Open Access Library Journal
2024, Volume 11, e11101
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Challenges in Teaching Integrated Science in Junior High Schools

Philip Dorsah[1], Gabriel Awini[1], Mary Okyer[2], Abdul-Ganiu Alhassan[3], Issahaku Shahadu[3], Alban Kaningen Nubazung Kpemuonye[4]

[1]Department of Science Education, C. K. Tedam University of Technology and Applied Sciences, Navrongo, Ghana
[2]Department of Science Education, Ola College of Education, Cape Coast, Ghana
[3]Department of Science Education, Gambaga College of Education, Gambaga, Ghana
[4]Department of Science Education, McCoy College of Education, Nadowli, Ghana
Email: pdorsah@cktutas.edu.gh

How to cite this paper: Dorsah, P., Awini, G., Okyer, M., Alhassan, A.-G., Shahadu, I. and Kpemuonye, A.K.N. (2024) Challenges in Teaching Integrated Science in Junior High Schools. *Open Access Library Journal*, **11**: e11101.
https://doi.org/10.4236/oalib.1111101

Received: December 12, 2023
Accepted: February 23, 2024
Published: February 26, 2024

Abstract

The purpose of this study was to investigate the difficulties of teaching integrated science at the Junior High School level in the Kassena-Nankana Municipality. Based on the positivist paradigm, a survey design was adopted. The study sampled eleven (11) integrated science teachers on purpose. The main challenges of teaching integrated science were discovered to be a lack of laboratories (M = 1.0, SD = 0.00), a lack of laboratory apparatus and equipment (M = 1.85, SD = 0.95), a lack of chemicals for simple experiments (M = 1.22, SD = 0.36), insufficient teaching and learning materials (M = 2.55, SD = 1.09), and insufficient curriculum materials (M = 1.86, SD = 0.64). There were no issues with teacher qualification (M = 3.73, SD = 1.56), teacher adequacy (M = 3.27, SD = 1.19), students' attitudes toward integrated science (M = 3.64, SD = 0.78), or teaching strategy (M = 3.23, SD = 0.28). This means that competent teachers are available in schools to teach integrated science. The study suggested that well-equipped laboratories be established, as well as investments in instructional and educational resources.

Subject Areas

Pedagogy

Keywords

Integrated Science, Science Education, Junior High School, Science Laboratories, Teaching Learning Resources, Kassena-Nankana

1. Introduction

Integrated science is the integration of multiple sciences [1]. Integrated science

in Ghana consists of biology, physics, chemistry, and agricultural science. According to Winarno *et al.* [1] integrated science learning at the basic and secondary levels can equip pupils with a solid foundation for learning additional integrated science or specialist subjects. According to Winarno *et al.* [1], integrated science seeks to integrate concepts, perspectives, and methodologies from many scientific fields in order to comprehend scientific occurrences in everyday life. Integrated science is a science that combines various fields (such as biology, chemistry, and physics) [2]. Educators have obstacles in teaching integrated science in numerous countries [1], and in most cases, teaching integrated science is teacher-centred, limiting student participation. Teachers continue to emphasise one subject over others [1]. Furthermore, teachers are not yet deemed able to design and present scientific content, scientific inquiry, scientific experiments, technology, and societal content [3]. Various governments in Ghana have expressed concern about the condition of science education, and researchers have concentrated on enhancing science education for economic development [4]. There is considerable concern about the outcomes of science instruction in schools all throughout the world. Science's relevance to society is significantly higher than its previous influence on human affairs [5]. Quality integrated science teaching and learning is required for citizens to understand fundamental scientific concepts [6]. Several researchers [4] [7] have reported pupils' disinterest in classroom science. Again, [8] and [9] identified factors such as the teacher's insufficient content knowledge and pedagogical skills, inadequate and inappropriate instructional materials, inappropriate mediums of instruction, a lack of effective supervision and monitoring at school, a lack of motivation for teachers, an insufficient number of qualified teachers, and poor attitudes affecting the teaching of integrated science [6]. According to Kaptan and Timurlenk [5], the issues facing scientific education include inadequate teacher salaries and professional development to recruit high-quality instructors; a lack of science teachers; and a lack of in-service training. Again, Kaptan and Timurlenk [5] noted that pupils lack enthusiasm and self-confidence when learning science and that laboratory facilities are inadequate.

Statement of the Problem

Low interest in science is caused by the less practical and authentic nature of science teaching and learning [4] [7]. Teachers must demystify how students think about science and help them make sense of it in order to make scientific education more successful and entertaining [4]. Science education is currently shifting toward interdisciplinary learning. Nonetheless, the implementation of integrated science in Ghana did not go as well as planned. As a result, students regard integrated science as difficult and boring. The problem with teaching integrated science is that teachers' educational backgrounds are inconsistent with integrated science, as are inadequate textbooks and curricula [1]. In several countries, educators experience problems teaching integrated science [1]. Pre-

vious studies prove that integrated science learning is teacher-centred, hence limiting students' participation. In teaching integrated science, teachers still emphasise within-subject knowledge instead of integrating multiple subjects [1].

It is crucial to note, however, that an integrated curriculum does not inherently result in integration into an individual. Instead, if the curriculum promotes information assimilation, the individual will respond with intellectual reorganisation and transformation [10]. There are difficulties in teaching integrated science, and teachers have consistently expressed concern and apprehension when confronted with the scenario [11]. Again, teacher incompetence is apparent in the manner in which they teach science [11]. Research found that the quality of the educational experience offered by the instructor is the most important element influencing attitudes toward school science [11].

One explanation for student attitudes toward classroom science is a dearth of skilled science teachers. Furthermore, many science teachers are compelled to teach subjects outside of their area of expertise, which undermines their confidence [5]. According to Kaptan and Timurlenk [5], students are interested in studying based on established interests. As a result, the best path ahead is to provide a high-quality science education that is both hard and interesting. Teachers must recognise what students bring to their studies as well as how various teaching approaches engage with their learning. Appropriate teaching approaches should be employed to accommodate the diversity of students' learning styles [5]. The poor performance in integrated science in Kassena-Nankana municipality could be related to various obstacles teachers experience in teaching and learning integrated science. As a result, the following questions are addressed in this research: What challenges do teachers face when teaching integrated science in junior high schools?

2. Literature Review

2.1. Teaching and Learning Resources

Teaching and learning resources can be described as the tools used to convey and transmit the specified educational material. Images, maps, pictures, sketches, schematics, films, and written information such as newspaper clippings or articles from scientific and technical literature are examples of this. The goal of using teaching and learning materials in class is to help the teacher with the presentation and transmission of educational content, as well as the attainment of educational objectives, while also assisting students in acquiring knowledge and profiling various abilities and values [12]. Teaching and learning resources have benefits such as increasing student motivation, developing creativity, evoking prior knowledge, encouraging understanding, decoding, organising, and synthesising educational content, logical thinking, communication, and interaction, and contributing to the development of different skills and the acquisition of values in students [12]. Science equipment and resources assist pupils learn scientific topics and allow them to experiment [13].

2.2. Laboratory in Science Education

The science laboratory is crucial to our efforts to diversify the learning environment in which students build their grasp of scientific concepts, science inquiry skills, and science perceptions [14]. The science laboratory, a one-of-a-kind learning environment, is a place in which students can examine scientific phenomena in small groups. Laboratory activities can improve constructive social interactions, positive attitudes, and cognitive growth [15] [16]. A school laboratory's social environment is typically less formal than that of a traditional classroom; thus, the laboratory provides opportunities for productive, cooperative interactions among students and with the teacher, which have the potential to promote an especially positive learning environment. Tobin [17] proposed that effective learning in the laboratory is achievable if students are given the opportunity to operate equipment and materials in an atmosphere conducive to building their understanding of phenomena and related scientific concepts. Again, Tobin [17] posits that "laboratory activities appeal as a way of allowing students to learn with understanding and engage in a process of constructing knowledge by doing science" (p. 405).

Inquiry refers to the various methods used by scientists to explore the natural world, propose ideas, and explain and justify assertions based on data acquired through scientific effort. It also refers to more authentic methods for students to examine the natural world, suggest ideas, and explain and justify assertions based on facts [14]. According to Gunstone [18], while using the laboratory to help students reconstruct their knowledge may appear rational, it is also naïve because creating scientific concepts from practical experiences is a very complex process. Thus, according to Gunstone and Champagne [19], effective learning in the laboratory would occur if students were given enough time and chances for interaction and reflection.

Many scientific educators now use a constructivist model as a theoretical organiser [14], which states that learners develop their ideas and understandings based on a succession of personal experiences. Tobin [17] defined learning as a dynamic, interpretative, iterative process. A social constructivist framework has a unique potential for guiding laboratory instruction. Students learn more scientific notions in interaction with peer investigators when they interact with challenges that they view to be important and connected to their experiences. According to research, laboratory inquiry alone cannot assist students in developing the complex conceptual understandings required by the contemporary scientific community [14].

According to researchers, science cannot be interesting to pupils unless they have worthwhile practical experiences in the school laboratory [20]. Laboratory experiences have been claimed to promote central science education goals such as improving students' understanding of scientific concepts and applications; scientific practical skills and problem-solving abilities; understanding of how science and scientists work; and interest and motivation [20]. Inquiry-style la-

boratories have the potential to develop students' abilities and skills in areas such as posing scientifically oriented questions [21] [22], developing hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments [20]. The laboratory has been given a central and distinct position in science education, and science educators have indicated that using laboratory activities provides rich learning benefits [23]. The laboratory is especially significant since inquiry has re-emerged as a primary style promoted for science teaching and learning. Making observations, posing questions, examining books and other sources of information to see what is already known, planning investigations, reviewing what is already known through experimental evidence, using tools to gather, analyse, and interpret data, proposing answers, explanations, and predictions, and communicating the results are all part of the process of inquiry. Inquiry necessitates the recognition of assumptions, the use of critical and logical thinking, and the evaluation of alternative answers [23]. The learning environment is heavily influenced by the activities performed in the laboratory, the teachers' and students' expectations, and the nature of assessment. It is influenced in part by the materials, apparatus, resources, and physical setting, but the resulting learning environment is much more a function of the climate and expectations for learning, collaboration and social interactions between students and teacher, and the nature of the inquiry pursued in the laboratory [23].

3. Methodology

3.1. Design of the Study

A survey design was used to investigate the obstacles that teachers face in teaching integrated science. Survey research can create intriguing data sets that allow researchers to analyse the relationship between concepts as well as evaluate causation [24].

3.2. Sample and Sampling Procedures

The study sample included 11 integrated science teachers selected from three junior high schools. All junior high school teachers in the Kassena-Nankana municipality were the target population. First, the three schools were chosen at random using simple random sampling. The sample's inclusion criteria were junior high school integrated science teachers. All integrated science teachers in the three schools were purposefully chosen for the study. Purposive sampling is a nonprobability sampling approach in which elements are chosen from the target population based on their fit with the study's objectives and specific inclusion and exclusion criteria [25].

3.3. Instruments for Data Collection

A questionnaire was utilised to collect data. The questionnaire was created by the researchers and consisted of 25 Likert-type items measuring the challenges of

teaching integrated science on a 5-point Likert scale with alternatives ranging from strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The items were developed based on the researchers' experiences and from the literature on the challenges of teaching integrated science. The questionnaire had nine dimensions or thematic areas: availability of laboratories, availability of lab apparatus, availability of chemicals, availability of teaching and learning resources, adequacy of teachers, teacher qualification, student attitudes toward integrated science, use of appropriate teaching approaches, and adequacy of curriculum materials. Internal consistency was verified using Cronbach's alpha reliability coefficient, which was 0.83, to confirm the reliability of the instrument. This helps to verify that the questions within each concept were consistently measured. To guarantee a sufficient response rate, the questionnaire was administered face-to-face [26]. Before data collection, informed consent was obtained, and participants were informed of the methods, risks, and benefits involved with the study.

3.4. Data Analysis

The information gathered was coded and entered into the computer. The data was analysed using descriptive statistics, such as frequencies and percentages, using the computer software SPSS.

4. Results

4.1. Demographic Characteristics of Participants

Table 1 shows the schools that participated in the research. Most of the participants (63.6%) were from Namolo Junior High School. Two teachers (18.2%) from St. John Bosco JHS and the other two (18.2%) from Adabayeri Junior High School.

Table 2 presents the sex of the participants. Many of the participants (54.5%)

Table 1. Schools selected for the study.

School	Frequency	Percent
St John Bosco JHS	2	18.2
Adabayeri	2	18.2
Namolo	7	63.6
Total	**11**	**100**

Table 2. Sex of participants.

Sex	Frequency	Percent
male	6	54.5
Female	5	45.5
Total	**11**	**100**

were males, while 45.5% were females.

The age distribution of the participants is shown in Table 3. Four participants (36.4%) were found to be between the ages of 25 and 30, two (18.2%) were between the ages of 31 and 36, four (36.4%) were between the ages of 37 and 42, and one (9.1%) was between the ages of 43 and 48. The majority of participants are divided into two age groups: 25 - 30 and 37 - 42, which account for 36.4% of all participants.

Table 4 shows the participants' professional qualifications. The majority of participants (81.8%) have a bachelor's degree in education, 9.1% have a teaching certificate, and the remaining 9.1% have a diploma in education.

4.2. Challenges of Teaching Integrated Science

Table 5 displays descriptive information about the difficulties of teaching integrated science.

According to the findings, there are challenges in teaching integrated science with an overall mean below 3.0 (M = 2.30, SD = 0.49). The bulk of items had mean scores that were less than 3.0. However, some items have mean scores above 3.0, such as there are charts and posters for teaching science processes (M = 3.64, SD = 1.03); there are adequate science teachers (M = 3.27, SD = 1.19); teachers are all trained science teachers (M = 3.73, SD = 1.56); students have a positive attitude towards science (M = 3.64, SD = 0.81); students like science (M = 3.64, SD = 0.92); I mostly use demonstration method to teach science (M = 3.09, SD = 1.51); I often give projects to my students (M = 3.73, SD = 0.65) and I often use an inquiry approach in teaching science (M = 3.45, SD = 1.21). Table 6 presents the thematic areas of the challenges of teaching integrated science.

It was found that the main challenges of teaching integrated science are a lack

Table 3. Age of participants.

Age	Frequency	Percent
25 - 30	4	36.4
31 - 36	2	18.2
37 - 42	4	36.4
43 - 48	1	9.1
Total	**11**	**100**

Table 4. Professional qualification.

Qualification	Frequency	Percent
Teaching certificate A	1	9.1
Diploma in education	1	9.1
Bachelor in Education	9	81.8
Total	**11**	**100**

Table 5. Descriptive statistics of the challenges of teaching integrated science.

S/N	Statement	N	M	SD
1	There is a laboratory for doing science practicals	11	1.00	0.00
2	There is laboratory equipment for teaching science	11	1.73	1.42
3	There are chemicals for performing basic experiments	11	1.00	0.00
4	There is iodine for testing for starch	11	1.00	0.00
5	There are HCl and H_2SO_4 for teaching acidity	11	1.09	0.30
6	There are litmus papers for testing acids and bases	11	1.73	1.42
7	There are other indicators, e.g. methyl orange, for testing acids and bases	11	1.73	1.19
8	There are chemicals for doing food test	11	1.27	0.47
9	There are enough thermometers	11	2.82	1.47
10	There are enough magnets to teach magnetism	11	1.91	1.22
11	There are hand lenses	11	1.09	0.30
12	There are models for teaching the human skeleton	11	2.27	1.62
13	There are models for teaching the human body and organs	11	2.64	1.43
14	There are charts and posters for teaching science processes, such as digestion and respiration	11	3.64	1.03
15	There are adequate science teachers	11	3.27	1.19
16	Teachers are all trained science teachers	11	3.73	1.56
17	The students have a positive attitude toward science	11	3.64	0.81
18	The students like science	11	3.64	0.92
19	I mostly use the lecture method to teach science	11	2.64	1.43
20	I mostly use the demonstration method to teach science	11	3.09	1.51
21	I often give projects to my students	11	3.73	0.65
22	inquiry approach in teaching science	11	3.45	1.21
23	There are enough science textbooks for teachers	11	1.73	1.01
24	There are curriculum materials for science teachers	11	2.00	0.89
25	There are computers for teaching science	11	1.64	1.21
	Overall mean	**11**	**2.30**	**0.49**

of laboratories (M = 1.00, SD = 0.00), a lack of laboratory apparatus and equipment (M = 1.85, SD = 0.95), a lack of chemicals for performing simple experiments (M = 1.22, SD = 0.36), inadequate teaching and learning materials (M = 2.55, SD = 1.09), and inadequate curriculum materials (M = 1.86, SD = 0.64). However, teacher qualification was not a challenge in the schools selected (M = 3.73, SD = 1.56), there were adequate teachers (M = 3.27, SD = 1.19), students' attitude towards integrated science was positive (M = 3.64, SD = 0.78), and the

Table 6. Means and Standard deviations of challenges in teaching integrated science.

S/N	Challenges	M	SD
1	Teacher Qualification	3.73	1.56
2	Students' Attitudes	3.64	0.78
3	Adequacy of Teachers	3.27	1.19
4	Use of appropriate teaching approach	3.23	0.28
5	Availability of TLRs	2.55	1.09
6	Adequacy of curriculum materials	1.86	0.64
7	Availability of Lab Apparatus	1.85	0.95
8	Availability of Chemicals	1.22	0.36
9	Availability of Laboratories	1.00	0.00

teachers used an appropriate teaching approach (M = 3.23, SD = 0.28). This implies there are adequate and qualified teachers in the schools for teaching integrated science. The students have a positive attitude and interest in science, and the teachers used the right methods for teaching integrated science, such as inquiry-based teaching, project-based teaching, demonstrations and hands-on activities.

5. Discussion

It was found that the main challenges of teaching integrated science are a lack of laboratories, a lack of laboratory apparatus and equipment, a lack of chemicals for performing simple science experiments, inadequate teaching and learning materials, and inadequate curriculum materials. The findings of this study are consistent with those of previous studies. For example, Adu-Gyamfi [4] found that science teaching materials and equipment are not available in schools. Again, the schools at the JHS level are without science laboratories [4]. The science laboratory has been recognised as a unique instructional environment that allows students to engage in processes of investigation and inquiry in a manner that makes student learning more meaningful than with other forms of science instruction [27]. Science educators have suggested that numerous benefits accrue from engaging students in science laboratory activities [16] [19]. Laboratories help in developing favourable attitudes towards science, which has often been listed as one of the important goals of science teaching [28]. Hofstein and Lunetta [16] have suggested that the laboratory, as a unique social setting, has great potential to enhance social interactions that can contribute positively to developing attitudes and cognitive growth. Students enjoy laboratory work in some courses, which can improve student attitudes and interest in science. The science laboratory is a setting in which students work cooperatively in small groups to investigate phenomena, a unique mode of instruction, and a unique mode of learning environment [28]. Cooperative team effort is required for

many laboratory activities, which provide opportunities for more constructive interactions between students and between students and their teachers and thus create a positive learning environment [19] [28].

Parker, Osei-Himah, and Asare [11] found that integrated science teachers think the lack of resources has a negative effect on their lesson delivery. Again, Parker *et al.* [11] reported that the majority (78.6%) of integrated science teachers stated that the physical space, materials, and equipment needed to teach science are inadequate. Parker *et al.* [11] reported that a lack of science resource centres in schools is a barrier that has a negative effect on lesson delivery. Quansah, Sakyi-Hagan, and Essiam [6] found that appropriate use of instructional material ensures effective teaching and learning of science. Adequate instructional materials and strategies give students the chance to use their senses of hearing, smelling, tasting, seeing, and feeling [29]. If instructional materials are inadequate, students are made to read textbooks while the teachers explain the concepts to them instead of performing activities as suggested by the integrated science curriculum [30].

Adu-Gyamfi [4] found that students' negative attitudes toward integrated science are a challenge. Adu-Gyamfi [4] reported that students' lack of preparedness to learn is a challenge in the teaching and learning of integrated science. The students perceived, integrated science as a difficult subject compared to the other subjects they study at the JHS level. In this study, it was found that integrated science teachers use appropriate teaching approaches, such as inquiry approaches, projects, and demonstrations. Consistent with these findings, Adu-Gyamfi [4] found that science teachers adapt to the use of the demonstration due to insufficient science equipment. However, Kebbie [31] reported that teachers' use of the wrong methodology in teaching science is another factor responsible for poor performance in science.

This study found that teacher qualifications were not a challenge in schools. Similarly, Green and Osah-Ogulu [32] found that integrated science teachers are competent but weak in pedagogy. The challenges faced by teachers consequently affect students' perceptions of integrated science [1]. This study found that students have a positive attitude towards integrated science as perceived by the teachers. According to research, students find integrated science difficult, boring, and uninteresting [1]. Putri and Widiyatmoko [33] reported that integrated science worksheets were effective for learning. Therefore, integrated science teachers must know the right learning strategies and develop the ability to use different approaches creatively [34]. One factor that influences the successful implementation of integrated science is teacher quality. Training in integrated science for teachers is also necessary to improve teachers' competence.

6. Conclusion

A barrier to teaching integrated science is a lack of laboratory equipment, reagents, and apparatus for teaching science. Laboratories are essential in the

teaching of integrated science. Teachers cannot teach concepts to children who do not have access to basic science equipment and materials. As a result, it is recommended that laboratory facilities be provided at junior high schools to support integrated science teaching and learning. Another issue in teaching integrated science is the lack of suitable teaching and learning materials, as well as curriculum materials. The relevance of teaching and learning materials in science lessons cannot be overstated [13]. Teaching and learning resources are critical to creating a constructivist learning environment. As a result, the Ghana Education Service should provide curriculum materials, and teaching and learning resources to support integrated science education in primary schools.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Winarno, N., Rusdiana, D., Riandi, R., Susilowati, E., Mega, R. and Afifah, A. (2020) Implementation of Integrated Science Curriculum: A Critical Review of the Literature. *Journal for the Education of Gifted*, **8**, 795-817. https://doi.org/10.17478/jegys.675722

[2] Hewitt, P.G., Lyons, S.A., Suchocki, J.A. and Yeh, J. (2013) Conceptual Integrated Science: Pearson New International Edition. Pearson Higher Ed., UK.

[3] Sun, D., Wang, Z.H., Xie, W.T. and Boon, C.C. (2014) Status of Integrated Science Instruction in Junior Secondary Schools of China: An Exploratory Study. *International Journal of Science Education*, **36**, 808-838. https://doi.org/10.1080/09500693.2013.829254

[4] Adu-Gyamfi, K. (2016) Challenges Face by Science Teachers in the Teaching of Integrated Science in Ghanaian Junior High Schools. *Journal of Science and Mathematics Education*, **6**, 59-80.

[5] Kaptan, K. and Timurlenk, O. (2012) Challenges for Science Education. *Procedia—Social and Behavioral Sciences*, **51**, 763-771. https://doi.org/10.1016/j.sbspro.2012.08.237

[6] Quansah, R.E., Sakyi-Hagan, N.A. and Essiam, C. (2011) Challenges Affecting the Teaching and Learning of Integrated Science in Rural Junior High Schools in Ghana. *Science Education International*, **30**, 329-333. https://doi.org/10.33828/sei.v30.i4.10

[7] Adu-Gyamfi, K. (2013) Lack of Interest in School Science among Non-Science Students at the Senior High School Level. *Problems of Education in the* 21*st Century*, **53**, 7-21. https://doi.org/10.33225/pec/13.53.07

[8] Anamuah-Mensah, J., Ananga, E.D., Wesbrook, J. and Kankam, G. (2017) National Teachers' Standards for Ghana-Guidelines. Ministry of Education, Accra.

[9] Ngman-Wara, E.I. (2015) Ghanaian Junior High School Science Teachers' Knowledge of Contextualised Science Instruction. *Journal of Curriculum and Teaching*, **4**, 174-176. https://doi.org/10.5430/jct.v4n1p167

[10] Harrell, P.E. (2010) Teaching an Integrated Science Curriculum: Linking Teacher Knowledge and Teaching Assignments. *Issues in Teacher Education*, **19**, 145-165.

[11] Parker, J., Osei-Himah, V. and Asare, I. (2018) Challenges Faced by Teachers in

Teaching Integrated Science in Junior High Schools in Aowin Municipality-Ghana. *Journal of Education and Practice*, **9**, 65-68.

[12] Bušljeta, R. (2013) Effective Use of Teaching and Learning Resources. *Czech-Polish Historical and Pedagogical Journal*, **5**, 55-69. https://doi.org/10.2478/cphpj-2013-0014

[13] Osei-Himah, V. and Adu-Gyamfi, K. (2022) Teachers' Perspective of Effective Use of Teaching and Learning Materials in Basic School Integrated Science Lessons. *Asian Journal of University Education* (*AJUE*), **18**, 257-270. https://doi.org/10.24191/ajue.v18i1.17195

[14] Hofstein, A. and Lunetta, V.N. (2004) The Laboratory in Science Education: Foundations for the Twenty-First Century. Wiley Periodicals, Inc., Hoboken.

[15] Hofstein, A. and Lunetta, V.N. (1982) The Role of the Laboratory in Science Teaching: Neglected Aspects of Research. *Review of Educational Research*, **52**, 201-217. https://doi.org/10.3102/00346543052002201

[16] Lazarowitz, R. and Tamir, P. (1994) Research on Using Laboratory Instruction in Science. In: Gabel, D.L., Ed., *Handbook of Research on Science Teaching and Learning*, Macmillan, New York, 94-130.

[17] Tobin, K.G. (1990) Research on Science Laboratory Activities: In Pursuit of Better Questions and Answers to Improve Learning. *School Science and Mathematics*, **90**, 403-418. https://doi.org/10.1111/j.1949-8594.1990.tb17229.x

[18] Gunstone, R.F. (1991) Reconstructing Theory from Practical Experience. In: Woolnough, B.E., Ed., *Practical Science*, Open University Press, Milton Keynes, 67-77.

[19] Gunstone, R.F. and Champagne, A.B. (1990) Promoting Conceptual Change in the Laboratory. In: Hegarty-Hazel, E., Ed., *The Student Laboratory and the Science Curriculum*, Routledge, London, 159-182.

[20] Hofstein, A. and Mamlok-Naaman, R. (2007) The Laboratory in Science Education: The State of the Art. *Chemistry Education Research and Practice*, **8**, 105-107. https://doi.org/10.1039/B7RP90003A

[21] Krajcik, J., Mamlok, R. and Hug, B. (2001) Modern Content and the Enterprise of Science: Science Education in the Twentieth Century. In: Corno, L., Ed., *Education across a Century*: *The Centennial Volume*, University of Chicago Press, Chicago, 205-238. https://doi.org/10.1177/016146810110300708

[22] Hofstein, A., Navon, O., Kipnis, M. and Mamlok-Naaman, R. (2005) Developing Students' Ability to Ask More and Better Questions Resulting from Inquiry-Type Chemistry Laboratories. *Journal of Research in Science Teaching*, **42**, 791-806. https://doi.org/10.1002/tea.20072

[23] Hofstein, A.V.I. and Lunetta, V.N. (2003) The Laboratory in Science Education: Foundations for the Twenty-First Century. Wiley Periodicals, Inc., Hoboken. https://doi.org/10.1002/sce.10106

[24] Toon, M. (2020) Survey Design for Quantitative Analysis: A Large-Scale Investigation into Stress and Burnout within the UK Dental Profession. Sage Research Methods Cases: Medicine and Health. SAGE Publications, Ltd., London. https://doi.org/10.4135/9781529744224

[25] Daniel, J. (2012) Choosing the Type of Nonprobability Sampling. SAGE Publications, Inc., London. https://doi.org/10.4135/9781452272047.n4

[26] Ornstein, M. (2013) Survey Data Collection. SAGE Publications Ltd., London. https://doi.org/10.4135/9781473913943.n7

[27] Domin, D.S. (2007) Students' Perceptions of When Conceptual Development Oc-

curs during Laboratory Instruction. *Educational Research*, **8**, 140-152. https://doi.org/10.1039/B6RP90027E

[28] Hofstein, A. (2004) The Laboratory in Chemistry Education: Thirty Years of Experience with Developments, Implementation, and Research. *Chemistry Education: Research and Practice*, **5**, 247-264. https://doi.org/10.1039/B4RP90027H

[29] Opara, P.N. and Etukudo, D.U. (2014) Factor Affecting Teaching and Learning of Basic Science and Technology in Primary Schools. *Journal of Educational Policy and Entrepreneurial Studies*, **1**, 46-58.

[30] Azure, J. (2015) Senior High School Students' Views on the Teaching of Integrated Science in Ghana. *Journal of Science Education and Research* (*JOSER*), **1**, 49-61.

[31] Kebbie, T. (2022) Integrated Science Teaching and Learning in Junior Secondary Schools in Sierra Leone: Challenges and the Way Forward. *International Journal for Research Trends and Innovation*, **7**, 787-795.

[32] Green, R.D. and Osah-Ogulu, D.J. (2003) Integrated Science Teachers' Instructional Competencies: An Empirical Survey in Rivers State of Nigeria. *Journal of Education for Teaching*, **29**, 149-158. https://doi.org/10.1080/0260747032000092657

[33] Putri, B.K. and Widiyatmoko, A. (2013) Pengembangan LKS IPA Terpadu Berbasis Inkuiri Tema Darah Di SMP N 2 Tengaran. *Jurnal Pendidikan IPA Indonesia*, **2**, 102-106.

[34] Alake, E.M. and Ogunseemi, O.E. (2013) Effects of Scaffolding Strategy on Learners' Academic Achievement in Integrated Science at the Junior Secondary School Level. *European Scientific Journal*, **9**, 149-155. http://www.eujournal.org/index.php/esj/article/view/1548