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Factors Impinging on Science Teaching and Learning at the College of Education in Ghana: A Mixed Method Study

Ebenezer Appah Bonney
Principal, Science Department, Peki College of Education, Ghana,
<https://orcid.org/0000-0002-5945-8863>

ABSTRACT

This study examined institutional, instructional, and resource-related factors affecting the teaching and learning of Integrated Science in Ghanaian Colleges of Education. Using a sequential explanatory mixed-methods design, data were collected from 543 teacher trainees, 33 tutors, and 36 administrators across six colleges through questionnaires, interviews, and focus groups. Quantitative findings identified insufficient instructional time, limited teaching and learning resources, and inadequate practical opportunities as major challenges, whereas syllabus coverage, assessment techniques, and tutors' beliefs had limited influence. Qualitative findings expanded these results by revealing inadequate laboratories, obsolete equipment, and competing co-curricular activities that constrained science instruction. Integrated findings showed that lecturers and administrators adopted adaptive strategies such as demonstrations, improvisation of materials, and the use of national service personnel despite persistent institutional constraints. The study concludes that improving instructional time, infrastructure, and practical resources is essential for strengthening science teacher education in Ghana.

Keywords: Colleges of Education; Educational Resources; Instructional Time; Integrated Science; Science Education; Teacher Trainees

INTRODUCTION

The teaching and learning of science is crucial in preparing students in educational institutions to support the teaching and learning process in colleges. According to the European Union [EU] (2012), teachers have a significant influence on how students perform in educational settings. Many governments and researchers have expressed interest in the state of science education and learning. Many countries focus on enhancing science education in order to have an impact on the economy (Adu-Gyamfi, 2014). Creating a learning environment that is focused on the needs of the students is the main goal of teaching science at the College of Education. To deliver a new curriculum that concentrated on fostering critical thinking, an active and child-centered strategy was required (Davidson, 2010). According to a study done in 2013 by Al Shammeri to look at the opinions of 136 science teachers in Kuwait, these teachers deal with a variety of difficulties, including a heavy workload, a lack of teaching resources, insufficient professional development, not enough time set aside to teach science, and problems with class management due to large class sizes. Additionally, Sengul et al. (2008) conducted another study in Turkey that revealed the difficulties primary science instructors faced, including a lack of pedagogical competence, a lack of physical resources, and a lack of time. Moreover, Al Ghamdi and Al Salouli (2013) cite a number of obstacles that prevent the teaching and learning of science, including a lack of instructional time, physical space restrictions, a lack of resources, and a lack of professional development. Students' poor attitude and interest towards school science is an issue identified across the world (Adu-Gyamfi, 2014; Fenshan, 2008; UNESCO, 2010). In Ghana, a study by Adu-Gyamfi (2013) asserts that students' lack of interest in science is based on the fact that they will have to spend more time and energy learning science, and the less practical nature of learning school science. According to a 2013 study by Adu-Gyamfi in Ghana, students' disinterest in science is due to the fact that learning science requires more time and effort and has a less practical focus than other subjects. According to research by Probyn (2005) in Grahamstown, South Africa, teaching science in a second language did not improve the efficiency of the teaching and learning process. Once more, a study by Pryor and Ampiah (2003) found that the majority of instructors were concerned about the language policy followed by Ghanaian Basic Schools, where the lower primary's L1 language of instruction. This is because all materials, with

the exception of those in Ghanaian, are written in L2, and students found it challenging to understand exercises and activities written in L2.

According to Mereku (2013), the curriculum for colleges of education (CoE) is not flexible enough to take into account new issues with the educational system like: 1. dealing with kids who struggle with reading, comprehension, and writing; 2. introducing problem-solving concepts; 3. assigning tough school-based assessment (SBA) assignments; 4. utilising data from national assessments (NEA & SEA) to enhance instruction; 5. creation of a plan to improve school performance (SPIP). According to Section (4)(d) of the Colleges of Education Act, a college of education must make sure that basic research and action research are conducted at the college level to ensure high-quality instruction and learning in the classroom (Government of Ghana, 2012). This claim, about the culture of study and publishing research findings, is essentially untrue at the Ghanaian CoE (Newman, 2013). Again, according to Newman (2013), the lack of research capacity in colleges of education is a result of the fact that during their time as non-tertiary institutions, the colleges' primary focus was on teaching and learning, and that their faculty members were not required to conduct research or publish their findings in order to advance their careers.

As a result, it would be challenging for the current group of college tutors to oversee the creation of high-quality research outputs among their students. In addition, research by Newman (2013) on the conversion of teacher-training programmes into CoE found that only about 37.55% of the colleges' faculty members hold master's or doctoral degrees. Furthermore, according to NAB's 2007 research, only 0.01% of teachers with master's degrees from CoE are qualified in the pertinent field. The majority of teachers in CoE who hold advanced degrees are trained in educational management (NAB, 2007). The laboratory and workshop equipment in the colleges was outdated, insufficient, and badly maintained, according to a NAB (2007) study. The board once more stated that tutors at institutions of education need office space. The NCTE confirmed the National Accreditation Board's assessment that "furnishing in the laboratories is quite low and equipment is not only meagre and puny, but out of date," as quoted in Newman (2013). Despite the fact that certain decisions have been implemented to improve infrastructure and equipment in the Colleges, not much has changed since the Colleges were elevated to tertiary status.

This study contributes to science education literature by providing empirical evidence from Ghanaian CoE on how institutional and instructional conditions shape science teaching and learning in teacher education institutions within developing country contexts. The study further contributes methodologically by integrating quantitative and qualitative evidence to provide a more comprehensive understanding of science education challenges in higher education.

Purpose of the Study

In spite of increasing concern about science education in developing countries like Ghana, limited empirical studies have examined how institutional, instructional, and resource-related factors collectively influence science teaching and learning in Ghanaian CoE. Existing studies have largely focused on students' attitudes toward science, with less attention given to how infrastructural limitations, instructional conditions, administrative practices, and learning resources shape science education outcomes in teacher education institutions. Therefore, this study employed a sequential explanatory mixed methods design to examine the factors impinging on science teaching and learning in CoE in Ghana and to explore how tutors, teacher trainees, and college administrators perceive and manage these challenges.

Objective of the Study

The purpose of this study was to examine the institutional, instructional, and resource-related factors that impinge on science teaching and learning in Ghanaian CoE. Specifically, the study sought to:

1. Identify the major factors affecting science teaching and learning in CoE in Ghana.
2. Examine how these factors are perceived by teacher trainees, tutors, and college administrators.
3. Explore the strategies adopted by stakeholders to manage or minimise these challenges.

Research Question

The following research questions guided the study:

1. What institutional, instructional, and resource-related factors impinge on science teaching and learning in Ghanaian CoE as perceived by teacher trainees, tutors, and college administrators?
2. How do teacher trainees, tutors, and college administrators describe their experiences regarding the challenges affecting science teaching and learning in CoE in Ghana?
3. In what ways do the qualitative findings help explain and expand the quantitative results regarding factors impinging on science teaching and learning in Ghanaian CoE?

LITERATURE REVIEW

Science Education in Developing Countries

Science education plays a critical role in national development, technological advancement, and economic growth, particularly in developing countries where scientific literacy is necessary for addressing social and economic challenges. According to UNESCO, strengthening science education remains essential for

promoting innovation, problem-solving, and sustainable development within emerging economies. However, many developing countries continue to face significant challenges in science teaching and learning, including inadequate infrastructure, insufficient instructional resources, overcrowded classrooms, and limited teacher preparation (UNESCO, 2021). Studies conducted across Africa and other developing contexts have shown that institutional constraints significantly affect the quality of science education delivery (Ojetunde & Ramnarain, 2026; Elizabeth, 2026). These challenges are particularly critical in teacher education institutions because they directly influence the preparation of future science teachers. Consequently, improving science teaching and learning within Colleges of Education has become an important educational priority in many developing countries.

Institutional and Resource-Related Challenges in Science Education

Several studies have identified inadequate teaching and learning resources as major barriers to effective science education. Science instruction requires laboratories, demonstration equipment, practical materials, libraries, and technological resources to facilitate inquiry-based and practical learning (Darling-Hammond et al., 2020). However, many teacher education institutions in developing countries experience shortages of laboratory equipment, overcrowded classrooms, and insufficient instructional materials (Penn & Ramnarain, 2022). Research conducted in sub-Saharan Africa indicates that inadequate infrastructure negatively affects students' participation and achievement in science subjects (Ogunniyi et al., 2026). Similarly, studies in Ghana have reported that many CoEs lack adequately equipped science laboratories and sufficient practical resources necessary for effective science instruction (Adu-Gyamfi, 2014; Newman, 2013). In addition to physical resources, instructional time has been identified as a significant factor affecting science learning outcomes. According to Lavy (2015), increased instructional time positively influences student achievement and engagement. Nevertheless, studies suggest that science teachers in many developing countries often experience insufficient time for practical activities due to overloaded curricula and administrative interruptions (Okeke & Okoye, 2013).

Instructional and Pedagogical Challenges in Science Teaching

Effective science teaching requires learner-centered pedagogical approaches that actively engage students in experimentation, inquiry, and critical thinking. However, previous studies have shown that many science tutors continue to rely heavily on lecture-based instructional approaches because of large class sizes, limited instructional materials, and curriculum pressures (Al Shammeri, 2013; Sengul et al., 2008). Studies further indicate that inadequate professional development opportunities and limited pedagogical support affect science tutors' ability to implement practical and student-centered instructional strategies

effectively (Darling-Hammond et al., 2020). In Ghanaian CoE, concerns have also been raised regarding the preparedness of tutors to support effective science instruction, particularly in contexts characterised by limited resources and expanding teacher education reforms (Newman, 2013).

Students' Attitudes and Perceptions Toward Science

Students' attitudes toward science have also been identified as important factors influencing science learning and participation. Research has shown that students who perceive science as difficult, abstract, or examination-oriented are less likely to develop sustained interest in science-related careers (Osborne et al., 2003; George, 2006). Negative attitudes toward science may reduce students' motivation, classroom participation, and academic engagement. In Ghana, Adu-Gyamfi (2013) found that some students perceive science as difficult and demanding due to the abstract nature of scientific concepts and limited opportunities for practical learning. Nevertheless, scholars argue that students' attitudes toward science are often shaped by broader institutional and instructional conditions, including the availability of resources, quality of teaching, and classroom experiences (Oh & Yager, 2004).

Science Teacher Education in Ghanaian Colleges of Education

Ghanaian Colleges of Education play a central role in preparing teachers for basic education. Following their conversion into tertiary institutions, Colleges of Education have been expected to strengthen teacher preparation, improve research capacity, and enhance instructional quality (Government of Ghana, 2012). However, several studies have reported persistent institutional challenges affecting teacher education in Ghana. Newman (2013) observed that many Colleges of Education continue to experience inadequate research capacity, insufficient qualified staff, and infrastructural deficiencies despite their tertiary status. Similarly, reports by the National Accreditation Board (2007) identified outdated laboratory equipment, inadequate facilities, and insufficient office and teaching spaces in many colleges. These institutional conditions may significantly affect the quality of science teacher preparation and ultimately influence science teaching and learning outcomes within Colleges of Education.

Research Gap

Although previous studies have examined students' attitudes toward science and challenges affecting science education in Ghana, limited research has comprehensively explored how institutional, instructional, and resource-related factors collectively affect science teaching and learning within Ghanaian Colleges of Education. In addition, few studies have integrated the perspectives of teacher trainees, tutors, and college administrators using a mixed methods approach. Therefore, this study addresses this gap by employing a sequential explanatory

mixed methods design to examine the factors impinging on science teaching and learning in Colleges of Education in Ghana.

RESEARCH METHOD

Research Design

The sequential explanatory mixed methods research design was used in the study (Creswell, 2003, 2005). A mixed method approach, according to Creswell (2012), "provides a deeper comprehension of a study problem and questions than either method by itself" (p.535). The mixed method approach adheres to the pragmatic paradigm (Gray, 2009), which holds that knowledge is socially created and based on the facts of our experience in the world (Gray, 2009). According to the pragmatists, it is the researcher's responsibility to do their research using whichever methods are practical (Frankel et al., 2012). The researchers were able to gather information from teacher trainees, administrators, and tutors using a mixed-methods technique. Additionally, it gave a fuller picture of the subjects being researched (Mertler & Charles, 2008). From November 2017 through February 2018, a four-month period was covered by this. In order to gather data for this study, questionnaires for teacher trainees, tutors, administrators, and interview guides were used. A sequential explanatory mixed methods design was adopted in this investigation. In the present study, the quantitative phase preceded the qualitative phase and informed the selection of issues explored during interviews and focus group discussions. The quantitative findings identified major concerns such as inadequate instructional time, poor laboratory facilities, insufficient teaching and learning resources, and negative perceptions toward Integrated Science. These findings guided the development of the qualitative interview questions, which sought deeper explanations and contextual understanding of the statistical results. Integration occurred during the discussion stage, where qualitative findings were used to explain, confirm, and expand the quantitative results. This design has the benefit of clearly delineated quantitative and qualitative components, which is advantageous to both readers and those responsible for planning and carrying out the study (Creswell, 2012, p. 566). However, the length of time needed to perform a mixed-approach study and the requirement that the researcher be well-versed in both qualitative and quantitative methods have raised questions in the literature (Creswell, 2005; Mertens, 2010). , Both quantitative (a questionnaire survey) and qualitative methodologies were used to investigate the research question (classroom observations). Questionnaires for tutors, teacher candidates, and administrators were given out. Interviews with focus group tutors, teacher trainees, administrators, and classroom teaching and learning observations were conducted as part of the qualitative method. Investigating the study's qualitative sections was our intended objective. As part of the study's qualitative component, talks from focus groups with teacher trainees, tutors, and administrators were analysed using whole groups as the unit of analysis.

For the purpose of evaluating the quantitative results, the qualitative data offered clarification and triangulation. According to Miles and Huberman (1984), qualitative approaches produce effective results because they make episodes and events easier to describe in concrete, vivid, and relevant ways. Thus, it is essential to use qualitative methodologies when summarising and generalising plausible alternative hypotheses (Campbell, 1974). Results from qualitative and quantitative methods are distinct and complement one another in substance, even though they both capture crucial information (Berg, 1998).

Population

In the 2017–2018 academic year, the target population at the six colleges of education in the CENWEST PRINCOF zone consisted of 1553 second-year teacher trainees.

Sampling Techniques

A census sampling approach was used for administrators, science tutors, and the six colleges of education in the CENWEST PRINCOF zone. Creswell (2012) noted that censuses are appropriate for small populations because they aim to include every member. Table 1 summarizes the participating tutors and sampling methods used in the colleges.

Table 1

Participating Tutors and Sampling Method Used in the Colleges in Central and Western Regions

College	Sample size	Sampling Method
A	5	Census
B	6	Census
C	5	Census
D	6	Census
E	5	Census
F	6	Census
Total	33	.

Simple random sampling was also used to sample teacher trainees in the six colleges. The administrators (College secretaries, Accountants, Principals, Vice Principals) were selected in order to give them a voice in telling what, for them, may well account for their views on the factors impinging on science teaching and learning at the COE. The researchers were looking for depth in discovering and exemplifying the factors impinging on science teaching and learning, and also to assist with the integrity, trustworthiness, and credibility within research. The research involved 612 respondents, which is made up of 33 tutors, 36 administrators (principals, college secretaries, and accountants), and 543 teacher trainees representing 37.73% (1622), and this is far above the minimum of 10% of the population that should be involved in a research study of this kind (Best & Kahn, 1995).

Data Collection Instruments

The research instruments that were used for data collection in this study were the teacher trainee questionnaire, tutor questionnaire, administrators' questionnaire, and interview schedules.

Validity of the Instruments

The researchers provided the draft copies of the instrument to two specialists in the field of scientific education in the Department of Science Education of the University of Cape Coast to review the questions for face and content validity. Their feedback was used to improve the study's questionnaire. All that was taken into account for the interview protocol was its face validity. This was accomplished by distributing copies to professionals in scientific education at the University of Cape Coast's Department of Science Education. They reviewed and commented after reading. The interview was conducted using the interview methodology with the necessary adjustments.

Trial Testing of the Instruments

The instruments were trial-tested with tutors, teacher trainees, and administrators from College G in the EAGA Zone. This was done in order to assist the researcher in fine-tuning the instruments before it was finally sent out for the main research.

Reliability of Instruments

The reliability of the questionnaire was determined using Cronbach's alpha (α). For the teacher trainee questionnaire, alpha, $\alpha = 0.738$. For the tutors' questionnaire, alpha, $\alpha = 0.886$, and administrators' questionnaire, alpha, $\alpha = 0.859$.

Ethical Considerations

An informational letter was written concerning the study. In the colleges where the research was done, consent forms were created for the administrators, tutors, and teaching candidates. These materials were given to the University of Cape Coast's ethics committee for assessment. This influenced the instruments before it gave the go-ahead for the research to be conducted. The researchers first presented the study's goal to the colleges before asking for their permission to perform the investigation. Interviewed tutors, teacher trainees, and administrators were requested to sign the agreement form. Two consent papers were signed by the lecturers being monitored. The study and its purpose were described to the tutors in the consent form.

Data Collection Procedure

The research design used two main data collection methods, namely, administering questionnaires and conducting interviews. Data were collected between November and February, 2018. With a letter of introduction from the Head of Science Education Department of the University of Cape Coast, the researchers visited the six colleges in the CENWEST zone and introduced themselves to the various principals and staff of the science departments. Data collection lasted for three days in each college. The survey questionnaires were distributed to tutors, teacher trainees, and administrators in each college. Out of the 630 sets of questionnaires given out, 612 sets were completed and returned. The entire set of teacher trainee questionnaires was administered by the researchers to teacher trainees on the first day. Trainees were allowed enough time to complete the questionnaire. The teacher trainee questionnaire was completed in one sitting in each college and handed in as soon as a trainee completed the questionnaire. The researcher checked each and every completed questionnaire as respondents brought their questionnaires to make sure that all sections and spaces were filled, and where there were blank cells, respondents were made to complete them. This process ensured that all the items on the questionnaire were filled out.

The tutor questionnaire was administered on the second day with the assistance of the heads of science departments. All sets of questionnaires administered to science tutors were collected on the same day. The administrative questionnaire was also administered on the second day in each college. In each of the six colleges, focus group interviews were conducted with eight teacher trainees, five tutors, and six administrators on the third day. The teacher trainees were made up of class representatives from each class. All interviewees were given assurance of confidentiality at the beginning of each interview session. All interviews took place in a serene environment with little possibility of distraction or intrusion so that teacher trainees, administrators, and tutors could talk freely. All interviews conducted in the study were recorded, using an audio - tape recorder augmented by note-taking. Six administrators, six tutors, and 12 trainees were also

interviewed. The purpose of the interview was to seek deeper insights into the factors impinging on the teaching and learning of science.

Data Processing and Analysis

Both quantitative and qualitative approaches were used in analyzing the data. Quantitative data obtained from the questionnaires were coded and analyzed using the Statistical Package for the Social Sciences (SPSS) version 18. Descriptive statistics, specifically frequencies and percentages, were used to summarize respondents' views regarding the factors impinging on science teaching and learning in CoE. Descriptive statistics were considered appropriate because the study primarily sought to identify and describe existing conditions and perceptions among respondents rather than establish causal relationships. The questionnaire items were mainly dichotomous (Yes/No) because the researchers intended to obtain direct responses regarding the presence or absence of specific institutional and instructional challenges affecting science teaching and learning. The use of dichotomous items also facilitated straightforward interpretation and comparison across the three participant groups. The qualitative data obtained from interviews, focus group discussions, and open-ended questionnaire responses were audio-recorded, transcribed verbatim, and analyzed thematically. Emerging themes were identified through repeated reading and coding of the transcripts. The qualitative findings were subsequently used to explain, expand, and provide contextual understanding of the quantitative results in line with the sequential explanatory mixed methods design (Creswell & Plano Clark, 2018). Although inferential statistical procedures such as t-tests and regression analyses could provide additional analytical depth, the present study focused primarily on descriptive exploration of stakeholders' perceptions regarding science teaching and learning challenges within Colleges of Education. Therefore, the emphasis of the quantitative phase was on identifying patterns and trends that informed the subsequent qualitative investigation.

RESULTS

Quantitative Findings

What institutional, instructional, and resource-related factors impinge on science teaching and learning in Ghanaian Colleges of Education as perceived by teacher trainees, tutors, and college administrators? The research question sought to find out extraneous factors impinging on the teaching and learning of Integrated Science in the Colleges of Education and how these are managed and/ or controlled by the tutors and the college administrators. To find answers to this, descriptive statistics were used in analyzing the data from questionnaires in order to answer this question. Table 2 displays the frequencies and percentages of tutors' views on factors that impinge on teaching and learning.

Table 2*Tutors Views on Factors Impinging on Teaching and Learning (N = 33)*

ITEM	Response	
	YES (%)	NO (%)
Insufficient time for teaching and learning	20 (60.6)	13 (39.4)
Teacher trainees 'poor attitude towards Integrated Science	25 (75.80)	8 (24.2)
Government policy interventions	13 (39.4)	20 (60.6)
Tutors' beliefs, attitudes, and perceptions	8 (24.2)	25 (75.8)
Depth of course syllabus	12 (36.4)	21 (63.6)

Table 2 indicates that the majority of the tutors (60.6%) are of the opinion that the time for teaching and learning was insufficient, whilst the minority (39.4%) said otherwise. Furthermore, the majority of the tutors (75.8%) indicated that teacher trainees have a poor attitude to Integrated Science, whilst the minority (24.2%) said that there was no poor teacher trainee's attitude to Integrated Science. Also, the majority of the tutors (60.6%) do not accept that government policy and interventions impinge on teaching and learning, whilst the minority (30.3%) believes otherwise. It can be seen from Table 2 that the majority of respondents (75.8%) do not agree that tutors' beliefs, attitudes, and perceptions impinge on teaching and learning, whilst the minority said otherwise. Finally, the majority of the respondents (63.3%) do not agree that the depth of course syllabus impinges on teaching and learning at the Colleges of Education, whilst the minority (36.4%) believe otherwise.

Table 3 presents the frequencies and percentages of teacher trainees' views on extraneous factors that impinge on teaching and learning.

Table 3

Teacher Trainees' Views on Factors Impinging on Teaching and Learning (N = 543)

ITEM	Response	
	YES (%)	NO (%)
Government policy and interventions	259 (47.7)	284 (52.3)
Coverage of syllabus	272 (50.1)	27 (49.9)
Field trips	316 (58.2)	227 (41.8)
Assessment techniques of the college	192 (35.4)	351 (64.6)
Tutor beliefs, attitudes, and perceptions	184 (33.9)	359 (66.1)
Lack of a well-equipped library	318 (58.6)	225 (41.4)
Parental attitude	155 (28.5)	388(71.5)

From Table 3, it can be seen that 52.3% of the majority of the teacher trainees disagreed that government policy and interventions impinge on teaching and learning, whilst the minority (47.7%) confirmed otherwise. Also, data in Table 3 indicates that 272 representing 50.1% teacher trainees assert that the syllabus was covered, whilst 271 teacher trainees, representing 49.9%, said the syllabus was not covered. This affirms teacher trainees' assertion that the depth of the syllabus does not impinge on teaching and learning at the College of Education. Furthermore, it can be seen that 316 teacher trainees (58.2%) of teacher trainees confirmed that field trips impinge on teaching and learning, whilst 227, representing 41.8%, said otherwise. This could be a result of the fact that most of the colleges do not have enough buses for the field trip. As a result of this, colleges would have to engage the services of private transport, which would be expensive. Again, data in Table 3 indicate that one out of nearly three teacher trainees confirmed the external assessment factor as impinging on teaching and learning. Almost two-thirds of the teacher trainees (64.6%) confirmed that external assessment factors do not impinge on teaching and learning at the Colleges of Education in Ghana. It can also be seen from Table 3 that the majority of the respondents (66.1%) do not agree that tutors' beliefs, attitudes, and perceptions impinge on teaching and learning at the College of Education, whilst the minority (33.9%) said otherwise. From Table 3, the majority of the teacher trainees (58.6%) said that Colleges lacked a well-equipped library, whilst the minority (41.4%) said otherwise. Finally, teacher trainees (71.5%) said that parental attitude does not impinge on teaching and learning at the College of Education, whilst the minority (28.5%) said that parental attitude impinges on teaching and learning.

Table 4 presents the frequencies and percentages of administrators' views on extraneous factors that impinge on teaching and learning.

Table 4

Administrators' View on Factors Impinging on Teaching and Learning of Science (N =36)

ITEM	Response	
	YES (%)	NO (%)
Government policy interventions	13 (36.1)	23 (63.9)
Assessment techniques of the college	7 (19.4)	29 (80.6)
Frequent changes in the course outline and textbooks	17 (47.2)	19 (52.80)
Insufficient time for teaching and learning	21 (58.3)	15 (41.7)

As shown in Table 4, the majority (63.9%) of the administrators disagreed that government policy and interventions impinge on teaching and learning, whilst the minority of administrators (36.1%) agreed. Also, one out of five administrators agreed that assessment techniques of the college impinge on teaching and learning, whilst more than half (80.6%) of the administrators said that assessment techniques of the college do not impinge on teaching and learning at the colleges. Further, 47.2% of administrators agreed that frequent changes in course outline and textbooks impinge on teaching and learning, whilst 19, representing 52.8%, disagreed that frequent changes in course outlines and textbooks impinge on teaching and learning. Finally, more than half of the administrators (58.3%) attributed insufficient time for teaching and learning as impinging on teaching and learning, whilst 41.7% of the administrators disagreed.

Qualitative Findings

The qualitative phase was conducted to explain and expand the quantitative findings regarding factors impinging on science teaching and learning in Colleges of Education in Ghana. The participants in the focus group discussions and the interviews were asked the same questions, and their responses were put together. Analysis of interviews and focus group discussions generated four major themes: Inadequate teaching and learning resources; insufficient instructional time; negative perceptions toward integrated science; and strategies adopted to manage instructional challenges.

Theme 1

Inadequate Teaching and Learning Resources

Participants across all groups indicated that inadequate teaching and learning resources negatively affected science instruction within the Colleges of Education. Teacher trainees and administrators particularly emphasized the lack of well-

equipped laboratories, modern textbooks, projectors, and practical science materials. For example, one teacher trainee stated:

“Resources are not adequate; we lack projectors, laboratory stools, and tables” (TA).

Another participant explained:

“The library does not have enough modern science books, and the few available books are inadequate” (TB).

Administrators also acknowledged infrastructural limitations affecting practical science instruction. One administrator noted:

“The size of our laboratory is too small, and the lack of maintenance culture has destroyed most of our equipment” (CA1).

Theme 2

Insufficient Instructional Time

Tutors and teacher trainees consistently reported that inadequate instructional time affected effective science teaching and learning. Participants explained that co-curricular activities, administrative routines, and non-academic duties reduced the time available for science instruction and personal study. One teacher trainee remarked:

“Teacher trainees still continue to weed the college compound, scrub bathrooms, and do activities that reduce our study time” (TC).

Tutors also explained that practical science activities were often constrained by limited contact hours and overloaded schedules.

Theme 3

Negative Perceptions toward Integrated Science

Some tutors observed that teacher trainees perceived Integrated Science as difficult, which negatively affected student engagement and participation during lessons. According to one tutor:

“Teacher trainees have the perception that Integrated Science is difficult to study” (TB).

Participants indicated that such perceptions often discouraged active participation in practical science learning activities.

Theme 4

Strategies for Managing Instructional Challenges

Participants described several coping strategies adopted to manage institutional and instructional challenges. Tutors explained that they improvised instructional materials and organized extra lessons outside regular lecture hours. One tutor stated:

“We improvise to teach when equipment and materials are obsolete or unavailable” (TE).

Administrators also indicated that national service personnel with science backgrounds were engaged to support laboratory practical work.

Integration of Quantitative and Qualitative Findings

The qualitative findings largely supported and expanded the quantitative results obtained from the questionnaires. For instance, while the quantitative data identified inadequate teaching and learning resources as a major challenge, the qualitative interviews provided detailed explanations regarding shortages of laboratory equipment, projectors, textbooks, and laboratory space. Similarly, the quantitative findings showed that tutors and administrators perceived instructional time as insufficient. The qualitative findings further explained that co-curricular activities, administrative routines, and student non-academic responsibilities reduced the time available for science instruction and independent learning. In addition, although quantitative findings identified teacher trainees' attitudes toward Integrated Science as a challenge, the interviews revealed that these attitudes were partly influenced by broader institutional conditions, including inadequate practical exposure and limited science resources. The integration of both quantitative and qualitative findings, therefore, provided a more comprehensive understanding of the institutional and instructional factors affecting science teaching and learning in Ghanaian Colleges of Education.

DISCUSSION

The purpose of this study was to examine the institutional, instructional, and resource-related factors impinging on science teaching and learning in Ghanaian Colleges of Education using a sequential explanatory mixed methods design. The study further sought to explore how tutors, teacher trainees, and college administrators perceive these challenges and how the qualitative findings explain the quantitative results. The integration of both quantitative and qualitative findings revealed that science teaching and learning within Colleges of Education are influenced more by institutional and instructional conditions than by individual attitudes alone.

The quantitative findings showed that tutors and administrators generally did not perceive government policy interventions as major impediments to science teaching and learning. However, a slight majority of teacher trainees believed that government policies and interventions negatively affected teaching and learning. The qualitative findings provided additional insight into this divergence in perception. Some teacher trainees explained that frequent institutional adjustments, administrative routines, and implementation challenges associated with educational reforms indirectly affected instructional delivery and learning experiences. This finding suggests that although administrators and tutors may perceive policies at the implementation level differently, students tend to

experience the practical consequences of such policies more directly within the classroom environment.

The findings further revealed that assessment techniques were generally not perceived by respondents as significant barriers to science teaching and learning. Both teacher trainees and administrators indicated that assessment practices within the Colleges of Education did not substantially impede instructional processes. This finding contrasts with earlier observations by Akyeampong (1997), who argued that examinations and certification requirements strongly shape instructional priorities within Colleges of Education. The present finding may suggest recent improvements in assessment practices or changing institutional approaches toward teacher education assessment in Ghana. Nevertheless, qualitative responses indicated that some students still perceived examinations as overly content-driven, thereby limiting opportunities for practical and inquiry-based science learning.

One of the most significant findings of the study was the issue of insufficient instructional time for science teaching and learning. Both tutors and administrators consistently identified inadequate instructional time as a major challenge affecting effective science instruction. The qualitative findings further explained that co-curricular activities, administrative duties, and non-academic responsibilities reduced the actual time available for practical science instruction and independent learning. Teacher trainees explained during the interviews that activities such as compound maintenance, meetings, and college programmes frequently interrupted academic schedules and limited study time. The findings regarding insufficient instructional time support earlier studies, which established that instructional time is an important determinant of academic achievement and learning quality (Lavy, 2015; Woessmann, 2003). Similarly, Okeke and Okoye (2013) reported that limited contact hours in science education often compel tutors to rely heavily on lecture-based teaching approaches rather than practical instructional methods. The qualitative findings in the present study confirmed this assertion, as tutors acknowledged that inadequate contact hours limited opportunities for laboratory practical work, demonstrations, and learner-centered instructional activities. Given that science education requires active experimentation and inquiry-based learning, reduced instructional time may negatively affect both conceptual understanding and practical competence among teacher trainees.

With respect to syllabus coverage, tutors and teacher trainees generally indicated that the science syllabus was covered within the Colleges of Education. However, the findings also revealed concerns regarding the depth and quality of coverage. Although respondents acknowledged that tutors often completed the syllabus, some participants explained during interviews that rapid coverage of course content sometimes occurred at the expense of practical understanding and learner engagement. This finding suggests that syllabus completion alone may not necessarily translate into effective science learning outcomes. The finding supports

Mbalaka's (2016) argument that syllabus coverage is an important measure of instructional performance because it influences students' preparedness for formative and summative assessments. Nevertheless, the present study demonstrates that the quality of instructional delivery and practical engagement are equally important considerations in science education. Ferla et al. (2009) further argued that effective syllabus coverage contributes to students' academic confidence and self-concept, particularly when students are actively engaged in the learning process.

Another important finding of the study was that tutors' beliefs, attitudes, and perceptions were generally not perceived as major factors impinging on science teaching and learning. Both tutors and teacher trainees largely agreed that tutors' personal beliefs and attitudes did not significantly influence classroom instruction. The qualitative findings expanded this result by showing that broader institutional conditions, such as inadequate teaching resources, curriculum demands, administrative pressures, and examination expectations, often exerted greater influence on instructional practices than tutors' personal dispositions. This finding aligns with previous studies, which suggest that tutors' beliefs do not always directly translate into classroom practice because instructional behaviour is often shaped by contextual and institutional factors (Lederman, 1999; Mellado, 1998; Savasci-Acikalin, 2009). The study therefore suggests that improving science teaching and learning in CoE requires greater attention to institutional support systems rather than focusing solely on tutors' personal attitudes or beliefs.

All in all, the integration of quantitative and qualitative findings provided a more comprehensive understanding of the factors affecting science teaching and learning within Ghanaian CoE. While the quantitative data identified broad patterns regarding instructional challenges, the qualitative findings provided contextual explanations that deepened understanding of how institutional conditions influence science education practices. The findings collectively suggest that improving science teaching and learning within CoE requires increased investment in science infrastructure, improved instructional scheduling, enhanced practical learning opportunities, and stronger institutional support for science tutors and teacher trainees.

The study further contributes to science education literature by demonstrating that challenges affecting science teaching and learning in developing countries are multidimensional and interconnected. Institutional conditions, instructional practices, resource availability, and administrative structures collectively shape the quality of science teacher preparation. Consequently, educational reforms aimed at improving science education within CoE should adopt a holistic approach that addresses both instructional and institutional barriers simultaneously.

Limitations of the Study

This study focused primarily on descriptive analysis of stakeholders' perceptions regarding science teaching and learning challenges in CoE in Ghana. Consequently, inferential statistical analyses were not conducted to examine causal relationships among variables. In addition, the use of dichotomous questionnaire items may have limited the depth of respondents' quantitative responses. However, the qualitative phase helped provide detailed contextual explanations that complemented the survey findings.

CONCLUSIONS

The study confirmed what the literature reports: COE lacked well-equipped laboratories and libraries, had insufficient resources, including chairs, tables, and textbooks, and basic equipment for practical science. From the literature reviewed for the study, it emerged that in the three-year CoE course, approximately one-third of that time was spent on activities related to classroom instruction and assessment. This excluded time lost as a result of college disruptions. Indeed, the findings from the study were in support of those from the literature review. Teacher trainees at the COE continue to weed the compound, scrub the bathrooms, and do other activities that are supposed to be done by college workers, which reduces the time trainees could use to do their personal study. This is also supported by the majority of tutors who assert that the time for teaching and learning was inadequate.

Recommendations

1. Teacher trainees should be relieved of weeding the compound, scrubbing the bathrooms, and doing other activities (grounds work) that are supposed to be done by college workers to enable them to concentrate on their studies.
2. The Ministry of Education and the governing councils of the various colleges should make an effort to improve the infrastructural facilities of the colleges by providing colleges with well-equipped laboratories, libraries, tables, textbooks for teaching and learning, and equipment for science practicals.
3. The amount of time allocated to Integrated Science teaching and learning in the college's timetable should be increased so that teacher trainees and tutors can have sufficient time for teaching and learning.

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Bio

Ebenezer Appah Bonney holds a PhD (Biology Education) from the University of Cape Coast, Ghana. He is currently the Principal of Peki College of Education, affiliated with the University of Ghana. He is a Senior lecturer and a Chartered Professional Administrator. His research interests are in the area of science teaching and learning, instructional effectiveness and quality improvement, STEM education, Biology education, Early Childhood education, Quality Assurance, and educational management. Email: eappahbonney@gmail.com