional strategies: Introducing particulate theory. Journal of Science Teacher Education, 19(2), 135-156.

Buabeng, I., & Ntow, D. F. (2010). A Comparison study of students' reasons/views for choosing/not choosing physics between undergraduate female non-physics and female physics students at University of Cape Coast. International Journal of Research in Education, 2(2), 44-53.

Bybee, R. (2000). Teaching science as enquiry. In J. Minstrel, & E. H. Van Zee (Eds.), Enquiring into enquiry learning and teaching in science (pp. 20-46). Washington DC: American Association for the Advancement of Science (AAAS).

Cerini, B., Murray, I., & Reiss, M. (2003). Student review of the science curriculum. Major findings. London: Planet Science/Institute of Education University of London/Science Museum. Retrieved from http://www.archive.planet-science.com/sciteach/index.html.

Chiu, M. & Lin, J. W. (2002). Using multiple analogies for investigating fourth graders' conceptual change in electricity. Chinese Journal of Research in Science Education, 10, 109-134.

Cozby, P. C., & Bates, S. C. (2012). Methods in behavioural research (11th ed.). New York, NY: McGraw Hill.

Creswell, J. W. (2014). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). Los Angeles, CA: Sage.

Dillon, J. (2008). A review of the research on practical work in school science. Retrieved from http://www.score-education.org/media/3671/review_of_research.pdf.

Domin, D. S. (2007). Students' perceptions of when conceptual development occurs during laboratory instruction. Chemistry Education Research and Practice, 8(2), 140-152.

Donnelly, J., Buchan, A., Jenkins, E., Laws, P., & Welford, G. (1996). Investigations by order: Policy, curriculum and science teachers' work under the Education Reform Act. Driffield: Studies in Education.

Driver, R. (1995). Constructivist approaches to science teaching. In L. P. Steffe, & J. Gale (Eds.), Constructivism in education (pp. 385-400). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Duschl, R. A. (2000). Making the nature of science explicit. In R. Millar, J. Leach, & J. Osborne (Eds.), Improving science education: The contribution of research (pp. 187-206). Philadelphia: Open University Press.

Fadaei, A. S. (2012). Investigating the effects of teacher training on learning Physics. Latin-American Journal of Physics Education, 6(1), 348-351.

Garnett, P. J., & Hackling, M. W. (1995). Refocusing the chemistry lab: A case for laboratory-based investigations. Australian Science Teacher Journal, 41, 26-32.

Gunstone, R. F. (1991). Reconstructing theory from practical experience. In B. E. Woolnough (Ed.), Practical Science (pp. 67-77). Milton Keynes: Open University Press.

Hodson, D. (1990). A critical look at practical work school science. School Science Review, 70(256), 33-40.

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. In S. K. Abell, & N. G. Lederman (Eds.), Handbook of research on science education (pp. 393-442). Mahwah: Lawrence Erlbaum Associates.

Hofstein, A. (2004). The laboratory in chemistry education: thirty years of experience with developments, implementation and evaluation. Chemistry Education Research and Practice, 5, 247-264.

Hofstein, A., & Cohen, I. (1996). The learning environment of high school students in chemistry and biology laboratories. Research in Science & Technological Education, 14(1), 103-104.

Holstermann, N., Grube, D., & Bögeholz, S. (2009). Hands-on activities and their influence on students' interest. Research in Science Education, 40(5), 743-757.

Institute of Physics. (2014). Promoting teaching practical physics in Ghana. Retrieved from http://www.iop.org/publications/iop/index.htm.

Ishak, M. Z., & Mohamed, Z. (2008). Teacher training of secondary school physics teachers in Malaysia: Critical issues and a new direction. In R. K. Coll, & N. Taylor (Eds.), Science education in context: An international examination of the influence of context on science curricula development and implementation (pp. 301-312). Rotterdam: Sense Publishers.

Jakeways, R. (1986). Assessment of A-level physics (Nuffield) investigations. Physics Education, 21(1), 12-14.

Jarrett, L, Takacs, G. J., & Ferry, B. (2010). Adding value to physics laboratories for pre-service teachers. International Journal of Innovation in Science and Mathematics Education, 18(1), 26-42.

Johnstone, A. H., & Al-Shualili, A. (2001). Learning in the laboratory; some thoughts from the literature. University Chemical Education, 5, 42-50.

Juceviciene, P., & Karenauskaite, V. (2004). Learning environment in physics: The context of double paradigm shift. Retrieved from http:// www.leeds.ac.uk/educol/documents/00003794.htm.

Kannari, Z., & Millar, R. (2004). Reasoning from data: how students collect and interpret data in science investigations. Journal of Research in Science Teaching, 41, 748-769.

Kasanda, C. D. (2008). Improving science and mathematics teachers' subject knowledge in Namibia. In R. K. Coll, & N. Taylor (Eds.), Science education in context: An international examination of the influence of context on science curricula development and implementation (pp. 199-209). Rotterdam: Sense Publishers.

Klafki, W. (2000). Didaktik analysis as the core of the preparation of instruction. In I. Westbury, S. Hopmann, & K. Riquarts (Eds.), Teaching as a reflective practice. The German didaktik tradition (pp. 139-160). London: Lawrence Erlbaum Associates.

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. In S. K. Abell, & N. G. Lederman (Eds.), Handbook of research on science education (pp. 393-442). Mahwah: Lawrence Erlbaum Associates.

Matthews, M. (1994). Science Teaching: The Role of History and Philosophy of Science. New York, NY: Routledge.

Mestre, J. P. (2001). Implications of research on learning for the education of prospective science and physics teachers. Physics Education, 36(1), 44-51.

Michael, V., & Möllmann, K. (2012). Low cost hands-on experiments for Physics teaching. Latin-American Journal of Physics Education, 6(1), 3-9.

Millar, R. (2004). The role of practical work in the teaching and learning of science. Retrieved from http://www.nationalacademies.org/bose/Millar_draftpaper_Jun_04.pdf.

Millar, R., & Abrahams, I. (2009). Practical work: making it more effective. School Science Review, 91(334), 59-64.

Ministry of Education. (2010). Teaching Syllabus for Physics (Senior High School 1-3). Accra, Ghana: Adwinsa Publications.

National Endowment for Science, Technology and the Arts, NESTA. (2005a). Science Teachers Survey. London: NESTA. Retrieved from http://www.planet-science.com/sciteach/realscience/science_teachers_report.pdf.

National Research Council. (2006). America's Lab Report: Investigations in High School Science. Committee on High School Science Laboratories: Role and Vision, S.R. Singer, M. L. Hilton, and H. A. Schweingruber, Editors. Board on Science Education, Centre for Education. Division of Behavioural and Social Sciences and Education. Washington, DC: The National Academies Press.

National Council of Educational Research and Training [NCERT]. (2006). Position paper of national focus group on teaching of science. New Delhi: National Council of Educational Research and Training.

National Council of Educational Research and Training [NCERT]. (2013). Pedagogy of science: Physical science, Textbook for B.Ed (pp. 279-283). New Delhi: National Council of Educational Research and Training.

Okebukola, P. A. O. (1986). An investigation of some factors affecting students' attitudes toward laboratory chemistry. Journal of Chemical Education, 86, 531-532.

Ottander, C., & Grelsson, G. (2006). Laboratory work: the teachers' perspective. Journal of Biology Teaching, 40(3), 113-118.

Oyoo, S. O. (2004). Effective teaching of science: The impact of physics teachers' classroom language. Doctoral Thesis, Faculty of Education, Monash University, Australia.

Perkins-Gough, D. (2007). The Status of the science laboratory, special report. Educational leadership, 93-94.

Pope, M., & Gilbert, J. (1983). Personal experience and the construction of knowledge in science. Science Education, 67(2), 193-203.

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2004). A Review of Research on Outdoor Learning. Preston Montford, Shropshire: Field Studies Council.

Saunders, W. L. (1992). The constructivist perspective: Implications and teaching strategies for science. School Science and Mathematics, 92(3), 136-141.

Scanlon, E., Morris, E., Terry, D. P., & Cooper, M. (2002). Contemporary approaches to learning science: Technologically-mediated practical work. Studies in Science Education, 38(1), 73-114.

Science Community Representing Education, SCORE. (2008). Practical work in science: a report and proposal for a strategic framework. London: Science Community Representing Education (SCORE).

Tamir, P. (1991). Practical work in school science: an analysis of current practice. In B. E. Woolnough (Ed.), Practical science: the role and reality of practical work (pp. 13-20). Milton Keynes: Open University Press.

Taylor, J. A., & Dana, T. M. (2003). Secondary school physics teachers' conceptions of scientific evidence: An exploratory case study. Journal of Research in Science Teaching, 40(8), 721-736.

Thair, M., & Treagust, D. F. (1999). Teacher training reforms in Indonesian secondary science: The importance of practical work in physics. Journal of Research in Science Teaching, 36(3), 357-371.

Tiberghien, A. (2000). Designing teaching situations in the secondary school. In R. Millar, J. Leach, & J. Osborne (Eds.), Improving science education: The contribution of research (pp. 27-47). Buckingham, UK: Open University Press.

Tobin, K. G. (1990). Research on science laboratory activities: In pursuit of better questions and answers to improve learning. School Science and Mathematics, 90(1), 403-418.

Van Driel, J. H., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practical knowledge. Journal of Research in Science Teaching, 38(2), 137-158.

Van Driel, J. H., Verloop, N. & de Vos, W. (1998). Developing science teachers' pedagogical content knowledge. Journal of Research in Science Teaching, 35(6), 673-695.

Wellington, J. (2002). Practical work in science: Time for a re-appraisal. In S. Amos, & R. Boohan (Eds.), Teaching science in secondary schools: A reader (pp. 55-66). London: Routledge.

Wenham, E. J., Dorling, G., Snell, J. A. M., & Taylor, B. (1984). Physics: Concepts and models. London: Addison Wesley.

Wolpert, L. (1992). The Unnatural Nature of Science. Cambridge, MA: Harvard University Press.

Wrenn, J., & Wrenn, B. (2009). Enhancing learning by integrating theory and practice.

Zhaoyao, M. (2002). Physics Education for the 21st Century: Avoiding a Crisis. Physics Education, 37(1), 18-24.