



## Perception of the Impact Of Availability and Utilisation of Laboratory Facilities On Science Teacher-Trainees' Knowledge and Attitudes Toward Improvisation In Science

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### Abstract

The study examined final-year science teacher-trainees' perceptions of the impact of availability and utilization of laboratory facilities on their knowledge and attitudes towards improvisation of instructional materials in science at Accra and Ada Colleges of Education within the Greater Accra Metropolis in the Greater Accra Region of Ghana. The study resulted from personal observation of the majority of in-service Junior High School (JHS) science teachers' inability to effectively teach science to make it more comprehensible to students. The study adopted the quantitative approach with a descriptive cross-sectional survey design involving 62 teacher-trainees, 15 science tutors, and two college principals who were selected through a purposive sampling technique to participate. The main research instrument was the questionnaire. Reliability coefficients of 0.84 and 0.86 were established for tutors' and teacher-trainees questionnaires respectively, which indicated that the questionnaires were reliable. The primary data were analyzed using descriptive and inferential statistics. The analysis revealed that the science teacher-trainees at the Ada College of Education held the view that availability and utilization of science laboratory facilities have had a high and positive impact on their knowledge and attitudes towards improvisation of instructional materials in science; whereas, at the Accra College of Education, the science teacher-trainees opined that availability and utilization of science laboratory facilities have had a moderate and neutral impact on their knowledge and attitudes towards improvisation of science instructional materials. It was recommended that the Ministry of Education provide adequate science laboratory facilities to promote the study of science and improve science teacher-trainees knowledge and attitudes towards improvisation in science, especially at the Accra College of Education.

**Keywords** *Laboratory Facilities, Science Teacher-Trainees, Knowledge of Improvisation, Impact of Availability and Utilisation, Attitudes Towards Improvisation*

### INTRODUCTION

Notwithstanding the crucial role that practical activities using actual laboratory facilities play in helping students acquire scientific knowledge and attitudes, there is the need to search for alternatives to actual practical work for use, especially in environments or situations where there is a lack of or inadequate science facilities, to give students the same or similar practical experiences as in the case of actual laboratory settings. The way and manner science teachers teach science content to their students is influenced by their own teaching experiences which they have acquired during their period of professional training as science teachers and the personal teaching philosophy they subscribed to. It has been argued that all the teaching experiences that science trainee teachers go through during their professional training in teacher training institutions

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greatly influence their understanding of how science content should be taught to science students. This means that science teachers' experiences and perceptions they hold about the nature of science are what they practice with their students in the classroom during science instruction (Bhattacharyya et al., 2009). It is contended that science teachers' experiences and perceptions about science impact their pedagogical content knowledge in science. In order words, science teachers' views, opinions, and experiences in science and about their learners would determine the type of instructional approach or strategy they would employ in teaching scientific knowledge to their students (Bhattacharyya et al., 2009). Research shows that no two individual science teachers with similar professional knowledge would teach science in the same way to students due to differences in the teachers' experiences and perceptions of science instruction (Bhattacharyya et al., 2009). Consequently, in situations where a science teacher does not believe in the concept of improvisation of science instructional materials or facilities but holds the view that science practical activities can be taught only in the science laboratory with adequate availability of the basic science facilities in the school environment, is likely not go the extra mile to engage students in practical activities when he/she is posted to teach science in schools where there are no science laboratories with little or no facilities. On the contrary, a science teacher who believes that improvisation of science instructional materials when efficiently utilized, can equally engage or stimulate students' interests in science, and make science teaching and learning more effective, which are similar experiences that actual science laboratory practical work would give, would no doubt use improvised science instructional materials to teach in situations where there are no science laboratory and facilities (Bhattacharyya et al., 2009). The teacher's perception of the foregoing is therefore critical in ensuring quality instructional delivery in science. Bhattacharyya et al., (2009) argue that teachers' perceptions greatly influence how teaching and learning occur. The objectives of the research were to explore science teacher-trainees perceptions of the impact of the availability and utilization of science laboratory facilities on their knowledge and attitudes toward improvisation in science at selected colleges of education in Ghana.

#### *Statement of the Problem*

Personal observation and experience over the years with in-service science teachers at the Junior High School (JHS) level showed that the majority of them were not able to effectively conduct meaningful hands-on practical activities with their students in science, although it is stated in the JHS science curriculum that science teachers should carry out hands-on practical activities with their students, and where necessary, improvise science instructional materials and resources and use the most efficient demonstration methods to teach science concepts to ensure that students get a deeper and practical understanding of the concepts so that they can apply such concepts in their daily life. However, the practice over the years is that some in-service science teachers introduce scientific concepts to students in an abstract way. They simply pour out and force the information they have read directly from textbooks down the throat of students and the students as well chew, pour and easily forget the concepts. It is contended that science teachers' experiences and perceptions about science impact their pedagogical content knowledge in science. In order words, science teachers' views, opinions, and experiences in science and about their learners would determine the type of instructional approach or strategy they would employ in teaching scientific knowledge to their students (Bhattacharyya et al., 2009).

Research revealed 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 (Adebisi, Tewogbade & Olajide, 2017). This could partly be attributable to poor knowledge of and attitudes towards improvisation, resulting in a lack of motivation on the part of science teachers to improvise

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instructional materials or use demonstration methods to teach scientific concepts in a practical way to foster better comprehension by the learners (Bektas et. al., 2011).

Many studies have been conducted on the availability and utilization of laboratory facilities. The present study sought to investigate further by exploring science teacher-trainees' perceptions of the extent to which the availability and utilization of laboratory facilities at the colleges of education impact their knowledge of and attitudes towards improvisation in science.

### *1.1. Objectives of the Study*

Specifically, the study sought to;

- a) explore science teacher-trainees perceptions of the impact of the availability and utilization of laboratory facilities on their knowledge of and attitudes toward improvisation in science at Accra College of Education
- b) explore science teacher-trainees' perceptions of the impact of the availability and utilization of laboratory facilities on their knowledge of and attitudes toward improvisation in science at Ada College of Education

### *1.2. Research Questions*

- a. To what extent has the availability and utilization of laboratory facilities impacted science teacher-trainees knowledge of improvisation in science at Accra and Ada Colleges of Education?
- b. To what extent has the availability and utilization of laboratory facilities impacted science teacher-trainees attitudes toward improvisation in science at Accra and Ada Colleges of Education?

## **LITERATURE REVIEW**

A study conducted by Anyanwu & Alafiatayo (2015) on teachers' attitudes towards improvisation of instructional materials revealed, that teachers had poor perceptions and negative attitudes towards improvisation in science subjects. This could partly be blamed on inadequate and improper training of science teachers in improvisation during their period of training at the teacher training institutions. There is therefore the need for science teacher educators to focus on training science teacher trainees to be competent in improvisation in science. This would go a long way to boost science teacher trainees' confidence by helping them to develop positive perceptions and attitudes towards improvisation and consequently lead to increased motivation to replicate the same in the classrooms.

A related study conducted by Anyanwu and Alafiatayo (2015) on teachers' perceptions of improvisation, revealed that teachers exhibited negative attitudes towards improvisation, in the sense that less than average of the teachers who took part in the study opined that they are able to produce and utilize instructional materials during science instructional process. These findings corroborate findings from a similar study which revealed a lack of confidence in chemistry teachers regarding the improvisation of instructional materials in chemistry subjects (Omiko, 2016). These findings do not promote effective science instruction in schools, especially in public basic schools in Ghana where it is believed that schools lacked science laboratory space and facilities for the conduct of practical activities in science, although it is part of the science curriculum requirements that teachers take learners through hands-on practical activities. In such situations, students' quest to have practical experience in science is at the mercy of the expertise of the science teacher in designing and using the right improvised science instructional facilities to help students gain some practical experience in science practical work in the absence of actual laboratory space and facilities. This is why science teacher trainees must be properly trained in the improvisation of science instructional materials in teacher training institutions before they pass out as qualified science teachers.

Nwagbo & Uzoma (2014) asserted that "the greatest hindrance to effective teaching in schools is not lack of necessary apparatuses but rather lack of their effective utilisation". This

assertion implies that there is an urgent need to ensure that science teacher trainees received adequate training in science laboratory practical work during their period of training at the teacher training colleges so that they can replicate the same in the schools.

The study adopted the experiential learning theory as the theoretical framework. In his *Nicomachean Ethics*, Aristotle made a philosophical statement that "for the things that we have to learn before we can do them, we learn by doing them". This statement is foundational to the concept of experiential learning theory. Experiential learning has been defined as "the strategic, active engagement of students in opportunities to learn through doing, and reflection on those activities, which empowers them to apply their theoretical knowledge to practical endeavours in a multitude of settings inside and outside of the classroom" (Burch et al., 2019). Experiential learning emphasizes the need for science teachers to actively engage students in practical experiences and give ample opportunity for students to use inquiry skills to construct new scientific knowledge or even confirm existing bodies of scientific knowledge for themselves and by themselves through a scientific investigation with the science teacher playing the role of a facilitator who guides students to search for knowledge by themselves. It has been established that there is a proportional relationship between experiential learning theory and adequate availability and efficient utilization of science laboratory resources since it offers students hands-on practical engagements with scientific concepts, laws, and theories; hence the adoption of experiential learning theory as the theoretical

## **RESEARCH METHOD**

The study adopted the quantitative approach because it enabled the researchers to use descriptive and inferential statistics to analyze the numerical data gathered from the respondents. The descriptive cross-sectional survey design was adopted for the study because it enabled the researchers to gather one-shot data from several people such as science tutors and science teacher trainees from two different colleges of education to give a succinct description of their views/opinions/perceptions on the topic. This was done to enhance the validity and reliability of the results.

### *Target Population*

The target population for the study was all final-year science specialism teacher-trainees and all Science Tutors at the Ada and Accra Colleges of Education. This category of students was chosen because they were believed to have undergone all the requisite theoretical and practical professional training to become competent science teachers that qualifies them to effectively teach science at the basic school level. The science tutors were selected for the study because of their direct involvement in the professional training of the prospective science teachers.

### *Sample and Sampling Procedure*

The purposive sampling technique was adopted to select 15 science tutors from the two colleges, two college principals, and a total of 62 final-year science trainee-teachers at the two colleges for the study. The science tutors were selected because of their direct involvement in the professional training of the teacher-training to become professional science teachers with the requisite pedagogical content knowledge (PCK) in science. 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 institutions may be privileged to receive greater attention when it comes to the provision of adequate funding and resources or facilities, aimed at promoting quality science education delivery, thereby leading to the production of competent science teachers with the requisite pedagogical content knowledge to effectively teach science at the basic school level. The convenience sampling technique was also adopted to

select Accra and Ada Colleges of Education because of the advantage it offered to the researchers, in terms of time and budgetary constraints, due to their proximity and easy accessibility to the respondents.

#### *Instruments for Data Collection*

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 teacher-trainees, 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 0.84 and 0.86 were established for tutors' and teacher-trainees questionnaires respectively. An 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 guides/schedule-one for science tutors and another for the teacher-trainees, were adopted for the study to enhance the credibility of the findings.

#### *The Study Area*

The study was carried out at the two public colleges of education in the Greater Accra Metropolis of Ghana 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 facilities or resources, aimed at promoting quality science education delivery, thereby leading to the production of competent science teachers who can effectively teach science at the basic school level. The study areas were selected for the study because of their proximity to the researchers and easy accessibility to the respondents. Hence, time and budgetary constraints were minimized.

#### *Ada College of Education*

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 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*

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 programs in Early Grade, Upper Primary, and Junior High School (JHS) education.

## **FINDINGS AND DISCUSSION**

Impact of Availability and Utilisation of Laboratory Facilities on Teacher-Trainees' Knowledge of and Attitudes Towards Improvisation at Accra and Ada Colleges of Education

Table 1: Ratings of the Impact of Availability and Utilisation of Laboratory Facilities on Trainee-Teachers' Knowledge and Attitudes Toward Improvisation in Science at Accra College of Education

S/N	Competency Areas	SA (5)	A (4)	N (3)	D (2)	SD (1)	Mean	Std Dev.
1	Knowledge of Improvisation in Science	3 (13.0%)	6 (26.1%)	7 (30.4%)	7 (30.4%)	0 (0.0%)	3.22	1.043
2	Attitudes Toward Improvisation in Science	4 (17.4%)	7 (30.4%)	3 (13.0%)	7 (30.4%)	2 (8.7%)	3.17	1.302

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

It can be observed from (Table 1) that, with mean responses of 3.22 (SD=1.043) and 3.17 (SD=1.302), the final-year science teacher-trainees at the Accra College of Education held the opinion that the availability and utilization of laboratory facilities for hands-on practical activities at their college has had a moderate but neutral impact on their knowledge of improvisation and attitudes toward improvisation of instructional materials in science respectively (Table 3).

Table 2: Ratings of the Impact of Availability and Utilisation of Laboratory Facilities on Trainee-Teachers' Knowledge and Attitudes Toward Improvisation in Science at Ada College of Education

S/N	Competency Areas	SA (5)	A (4)	N (3)	D (2)	SD (1)	Mean	Std Dev.
1	Knowledge of Improvisation in Science	5 (12.8%)	22 (56.4%)	6 (15.4%)	4 (10.3%)	2 (5.1%)	3.62	1.016
2	Attitudes Toward Improvisation in Science	7 (17.9%)	18 (46.2%)	6 (15.4%)	5 (12.8%)	3 (7.7%)	3.54	1.166

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

From (Table 2), with mean responses of 3.62 (SD=1.016) and 3.54 (SD=1.66), an observation can be made to the fact that the final-year science teacher-trainees held the view that the availability and utilization of science laboratory facilities for hands-on practical activities at the Ada College of Education has had a high and positive impact on their knowledge of improvisation and attitudes toward improvisation of instructional materials in science (Table 3).

Table 3: Reference for Ratings of the Impact of Availability and Utilisation of Laboratory Facilities on Trainee-Teachers' Knowledge and Attitudes Towards Improvisation

Scale	Agreement	Range	Interpretation	Classification
5	Strongly Agree	4.21 - 5.00	Very High Impact	Positive
4	Agree	3.41 - 4.20	High Impact	
3	Neutral	2.61 - 3.40	Moderate Impact	Neutral

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2	Disagree	1.81 - 2.60	Low Impact	Negative
1	Strongly Disagree	1.00- 1.80	Very Low Impact	

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## DISCUSSION

Table 1 revealed that the final-year science teacher-trainees at the Accra College of Education held a neutral position/view regarding the impact of the availability and utilization of laboratory facilities for hands-on practical activities on their knowledge and attitudes towards improvisation in science, although the impact was interpreted as moderate. This implies that these science teacher-trainees had poor perceptions and attitudes toward improvisation. This corroborates findings from a study conducted by Anyanwu & Alafiatayo (2015) on teachers' attitudes towards improvisation of instructional materials which revealed that teachers had poor perceptions and negative attitudes towards improvisation in science subjects, and further buttressed by a study conducted by Anyanwu and Alafiatayo (2015) on teachers' perceptions on improvisation which revealed that teachers exhibited negative attitudes towards improvisation, in the sense that less than average of the teachers who took part in the study opined that they can produce and utilize instructional materials during science instructional process. These findings corroborate findings from a similar study which revealed a lack of confidence in chemistry teachers regarding the improvisation of instructional materials in chemistry subjects (Omiko, 2016). Consequently, if the status quo remains unchanged, there is the likelihood that when these trainee-teachers are finally posted to teach in the schools, they would find it challenging to improvise instructional materials for their learners. According to the science tutors and the science teacher-trainees, this negative trend could be blamed on the inadequate availability of laboratory facilities and infrequent utilization of same for practical activities which were mainly minds-on and not hands-on at the college. There is therefore, an urgent need for stakeholders of science education, such as Non-Governmental Organisations (NGOs) and the Government of Ghana through the Ministry of Education to come to the aid of Accra College of Education through the provision of adequate funding and facilities to arrest this negative trend, thereby promoting the study of science and the production of competent science teachers from the college to teach science at the basic school level.

However, from (Table 2), it can be observed that the final-year science teacher-trainees at the Ada College of Education held the view that the availability and utilization of laboratory facilities for hands-on practical activities in science has had a high positive impact on their knowledge of improvisation and attitudes towards improvisation of instructional materials in science. This according to the science tutors and science teacher-trainees, could be attributable to the fact that, although laboratory facilities were available to a moderate extent at the college, the science tutors engaged the teacher-trainees in frequent and efficient hands-on practical activities which boosted their professional knowledge, values, and attitudes towards laboratory practical activities as well as in improvisation of instructional materials in science. This implies that the science trainee-teachers at Ada College hold positive perceptions and attitudes improvisation. Consequently, this crop of final-year science teacher-trainees would most likely be able to improvise instructional materials to teach science nearly for better comprehension by their learners when they are finally posted to teach in the schools after graduating from college.

## CONCLUSION

The study revealed that, although laboratory facilities were available to a moderate extent, their frequent and efficient utilization at the Ada College of Education, has resulted in the science

teacher-trainees developing positive perceptions and attitudes towards practical activities in general and improvisation of instructional materials in science in particular. This implies that, with adequate availability and frequent and efficient utilization of the facilities, Ada College of Education science teacher-trainees knowledge and attitudes towards improvisation and their overall competencies in science would further be boosted, and the learners at the basic school levels would be the ultimate beneficiaries.

The study further revealed that because laboratory facilities at the Accra College of Education were to a low extent, and hence the science tutors under the circumstance, were only able to infrequently engage the science teacher-trainees in practical activities which were mainly minds-on and not hands-on, the final-year science teacher-trainees held a neutral view, which was interpreted as negative (Table 3), regarding the impact of availability and utilization of laboratory facilities on their knowledge and attitudes towards improvisation of instructional materials in science. For this negative trend to be reversed, the Ministry of Education and other stakeholders in science education ought to urgently come to the aid of the two colleges, especially Accra College of Education, through the provision of adequate funding and science laboratory facilities to promote the study of science at the two colleges.

### **LIMITATIONS & FURTHER RESEARCH**

The present study was delimited to only final-year science teacher-trainees offering bachelor's degrees in science specialism at the Accra and Ada Colleges of Education, and not all Colleges of Education in Ghana. The data collection period coincided with the time that final-year science teacher-trainees were feverishly preparing to write their semester examinations, hence a group interview method was employed instead of the preferred one-on-one interview with the teacher-trainees and their tutors due to their busy schedules. Questionnaires were administered to a section of the science teacher-trainees who availed themselves immediately after writing their papers, while the researcher had to schedule special meetings on weekends to administer the questionnaires and also interview the rest of the students and science tutors. These were some of the limitations of the study.

It is recommended that the government of Ghana, through the Ministry of Education, should as a matter of urgency, release funds for the provision of adequate science laboratories and facilities for use by tutors and trainee teachers at Accra and Ada Colleges of Education to promote the study of science and the production of competent science teachers with the requisite professional knowledge, values, and attitudes towards science instruction in the schools.

It is also recommended that, in the interim, the Principals of Accra and Ada Colleges of Education, should liaise with their affiliated universities, to fashion out a convenient way by which the science trainee-teachers can be sent to these universities regularly to have hands-on practical sessions to boost their practical skills in general and knowledge and attitudes towards improvisation of instructional materials in particular. This would enable the science teachers to effectively teach science at the public basic level, where there are no laboratory facilities needed to engage the learners in any meaningful laboratory practical activities in science, and the science teachers' knowledge and attitudes towards improvisation become crucial to give the learners some practical experience to make science teaching and learning easier for the learners and the teachers alike.

The study sought to explore science teacher-trainees' perceptions of the impact of the availability and utilization of laboratory facilities on their knowledge and attitudes toward improvisation science at the Ada and Accra Colleges of Education. The findings of the research would draw the attention of stakeholders in science education, especially the Ministry of Education, to provide adequate facilities to enable the science tutors to engage the science teacher trainees in meaningful practical activities to boost their pedagogical content knowledge and practical skills to become competent science teachers. The research was aimed at ensuring effective monitoring by the heads of science departments and the principals of the colleges to ensure that the science tutors



frequently engage the trainees in hands-on practical activities to build and boost their knowledge and attitudes toward improvisation. This would ensure the production of science teachers with the requisite competencies to teach science to students at the basic school level in the most comprehensible way.

It is suggested that a comprehensive study be conducted to assess the status of the implementation of quality science education delivery in all quasi-science public colleges of education in Ghana. The findings of the study would inform the Ministry of Education of Ghana and other stakeholders in science education regarding the status of implementation of the curriculum for training science teachers at the colleges of education. The study would also help the Ministry of Education to identify the challenges impeding the effective teaching and learning of science and find measures to immediately address them to promote quality science instruction and the production of quality science teachers from the colleges to effectively teach science at the basic school level.

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