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The Perception of Science Tutors on the Availability and Utilisation of Science Laboratory Facilities on Pre-service Science Teachers' Practical Competencies in Science

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Abstract

The study examined science tutors' assessment of the extent of availability and frequency of utilisation of science laboratory facilities and its perceived impact on science teacher-trainees' practical competencies in science at the public colleges of education within the Greater Accra Metropolis of Ghana. The study adopted the quantitative approach with a descriptive survey design involving, 15 science tutors, 15 science laboratory assistants, and two college principals who were selected through a purposive sampling technique to participate. The main research instrument was the questionnaire. Reliability coefficients of 0.86 and 0.84 were established for tutors' and science laboratory assistants' questionnaires respectively, which indicated that the questionnaires were reliable. The primary data collected from participants were analyzed using descriptive and inferential statistics. The analysis revealed that science laboratory facilities were available to a low extent and rarely utilized for hands-on practical activities, and this has had a high impact on the science teacher trainees' practical competencies in science within the Greater Accra Metropolis with Accra College of Education in perspective; whereas, the facilities were available to a high extent and fairly utilized for hands-on practical activities, and this has had a very high impact on science teacher trainees' practical competencies in science within the Greater Accra Metropolis, as far as the Ada public college of education was concerned. It was recommended that the Ministry of Education of Ghana, the international community, and other stakeholders such as Non-Governmental Organizations (NGOs) provide adequate science laboratory facilities to promote the study of science and the production of practically competent science teachers from the public colleges of education who can effectively teach science in Ghanaian schools and elsewhere across the globe.

Keywords: Science Tutors' Perceptions, Pre-service Science Teachers, Practical Competencies, Availability and Utilisation, Science Laboratory Facilities.

Persepsi Tutor Sains Mengenai Ketersediaan dan Pemanfaatan Fasilitas Laboratorium Sains terhadap Kompetensi Praktis Calon Guru Sains

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Abstrak

Studi ini mengkaji penilaian para tutor sains mengenai tingkat ketersediaan dan frekuensi pemanfaatan fasilitas laboratorium sains, serta dampaknya terhadap kompetensi praktis calon guru sains di perguruan tinggi keguruan negeri di wilayah Greater Accra, Ghana. Penelitian ini menggunakan pendekatan kuantitatif dengan desain survei deskriptif, yang melibatkan 15 tutor sains, 15 asisten laboratorium sains, dan dua kepala perguruan tinggi yang dipilih melalui teknik pengambilan sampel bertujuan (*purposive sampling*). Instrumen penelitian utama yang digunakan adalah kuesioner. Koefisien reliabilitas sebesar 0,86 untuk kuesioner tutor dan 0,84 untuk kuesioner asisten laboratorium sains menunjukkan bahwa instrumen tersebut reliabel. Data primer yang dikumpulkan dari para peserta dianalisis menggunakan statistik deskriptif dan inferensial. Hasil analisis menunjukkan bahwa di Accra College of Education, fasilitas laboratorium sains tersedia dalam tingkat yang rendah dan jarang dimanfaatkan untuk kegiatan praktikum langsung; kondisi ini berdampak besar terhadap kompetensi praktis calon guru sains di wilayah tersebut. Sebaliknya, di Ada College of Education, fasilitas laboratorium sains tersedia dalam tingkat yang tinggi dan cukup sering dimanfaatkan untuk kegiatan praktikum langsung, yang memberikan dampak besar terhadap kompetensi praktis calon guru sains di wilayah Greater Accra. Studi ini merekomendasikan agar Kementerian Pendidikan Ghana, komunitas internasional, dan pemangku kepentingan lainnya—seperti organisasi non-pemerintah (NGO) menyediakan fasilitas laboratorium sains yang memadai. Langkah ini diharapkan dapat mendukung pembelajaran sains serta menghasilkan calon guru sains yang kompeten secara praktis, yang mampu mengajar sains secara efektif di sekolah-sekolah di Ghana maupun di berbagai belahan dunia lainnya.

Kata kunci : Persepsi Tutor Sains, Calon Guru Sains, Kompetensi Praktis, Ketersediaan dan Pemanfaatan, Fasilitas Laboratorium Sains.

INTRODUCTION

A report by the Ministry of Education (MoE) of Ghana (2017), through the National Teacher Education Curriculum Framework, identifies teacher preparation as a crucial component in enhancing the quality of education. In the context of science education in Ghana, the high-quality preparation of prospective teachers is essential, ensuring they not only master scientific concepts but also possess the ability to effectively design and implement practical laboratory or hands-on activities. Research at the primary school level by Yeboah et al. (2019) demonstrates that the use of inexpensive and easily accessible learning resources can support a more practical approach to science education. Furthermore, Antwi et al. (2021) found that practical activities can improve learning outcomes, science process skills, and students' positive attitudes toward the study of physics. The importance of developing teacher competence

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is further underscored by Coffie et al. (2025), who indicate that professional development activities help science teachers cultivate more student-centered instructional practices. Additionally, a study by Adu-Yeboah and Kwaah (2018) highlights the significance of practical experience for prospective teachers in developing pedagogical skills—such as lesson planning, content delivery, time management, and the effective use of learning resources. Consequently, the education of prospective science teachers in Ghana must integrate subject-matter mastery, pedagogical skills, and practical teaching experience, ensuring that these future educators possess the competencies required to effectively design, implement, and evaluate science instruction in alignment with student needs and the specific conditions of their schools.

Some schools possess adequate science laboratory facilities, yet they are not utilized optimally. Teachers often choose to teach practical science material through lectures, relying solely on textbooks and chalk to verbally explain the entire process of a scientific experiment to students, without providing them the opportunity to observe, handle, or use the available laboratory facilities to conduct experiments themselves. As noted in research by Olajide et al. (2017), schools frequently have sufficient laboratory facilities for learning activities, yet these resources remain entirely unused or, in some instances, are not employed efficiently by either science teachers or students. Although hands-on practical work in science offers significant benefits to both students and teachers, research indicates that even when adequate laboratories and science facilities are available, teachers in some schools still fail to guide their students through practical, hands-on activities (Kibirige & Tsamago, 2013). Researchers attribute this situation to poor and inefficient implementation of laboratory-based practical training during the preparation phase for prospective teachers. Consequently, these aspiring science teachers often emerge with low levels of competence, a lack of self-confidence, and a less-than-positive attitude toward practical science activities (Kibirige & Tsamago, 2013). Coffie et al. (2025) examine changes in the instructional practices of science teachers within the context of curriculum reform in Ghana, highlighting the importance of professional development for teachers in supporting shifts in their teaching practices. Amoah et al. (2023) examined the availability and utilization of biology learning materials in several senior high schools in the Central Region of Ghana, which is relevant for understanding the challenges involved in conducting practical instruction.

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It has been contended that there were many instances where schools had adequate laboratory instructional facilities available, but the facilities were not utilized at all and in some cases, the facilities were not efficiently utilized by science teachers and students (Olajide et al, 2017)). Despite the enormous advantages that hands-on practical work in science offers to students and teachers, research shows that even amidst adequate science laboratories and facilities, science teachers in some schools are not able to take their students through hands-on practical activities in science (Kibirige & Tsamago, 2013). As a result, these teachers often resort to the teaching of science practical lessons using the lecture method, whereby the teacher simply uses textbooks and chalk as the only instructional resources to orally explain to students how a particular practical activity in science could be carried out from beginning to the end of the practical lesson, without giving students the opportunity to see, handle or manipulate the available laboratory facilities to perform the experiments by themselves. Researchers have blamed the situation on poor and inefficient science laboratory practical engagements with teacher-trainees, which has resulted in the science teacher-trainees developing low competencies, confidence, and poor attitudes towards science practical work (Kibirige & Tsamago, 2013).

It has also been argued that there is a consensual agreement among science teacher educators about the urgent need for science tutors and/or science laboratory assistants at the teacher training colleges to always engage their students in student-to-student and tutor-to-students discussions during and immediately after each practical session which should be centered on the similarities, differences, relationships and trends or patterns identified by the students, as well as interpretations of these observations and measurements by the students in relation to real-life contexts. It is believed that it is only in doing so that students' understanding can be enhanced, and the knowledge acquired can be applied in real-life situations. The implication of this is that there must be an integration of practical activities with discussions preceding the practical task because there is no point in separating them. In order words, science laboratory practical activities should be both "hands-on and minds-on", with the "hands-on" aspect referring to the opportunity given to students to manipulate the science laboratory facilities and perform practical tasks themselves whiles the "minds-on" aspect refers to the opportunity given to students to engage in discussions preceding

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every practical activity that enhances deeper understanding and provides the basis for students to apply what has been learned to real-life contexts (Bailey et. al., 2011).

Science laboratory instructional facilities have been defined as all the resources, such as laboratory space, equipment, materials, specimen, and chemicals, among others, that are needed by students and science teachers to promote or enhance effective instructional delivery of science content to students in the laboratory or the classroom (Sampson et al., 2016). Laboratory instructional facilities have also been defined as tools that enable science teachers to engage students in laboratory practical work or experiences, aimed at enhancing students understanding of scientific concepts (Sampson et al., 2016). Science teachers use instructional materials to stimulate students' interest in science learning, used to actively engage students learning by making abstract concepts concrete and more meaningful for students to easily relate with and learn without any difficulty (Sampson et al., 2016).

Although several studies have addressed the availability and utilization of laboratory facilities, as well as the implementation of practical instruction in Ghana, these studies differ in their focus and scope. For instance, Asante (2022) examined the availability and use of biology laboratory facilities in senior high schools within Ghana's Central Region, while Anane and Ankamah-Lomotey (2023) investigated pre-service science teachers' perceptions regarding laboratory availability and utilization, and how these relate to their pedagogical knowledge. Furthermore, research on chemistry laboratory safety in Ghanaian colleges of education has highlighted issues concerning infrastructure and safety facilities (Ansah et al., 2024). These findings indicate that while the study of laboratories has received some attention, there is a lack of research that integrates the physical condition of laboratories, the completeness and suitability of equipment, safety aspects, and the extent to which these facilities are utilized in science instruction. An area of concern in science teacher education that needs urgent attention is the issue of how pre-service science teachers can organize and effectively carry out science practical activities with their students in the classroom when they finally pass out of the training colleges and are posted to teach science and this responsibility stares them in the face. The issue of whether these science teachers would be up to the task or not, would, among other factors, depend on how well their

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science tutors engaged them in laboratory practical activities during their period of training at the colleges.

Science teacher trainees at the public Colleges of Education (CoE) in Ghana are likely to develop poor perceptions and attitudes towards science practical work and science in general if science tutors fail to engage them in adequate and meaningful science laboratory practical activities (Kibirige & Tsamago, 2013). Since science laboratory practical activities are dependent on the availability of laboratory facilities, coupled with the fact that science tutors' perceptions about the nature of science are critical in engaging the science trainee teachers in frequent and efficient hands-on practical activities; the present study sought to examine science tutors' assessment of the extent of availability and frequency of utilization of science laboratory facilities and its perceived impact on science teacher trainees' practical competencies in science, using the public colleges of education within the Greater Accra Metropolis of Ghana as a case study.

RESEARCH METHODS

The quantitative approach was adopted for the study because it enabled the investigators to use descriptive and inferential statistics, such as means, pooled means, and standard deviations to analyze the numerical data gathered from the respondents. The descriptive survey design was adopted for the study because it enabled the investigators to give a succinct description of views/opinions/perceptions of science tutors and laboratory assistants on the extent of availability and frequency of utilisation of laboratory facilities and its perceived impact on science teacher-trainees' practical competencies in science. The population of the study is science tutors and science laboratory assistants. The final-year teacher trainees were the focus of the study because they are believed to have undergone all the requisite professional training and would be posted to teach science at the basic school level after graduation. The science tutors and laboratory assistants were selected for the study because of their direct involvement in engaging the science teacher-trainees in hands-on practical activities.

The purposive sampling technique was adopted to select the sample for the study because it enabled the investigators to select the participants whose characteristics were of direct interest to the research topic. This technique was used to select 15 science tutors and 15 laboratory assistants from the two colleges and two college principals for

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the study. A convenience sampling technique was adopted to select Accra and Ada Colleges of Education because the two institutions are located within the region and catchment area of the national capital of Ghana and the national headquarters of the Ministry of Education, and therefore, it is believed that these two teacher training institutions may be privileged to receive greater attention when it comes to provision of adequate funding and resources. The convenience sampling technique was also adopted to select Accra and Ada Colleges of Education because of the advantage it offered to investigators, in terms of time and budgetary constraints, due to their close proximity and easy accessibility to the respondents.

The main research instrument was the questionnaire. To crosscheck the credibility of the responses provided by the respondents, two separate close-ended questionnaires were administered; one for science tutors and another for the science laboratory assistants, to gather data on the research topic. A Cronbach's Alpha Coefficient was adopted by the researcher to ascertain the internal consistency reliability of the 5-point Agree (A)-Disagree (D) Likert Scale questionnaire items. Reliability coefficients of 0.86 and 0.84 were established for tutors' and laboratory assistants' questionnaires respectively. Observation checklist was adopted to personally observe, rate and record the extent of availability of the laboratory facilities available at the two colleges to crosscheck the credibility of the results. Due to the advantages of triangulation, two separate structured interview guide/schedule-one for science tutors and another for the laboratory assistants, were employed in the study to enhance the credibility of the findings.

The study was carried out at the two public colleges of education in the Greater Accra Metropolis of Ghana. This is because the institutions are located within the catchment area of the national capital of Ghana and the national headquarters of the Ministry of Education, and therefore, it is believed that they may be privileged to receive greater attention when it comes to the provision of adequate funding and resources. The study areas were selected for the study because of their close proximity to the researchers and easy accessibility to the respondents. Hence, time and budgetary constraints were minimized. Ada College of Education is in Ada-Foah within the Accra Metropolis in the Greater Accra Region of Ghana. It was established in 1965. Geographically, the college is located within Ada-Foah, Ada East, GY0249, Ghana

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5.78044◦N 0.62001◦ E. Ada College of Education currently runs bachelor's degree programs in Early Grade, Upper Primary and Junior High School (JHS) education. Accra College of Education is located within the Greater Accra Metropolis of Ghana. It was established in 1909. Geographically, the institution is located within Accra, Accra Metro, GA516, Ghana 5.65719◦ N 0.16094◦ W. The college currently runs bachelor's degree programmes in Early Grade, Upper Primary and Junior High School (JHS) education.

RESULTS AND DISCUSSION

Science tutors have indicated that the availability of science laboratory facilities in public Colleges of Education within the Greater Accra region of Ghana remains at a level that requires special attention, as shown in Table 1 below.

Table 1: Science Tutors' Rating of Extent of Availability of Science Laboratory Facilities within the Greater Accra Metropolis (Accra College of Education)

S/N	Laboratory Facilities	VHE (5)	HE (4)	ME (3)	LE (2)	VLE (1)	Mean	Std Dev.
1	Laboratory Space	0 (0.0%)	0 (0.0%)	6 (85.7%)	1 (14.3%)	0 (0.0%)	2.14	.378
2	Furniture	0 (0.0%)	0 (0.0%)	6 (30.4%)	1 (14.3%)	0 (0.0%)	2.14	.378
3	Shelves	0 (0.0%)	0 (0.0%)	0 (0.00%)	7 (100%)	0 (0.00%)	2.00	.000
4	Storage room and Prep room	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (100%)	0 (0.0%)	2.00	.000
5	Chemicals	0 (0.0%)	0 (0.0%)	1 (14.3%)	1 (14.3%)	5 (71.4%)	1.43	.787
6	Specimen	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (85.7%)	1 (14.3%)	1.86	.378
7	Office(s)	0 (0.0%)	0 (0.0%)	1 (14.3%)	5 (71.4%)	1 (14.3%)	2.00	.577
	Pooled Mean						1.94	0.357

VHE: Very High Extent, HE: High Extent, ME: Moderate Extent, LE: Low Extent, VLE: Very Low Extent. Source: Field Data, 2022

Based on Table 1, the overall mean response of 1.94, with a mean standard deviation of 0.357, indicates that science tutors agree that laboratory facilities at selected public teacher education colleges in the Greater Accra region of Ghana—with a focus on the integrated science laboratory at Accra College of Education—are available only to a limited extent. This finding is significant because the availability of laboratory facilities

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is a key factor supporting the implementation of experiment-based science instruction. Research by Anane and Ankamah-Lomotey (2023a) indicates that the availability and utilization of laboratory facilities at Accra College of Education are considered inadequate, having a limited impact on the development of pedagogical content knowledge among pre-service science teachers. Their other research also reveals that the perceptions of pre-service science teachers at Accra College of Education regarding laboratory availability and utilization differ from those of pre-service teachers at Ada College of Education, suggesting variations in the state of facilities and their usage across teacher education institutions in Ghana (Anane & Ankamah-Lomotey, 2023b). Furthermore, Ansah et al. (2024) identified various deficiencies in physical infrastructure and safety facilities within chemistry laboratories at public teacher education colleges in Ghana. Collectively, these findings underscore the importance of a systematic evaluation of the availability, adequacy, and utilization of laboratory facilities to ensure that practical activities can be conducted effectively, thereby supporting the enhancement of competencies among pre-service science teachers. This corroborates findings from a study that revealed that the challenge of lack of and/or laboratory facilities is negatively impacting on effective implementation of science experimental activities in schools (Enderle & Leanne, 2016).

Table 2: Science Tutors' Rating of Extent of Availability of Science Laboratory Facilities within the Greater Accra Metropolis (Ada College of Education)

S/N	Laboratory Facilities	VHE (5)	HE (4)	ME (3)	LE (2)	VLE (1)	Mean	Std Dev.
1	Laboratory Space	4 (50.0%)	4 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.50	.535
2	Furniture	4 (50.0%)	4 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.50	.535
3	Shelves	3 (37.5%)	5 (62.5%)	0 (0.00%)	0 (0.0%)	0 (0.00%)	4.38	.518
4	Storage room and Prep room	3 (37.5%)	5 (62.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.38	.518
5	Chemicals	3 (37.5%)	5 (62.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.38	.518
6	Specimen	1 (12.5%)	0 (0.0%)	7 (87.5%)	0 (0.0%)	(0.0%)	3.25	.707
7	Office(s)	0 (0.0%)	1 (2.5%)	7 (87.5%)	0 (0.0%)	(0.0%)	3.13	.354
8	Microscope	3 (37.5%)	5 (62.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.38	.518
	Pooled Mean						4.11	0.525

VHE: Very High Extent, HE: High Extent, ME: Moderate Extent, LE: Low Extent, VLE: Very Low Extent. Source: Field Survey, 2022; Biology and Agriculture Science Laboratory.

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Based on Table 2, the combined mean response of 4.11, with an average standard deviation of 0.525, indicates that science tutors perceive the science laboratory facilities at public Colleges of Education in Ghana—specifically at Ada College of Education, which integrates Biology and Agriculture laboratories—to be available at an adequate level, assuming this interpretation aligns with the categories of the measurement scale employed. The availability of laboratory facilities is a crucial aspect of supporting experiment-based science learning, as it enables pre-service teachers to develop conceptual knowledge, practical skills, and pedagogical competencies. Other research by the same authors explores pre-service teachers' perceptions regarding the availability and utilization of laboratory facilities, as well as the relationship between these factors and their knowledge of and attitudes toward the improvisation of science learning materials (Anane & Ankamah-Lomotey, 2023b). Furthermore, Asmah et al. (2022) highlight the importance of learning support materials in the execution of titration practicals in Ghanaian senior high schools, while Yeboah et al. (2019) demonstrate that the use of interactive learning resources can help make science instruction more practical. Safety aspects must also be considered, as laboratory safety is a vital component of conducting effective experimental activities (Ansah et al., 2024). Thus, while the findings of this study suggest that science tutors at Ada College of Education consider the laboratory facilities to be adequate, further evaluation is necessary to ensure that this availability aligns with the condition of the equipment, the completeness of materials, adherence to safety standards, and the intensity with which these facilities are utilized for practical activities.

Table 3: Science Tutors' Rating of Extent of Availability of Science Laboratory Facilities within the Greater Accra Metropolis (Ada College of Education)

S/N	Laboratory Facilities	VHE (5)	HE (4)	ME (3)	LE (2)	VLE (1)	Mean	Std Dev.
1	Laboratory Space	2 (25.0%)	6 (75.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.25	.463
2	Furniture	3 (37.5%)	5 (62.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.38	.518
3	Shelves	3 (37.5%)	5 (62.5%)	0 (0.00%)	0 (0.0%)	0 (0.00%)	4.38	.518
4	Storage room and Prep room	2 (25.0%)	6 (75.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.25	.463

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5	Chemicals	1 (12.5%)	0 (0.0%)	7 (87.5%)	0 (0.0%)	0 (0.0%)	2.75	.707
6	Specimen	1 (12.5%)	0 (0.0%)	7 (87.5%)	0 (0.0%)	(0.0%)	2.75	.707
7	Office(s)	2 (25.0%)	6 (75.0%)	0 (0.0%)	0 (0.0%)	(0.0%)	4.25	.463
	Pooled Mean						3.86	0.548

VHE: Very High Extent, HE: High Extent, ME: Moderate Extent, LE: Low Extent, VLE: Very Low Extent. Source: Field Data, 2022; Chemistry and Physics Laboratory.

From Table 3, the pooled mean response of 3.86 and standard deviation of 0.548 shows that the science tutors opined that science laboratory facilities at the combined Chemistry and Physics laboratory at the Ada College of Education within the Greater Accra Metropolis were available to a high extent. This contrasts with the findings of Appah Bonney et al. (2022), who identified limitations in science laboratory infrastructure and resources across several Colleges of Education in Ghana. Meanwhile, Ansah et al. (2024a) discovered deficiencies in physical infrastructure and laboratory safety facilities for chemistry laboratories at various public teacher training colleges in Ghana.

The following data presents the frequency with which science laboratory facilities are used for practical science activities at public teacher-training higher education institutions in the Greater Accra Metropolitan Area, Ghana, as shown in Table 4 below:

Table 4*:* Science Tutors' Rating of Frequency of Utilisation of Laboratory Facilities at Accra and Ada

College of Education	A (5)	O (4)	S (3)	R (2)	N (1)	Mean	Std Dev.
Accra	0 (0.0%)	0 (0.0%)	3 (42.9%)	4 (57.1%)	0 (0.0%)	2.43	1.95
Ada	0 (0.0%)	0 (0.0%)	6 (75.0%)	2 (25.0%)	0 (0.0%)	2.75	2.83
Pooled Mean						2.59	2.39

Always O: Often S: Sometimes R: Rarely N: Neutral

An observation can be made from table 4 that, a pooled mean of the responses 2.59 (S.D =2.39) from the science tutors indicates that science laboratory facilities were rarely utilised for hands-on practical activities at the two selected public colleges of education within the Greater Accra Metropolis of Ghana. These findings align with research by

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Anane and Ankamah-Lomotey (2023), which examined the availability and utilization of laboratory facilities at Accra College of Education and Ada College of Education, identifying differences in perceptions regarding the use of these facilities in the education of prospective science teachers. Furthermore, Babb and Stockero (2020) indicated that science instruction in several schools within the Greater Accra region faces challenges, including a shortage of laboratory materials and a lack of support for hands-on, practice-based learning. Similarly, Amoah et al. (2023) found that the majority of biology teachers in the senior high schools studied in the Central Region of Ghana do not conduct practical activities on a regular basis due to a lack of learning resources.

Data regarding perceptions of the impact of the availability and utilization of science laboratory facilities on the practical competence of prospective science teachers—encompassing pedagogical content knowledge (PCK), knowledge of improvisation, and attitudes toward improvisation—in the Greater Accra Metropolis, Ghana (specifically at Accra College of Education and Ada College of Education), are presented in Table 5;

Table 5: Science *Tutors'* Ratings of the Impact of Availability and Utilisation of Science Laboratory Facilities on Trainee-Teachers' Practical Competencies in Science within the Greater Accra Metropolis of Ghana (Ada College of Education) in perspective

S/N	Competency Areas	SA (5)	A (4)	N (3)	D (2)	SD (1)	Mean	Std Dev.
1	PCK in Science	6 (75.0%)	2 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.75	0.463
2	Knowledge of Improvisation in Science	5 (62.5%)	2 (37.5%)	0 (0.0%)	0 (0.0%)	(0.0%)	4.63	0.518
3	Attitudes toward Improvisation in Science	0 (17.9%)	8 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.00	0.000
	Pooled Mean						4.46	0.327

SA: Strongly Agree, A: Agree, N: Neutral, D: Disagree, SD: Strongly Disagree

It can be observed from Table 5 that, with mean responses of 4.75 (S.D=0.463), 4.63 (S.D=0.518) and 4.00 (S.D=0.000), the science tutors at Ada College of Education held the view that availability and utilisation of laboratory facilities has had a very and high impact on science teacher-trainees' pedagogical content knowledge and knowledge of improvisation, and attitudes toward improvisation in science respectively. The

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importance of PCK in supporting the effectiveness of science instruction is supported by research from Siemoh et al. (2025), who identified several dimensions of PCK among science teachers in Ghana, including knowledge of instructional strategies, curriculum, and student understanding. Furthermore, Inusah et al. (2025) examined teachers' understanding of improvisation techniques in science instruction in Ghana, particularly in the context of limited resources. Anim-Eduful and Forson (2025) also found that the implementation of chemistry practicals in Ghanaian senior high schools faces various challenges, such as a lack of laboratory equipment, insufficient funding, and a shortage of laboratory technicians. These findings corroborate findings from a study on the effects of hands-on science laboratory work on students' acquisition of science process skills in Nigeria, which reported that teaching methods that involved practical activities with students were more effective in promoting the acquisition of science process skills in students (Nwagbo and Uzoma, 2014)

Table 6*:* Science Tutors' Ratings of the Impact of Availability and Utilisation of Laboratory Facilities on Trainee-Teachers' Practical Competencies in Science within the Greater Accra Metropolis of Ghana (Accra College of Education) in perspective

S/N	Competency Areas	SA (5)	A (4)	N (3)	D (2)	SD (1)	Mean	Std Dev.
1	PCK in Science	0 (0.0%)	7 (100%)	0 (0.0%)	(0.0%)	0 (0.0%)	4.00	0.000
2	Knowledge of Improvisation in Science	6 (85.7%)	1 (14.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.86	0.378
3	Attitudes toward Improvisation in Science	0 (0.0%)	6 (85.7%)	1 (14.3%)	0 (0.0%)	0 (0.0%)	3.86	0.378
	Pooled Mean						4.24	0.252

SA: Strongly Agree, A: Agree, N: Neutral, D: Disagree, SD: Strongly Disagree

It can be observed from Table 6 that, An observation can be made to the fact that, with mean responses of 4.00 (S. D=0.000), 4.86 (S.D=0.378) and 3.86 (S.D=0.378), the science tutors held the view that availability and utilisation of laboratory facilities has had a high, very high, as well as a high and positive impact respectively on science teacher trainees' pedagogical content knowledge, knowledge of improvisation, and attitudes toward improvisation at the Accra College of Education. Pentingnya PCK bagi efektivitas pembelajaran sains didukung oleh Siemoh et al. (2025), yang mengkaji dimensi PCK guru sains di Ghana. Selain itu, Amponsah et al. (2025) menunjukkan

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bahwa pemahaman guru terhadap teknik improvisasi berperan penting dalam mendukung pembelajaran sains di lingkungan dengan sumber daya terbatas. Sementara itu, Babb dan Stockero (2020) membahas penerapan pembelajaran sains praktis di sejumlah kelas sains sekolah menengah pertama di Ghana, sehingga memberikan konteks mengenai pentingnya kegiatan pembelajaran yang melibatkan pengalaman langsung.

CONCLUSION

Following the findings of the study, the following conclusions were drawn. The study revealed that science laboratory facilities were available to a low extent at the public colleges of education within the Greater Accra Metropolis of Ghana. The science tutors opined that although there were inadequate science laboratory facilities, the facilities were rarely and sometimes fairly utilized by the tutors and teacher trainees in hands-on practical activities in science, and this has had a very high and positive impact on science teacher-trainees' practical competencies in science. The implication is that with adequate provision of science laboratory facilities and efficient utilization of same by teacher trainees and tutors, the science teacher trainees' knowledge, skills, attitudes, and general practical competencies in science would be boosted and the ultimate beneficiaries would be the students in the schools. There is therefore an urgent need for stakeholders in science education in Ghana and across the globe to ensure that there is adequate provision of science laboratory facilities to train practically competent science teachers from the teacher training colleges to effectively teach science in the schools.

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DECLARATION:

Phenomenon: Jurnal Pendidikan MIPA was selected as the target journal for the publication of our paper because this journal strives to promote the implementation of high-quality mathematics and science education at all educational levels, an objective

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that aligns with the aims and scope of this internationally reputable journal. We confirm that both authors have approved the manuscript for publication in your journal.

Availability of Data and Materials: The data supporting the study were classified according to the institutions' authorities; therefore, the participants only agreed to participate in the study based on anonymity, and a confidentiality agreement was reached. The data can therefore not be divulged to any third party without official permission granted by the institutions, which can either be accepted or declined.

Competing interest: The authors declare that they have no conflicting interests in the publication of the paper in your journal.

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