

Assessing Pre-Service Teachers' Competencies in Teaching Basic School Science Curriculum: A Case Study

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Abstract

The purpose of the study was to assess pre-service teachers' competencies in teaching basic school science curricula, and the challenges they encountered in teaching basic school science. A case study approach was used as the research design, which is qualitative in nature. Forty (40) research pre-service teachers were selected for the study to gain a deeper understanding of the phenomenon under investigation. The researchers used interviews and observation schedules. An observation checklist was also used during the macro-teaching to collect data by ticking appropriately between 1 and 5 on a Likert ranking scale list of the competencies pre-service teachers exhibited in the teaching process. The semi-structured interview schedule called the pre-service teachers' interview schedule (PTIS) consisted of open-ended interview questions. The interview was audiotaped, coded, and edited to find similar themes that emerged. The interview for each research participant lasted for 15–20 minutes. Thematic analysis was used to examine the data from the interviews and classroom observations. The study findings revealed that pre-service teachers demonstrated knowledge and understanding of lesson planning and delivery. Most of the schools visited for the study showed a paucity of curriculum materials for science teaching. It is therefore recommended that the government of Ghana provide adequate curriculum materials for basic school science teaching. Pre-service teachers should produce no-cost and low-cost improvised teaching and learning materials as project work. This will reduce the challenge of teaching and learning materials

in basic schools.

Keywords: Pre-service teachers, competencies, science, curriculum, basic school

Introduction

Assessing the competencies of pre-service teachers in the teaching of the basic school science curriculum in Ghana is an essential step toward ensuring the quality of science education in the country (Owusu-Ansah, 2017). According to Owusu-Ansah, the ability of pre-service teachers to effectively teach science is influenced by their content knowledge, pedagogical knowledge, and technological proficiency.

A number of studies have been conducted to measure the potential teachers' capacity to instruct Ghana's elementary science curriculum. Amoah, Ankoma-Sey, and Appiah (2020), for instance, assessed how well pre-service teachers knew the pedagogical material required to teach science to elementary school students. The study found that pre-service teachers lacked the pedagogical skills and subject-matter knowledge needed to instruct the subject matter successfully. Amoah and Nyarko (2021), who found that pre-service teachers lacked the skills necessary to impart science using inquiry-based methodologies, came to similar conclusions.

To address these concerns, the Ghanaian government has begun a number of reforms in pre-service teacher education through the Ministry of Education. These adjustments are made to ensure that pre-service teachers are prepared to successfully teach the basic science curriculum and to raise the bar for that preparation. For instance, the Ministry of Education recently introduced a revised pre-service teacher education curriculum that gives future educators more opportunities for hands-on training and classroom experience (Ministry of Education, 2018).

Statement of the Problem

One of the challenges faced by basic schools in Ghana is the evaluation of pre-service teachers' capacities to teach the basic science curriculum. According to UNESCO, science education is crucial to fostering sustainable development and economic growth (2021). Yet, very little research has been done on how to effectively assess pre-service teachers' science teaching abilities in Ghanaian basic schools. In order to fill this literature gap and improve the quality of science education in Ghana, this study investigates the practices used to assess pre-service teachers' ability to teach the basic school science curriculum.

Purpose of the Study

The purpose of the study was to assess pre-service teachers' competencies in teaching basic school science curricula and the challenges they encounter in teaching basic school science in Dormaa East District in Ghana.

Research Questions for the Study

1. What competencies do pre-service teachers exhibit during the teaching and learning of the basic science curriculum?
2. What challenges do pre-service teachers have in teaching the basic school science curriculum?

Review of Related Literature

Pre-service teachers' competencies in teaching the basic school science curriculum are essential to helping pupils acquire the necessary scientific knowledge and skills. In the Ghanaian context, the basic school science curriculum aims to provide pupils with fundamental scientific concepts and skills. According to the Ghana Education Service (2019), the basic school science curriculum comprises three major areas: physical science, life science, and earth and space science.

Conceptual Framework

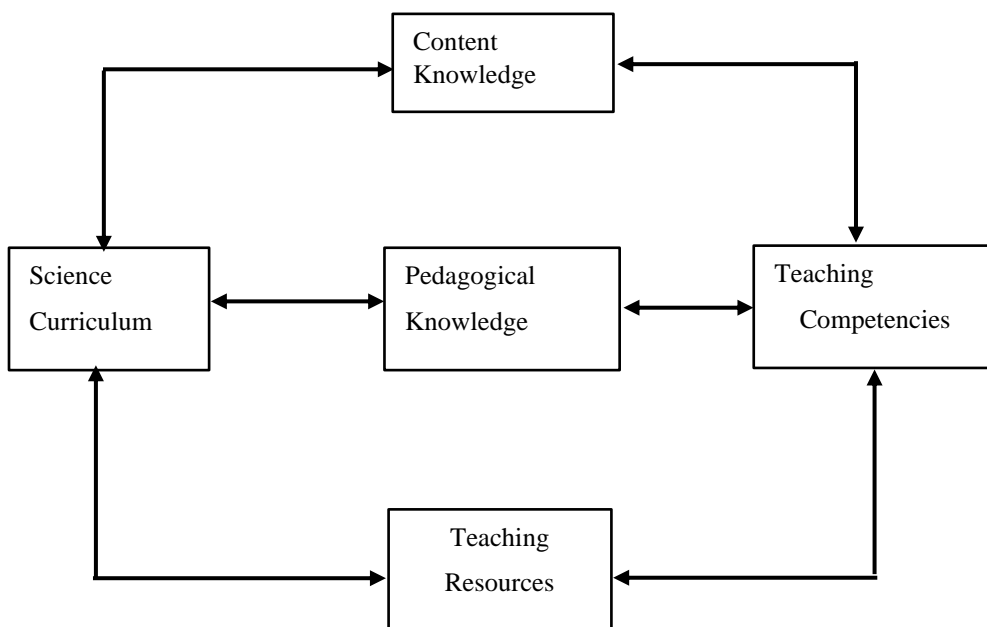


Fig.1. (Authors' Construct, 2023): A conceptual framework for assessing pre-service teachers' competencies in teaching the basic school science curriculum at Dormaa East District in Ghana

Fig.1 shows the interconnections between competencies, science curriculum, teaching resources, content knowledge, and pedagogical knowledge, which are crucial for the effective teaching and learning of science in basic schools. Pre-service teachers must have a deep understanding of these connections to develop the competencies necessary for effective teaching of the science curriculum.

First of all, the science curriculum serves as the foundation for science instruction at basic schools (Osborne & Dillon, 2008). Therefore, for pre-service teachers to create effective instructional strategies for their students, they must have a solid understanding of the science curriculum and its goals. This understanding necessitates having a firm grasp of the material, which is knowledge of the scientific theories and principles being taught.

Secondly, pre-service teachers need to have pedagogical knowledge, which is the knowledge of teaching and learning strategies that are most effective for teaching science concepts to students (Godino, Ortiz, Roa, & Wilhelmi, 2011). They must be able to select and use the appropriate instructional strategies and approaches that align with the objectives of the science curriculum.

Thirdly, teaching resources such as textbooks, laboratory equipment, and other materials should be aligned with the science curriculum and the teaching and learning strategies used by pre-service teachers. These resources can support the teaching and learning of science concepts and principles and help pre-service teachers achieve their objectives.

Finally, pre-service teachers' competencies are, therefore, the combination of their content knowledge, pedagogical knowledge, and skills in using appropriate teaching resources. Pre-service teachers must be able to apply their knowledge and skills to develop effective lesson plans and assessments that align with the objectives of the science curriculum.

Empirical Review

In a study by Aguilar and Cortina (2020), pre-service teachers' competencies can be assessed through self-evaluation and peer observation of their teaching practices. These self-evaluation tools include observation, assessment of lesson plans, and good professional practices in the classroom. The study showed that pre-service teachers' self-evaluation and peer observation were effective tools for assessing their competencies.

In another study by Otiende and Mireri (2020), pre-service teachers' competencies in teaching science were assessed through their lesson plans. The study found that pre-service teachers' lesson plans indicated a good level of understanding of science concepts and the ability to design and implement effective learning experiences for students.

Owusu-Ansah and Tawiah (2019) also assessed pre-service teachers' competencies in teaching the basic school science curriculum through a written examination. The findings showed that pre-service teachers had a good understanding of scientific concepts, but their ability to design and implement effective learning experiences was limited.

Various assessment methods have been used to evaluate pre-service teachers' competencies in teaching and learning the basic school science curriculum (Oyoo & Indoshi, 2018; Ampiah & Amponsah, 2017; Asiedu-Addo & Opoku, 2017). According to Oyoo and Indoshi (2018), pre-service teachers' ability to accurately teach science ideas was hampered by their lack of subject expertise. Again, Ampiah and Amponsah (2017) studied pre-service teachers' competencies and assessed them using a combination of written tests, practical exams, and classroom observations. The findings revealed that pre-service teachers performed well in the written tests but struggled in the practical exams and classroom observations. Another issue that pre-service teachers encounter, according to Asiedu-Addo and Opoku (2017), is inadequate access to teaching resources.

According to the literature, pre-service teachers in low-income areas often have limited access to teaching resources such as laboratory equipment and textbooks. This lack of resources negatively impacts the quality of education that students receive. Inadequate pedagogical skills are also a challenge for pre-service teachers. Pre-service teachers frequently lack the pedagogical abilities required to teach science effectively (Appiah et al., 2020). The children's education is badly impacted by this lack of ability. In a study by Oduro (2018), classroom observations were used to assess the classroom management skills of in-service teachers who were teaching science. The study found that in-service instructors had weak classroom management skills, which could negatively affect their ability to maintain discipline and foster effective learning. Finally, a lack of interest in teaching science is another challenge that pre-service teachers face. The literature claims that many pre-service teachers are not interested in teaching science, which has a detrimental influence on their capacity to do so (Kumar & Al-Amin, 2017).

Methodology

The study was analysed qualitatively. Qualitative research is a naturalistic inquiry that uses non-interfering data collection strategies to discover the natural flow of events and processes. A case study approach was used as the research design, which is qualitative in nature. The case study design is the most suitable approach as it is flexible and adaptable to processes, people, and real-life contexts. Investigating pre-service teachers' abilities to teach and learn about the basic school science curriculum is best done through

qualitative research (Creswell, 2014). Wahyuni (2012) identified three main types of case study designs: intrinsic, instrumental, and collective. This study uses an intrinsic case study design to assess pre-service teachers' competencies in teaching basic school science curricula in Dormaa East District in Ghana. Ten (10) research pre-service teachers were selected for the study to gain a deeper understanding of the phenomenon under investigation. To gather information for the study, the researchers used interviews and observation schedules. This was because the data collection methods were chosen with the qualitative nature of the study in mind, which made them simple to administer, easy to elicit responses from, valid, and reliable. It was also because of scheduling.

Research Instrument

The instruments used for the study were semi-structured interviews and observation schedules, which were constructed and structured by all three authors. According to Carter (2007), an interview involves a researcher-participant conversation that aims at helping the former gather research-relevant information. Given that it reveals pre-service teachers' everyday classroom experiences as well as their underlying beliefs, attitudes, and sentiments about the implementation of the science curriculum, an interview is thought to be one of the most effective methods for gathering qualitative research data. The semi-structured interviews were supplemented with observations for the purpose of triangulation. An observation is an important supplementary technique for research that is based on interviews, where the researcher makes notes on the observable behaviours of participants at the research site (Creswell, 2012, p. 190). The critical "watch-on" during the instructional process helped the researchers identify the strengths and weaknesses that pre-service teachers possess in science lesson presentations.

To ensure the face and content validity of the instruments, they were given to colleague post-graduate students at the University of Education, Winneba, to determine the content validity, identify any ambiguities, and also make the necessary clarifications to the items. This was to ensure that the items reflected the intent of the instruments. To ensure the reliability of the research instruments, classroom teaching observation was carried out on three different occasions for each of the research participants' lesson delivery. The reliability of the interview questions was pilot tested at Foso College of Education by the second author, who was also a tutor at the college.

Data Collection and Analysis

Pre-service teachers were interviewed using a semi-structured interview schedule known as the pre-service teachers' interview schedule (PTIS), which was created by all the authors and used to gather data from the

participants. The PTIS included open-ended interview questions that examined the pre-service teachers' capacity to teach and comprehend the basic school science curriculum. The PTIS took the form of face-to-face, free, and friendly interaction after pre-service teachers had taught specific science concepts to pupils. This exercise sought to elicit pre-service teachers' views on their strengths and weaknesses with regard to the science lessons taught. Each interview schedule lasted between 15 and 20 minutes, and the authors took turns interacting and asking questions. Between two and three pre-service teachers were observed and interviewed a day during their macro-teaching experiences.

An observation checklist was also used during the macro-teaching to collect data by ticking appropriately between 1 and 5 on a Likert ranking scale list of the competencies pre-service teachers exhibited in the teaching process. Finally, the author was assigned the pseudonym A1 and the pre-service teachers as PSt1, PSt2, PSt3, up to PSt10 for each of their responses to the interview questions, noting similarities and differences.

The competencies that were observed included a lesson plan, teaching methodology and delivery, classroom organization and management, and professional commitment. Classroom lesson observations of the 10 pre-service teachers were conducted when the basic schools were fully in session. Each lesson observed lasted approximately 40 minutes for six weeks in succession. All ten pre-service teachers were observed three times on different occasions during their macro-teaching in their respective schools of practice. The observation was systematically done, analyzed manually, and reflected on to gain valuable insights into the effectiveness of the teaching process. The interviews were also audiotaped for each of the ten pre-service teachers and played several times for transcription. Transcriptions of recorded interviews were done by listening to the taped conversations repeated and carefully writing them down with each interviewee. In all, ten pre-service teachers were observed and interviewed for a period of six weeks.

Thematic analysis was used to examine the data from the interviews and classroom observations. Finding patterns, themes, and meanings within qualitative data was done using thematic analysis (Braun & Clarke, 2006). The information was coded and transcribed. The codes were organized into themes, which were then examined to find patterns and interpretations.

Ethical Considerations

The pre-service teachers provided their informed consent prior to the data collection, and St. Ambrose College of Education granted ethical approval for the study. The pre-service teachers' anonymity and privacy were respected throughout the entire study.

Results and Discussions of Research Questions

Research Questions 1: What competencies do pre-service teachers exhibit during teaching and learning of basic science curriculum?

The first research question examined how pre-service teachers used the teaching materials provided for the particular scientific course to demonstrate their subject and pedagogical expertise. The pre-service teachers interviewed provided the following responses.

A1: How do you plan to integrate hands-on activities and experiments into your science lessons?

PSt 1: I normally choose activities that align with learning objectives to help pupils develop a deeper understanding of concepts.

PSt 2: For the hands-on exercise, I provide all the essential materials and equipment to the pupils. I even go so far as to explain to them the instructions' safety and precautionary implications before I give out specific directions that must be followed.

PSt 3: As for me, I try to encourage pupils to experiment and explore with the tools and resources. By so doing pupils are given the opportunity to discuss their findings and reflect on their learning after the activity or experiment

A1: How will you differentiate instruction in science to meet the needs of pupils with varying levels of prior knowledge and skill?

PSt 5: As for me, I'll make use of flexible groupings, such as small-group instruction and peer-to-peer support

A1: Suggest one teaching and learning approach that you consider most effective in teaching basic school science and give a reason

PSt 6: Hahaha!!! I'll also go for collaborative learning. With that, pupils will develop communication, teamwork, and leadership skills while also reinforcing science concepts.

Findings on Research Question 2: What challenges do pre-service teachers have in teaching the basic school science curriculum?

This research question sought to determine the challenges that aspiring teachers have when implementing the basic school science curriculum. The responses to the interview were;

A1: What challenges do you have in teaching the basic school science curriculum?

PSt 6: Hmmm, sir we don't have enough textbooks for science in this school and the pupils also can't afford exercise books for exercises.

PSt 7: In this school, we don't have adequate teaching-learning materials. Sometimes, I have to use my own money to buy teaching and learning materials for my lessons.

PSt 8: The time for the macro-teaching is small and I cannot finish my scheme of work for the term.

The interview was triangulated with classroom observation, and the following findings were identified during observation schedules:

1. Most of the schools visited in the Dormaa East District of Ghana lack basic curriculum materials for effective teaching and learning of the basic school curriculum.
2. Teaching and learning materials for science teaching and learning are inadequate for the schools visited in the district for the study.
3. Pre-service teachers have challenges at different stages of their lesson delivery with regard to the appropriateness of the teaching and learning materials to be used.
4. Pre-service teachers demonstrated good knowledge and understanding in the preparation of lesson plans.
5. Lessons observed were mostly pupil-centered.
6. The findings from the observations and interviews showed that the pre-service teachers' language was gender-responsive in the classroom because they were kind and treated men and women equally.

Discussions

Regarding the research question, "What competencies do pre-service teachers exhibit during teaching and learning of the basic science curriculum?", the study's responses showed that pre-service teachers demonstrated content and pedagogical knowledge during basic school science teaching and learning. The outcome of this study on competencies pre-service teachers exhibits in the teaching and learning of the basic science curriculum was confined to pre-service teachers at St. Ambrose College of Education in Ghana. Nevertheless, this study's results supported several other studies' results that identified or worked on competencies pre-service teachers exhibit in the teaching of the basic school science curriculum that was effective at different institutional levels, different course areas, and different geographical locations in Ghana and beyond.

In research conducted in Kenya by Otiende and Mireri (2020), lesson plans were used to evaluate the readiness of prospective teachers to teach science. The study found that pre-service teachers' lesson plans indicated a good level of understanding of science concepts and the ability to design and implement effective learning experiences for students. Aguilar and Cortina (2020) found that pre-service teachers' competencies may be evaluated by self-evaluation and peer observation of their instructional strategies. In addition to observation and lesson plan evaluation, these self-evaluation methods also offer a look at the best instructional approaches. According to the study, pre-service teachers' self-evaluations and peer observations were useful techniques for determining their competency levels. Amoah, Ankoma-Sey, and Appiah (2020), furthermore, assessed how well pre-service teachers knew

the pedagogical material required to teach science to elementary school students. The study found that pre-service teachers lacked the pedagogical skills and subject-matter knowledge needed to instruct the subject matter successfully. The research findings of the study gave a contrary view to the results at hand. This is because, in this study, it was observed that the pre-service teachers demonstrated good knowledge and understanding of lesson planning and lesson delivery.

Also, regarding research question 2, "What challenges do pre-service teachers encounter in the teaching of the basic school science curriculum?". It came out that most of the basic schools visited for the study lacked textbooks and teaching-learning materials, and pupils could not afford exercise books. These findings support the study of Asiedu-Addo and Opoku (2017), who observed limited access to teaching resources as another challenge that pre-service teachers face. According to the literature, pre-service teachers in low-income areas often have limited access to teaching resources such as laboratory equipment and textbooks. This lack of resources negatively impacts the quality of education that students receive.

Conclusion and Recommendation

According to the study's findings, pre-service teachers had a solid understanding of lesson planning and how to conduct lessons. The results of the study, however, suggest that pre-service teachers should receive training in resourcefulness and the capacity to improvise teaching and learning materials at no cost or at a minimal cost in order to effectively teach the basic school science curriculum, particularly in remote, disadvantaged rural areas. Again, as a matter of urgency, the government of Ghana should provide basic schools in Dormaa-East with adequate teaching and learning resources to enhance effective teaching and learning of basic school science. Finally, the duration of macro-teaching is not sufficient for efficient training of pre-service teachers in teaching basic school science.

Conflict of Interest: The authors declare no conflict of interest in the conduct of this study.

Data Availability: All the data is incorporated within the paper's content. No data has been excluded.

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Declaration for Human Participants: This study has been approved by: St Ambrose College of Education Academic Board in Ghana with the ethical

identification number SACE2401, and the principles of the Helsinki Declaration were followed.

Authorship

All authors contributed equally during the study. Authors shared ideas during the write-up. The last author made the necessary editing and proof reading of the work.

References:

1. Adeyemo, A. O. (2020). Teachers' perception on the use of improvised materials in teaching basic science in primary schools. *International Journal of Scientific Research and Management*, 8(1), 7338-7346.
2. Adu-Gyamfi, K., Appiah, S. K., & Owusu-Mensah, A. (2020). Assessing pre-service science teachers' competencies in Ghana: The case of University of Education, Winneba. *International Journal of Environmental & Science Education*, 15(7), 1-14.
3. Aguilar, J., & Cortina, J. L. (2020). Competencies in Science Teaching: Self-evaluation and peer observation as tools for initial teacher training. *Journal of Science Education and Technology*, 29(1), 82-94.
4. Amoah, V. A., & Nyarko, K. (2021). Inquiry-Based Teaching and Learning Approach in Pre-Service Science Teachers Training in Ghana. *Journal of Education and Practice*, 12(7), 13-22.
5. Amoah, V. A., Ankoma-Sey, V., & Appiah, D. F. (2020). Pedagogical content knowledge of pre-service teachers in teaching science in basic schools in Ghana. *European Journal of Educational Research*, 9(4), 1509-1524.
6. Appiah, D. K., Amoako, R. A., & Asare, F. (2020). Exploring pre-service teachers' perceptions and practices in the teaching of science. *Journal of Education and Practice*, 11(28), 139-147.
7. Armah, M. A., & Agyeiwaa, D. (2020). Science teacher preparation in Ghanaian basic schools: A review of the literature. *Journal of Education and Learning*, 9(1), 1-11.
8. Asiedu-Addo, S. K., & Opoku, M. P. (2017). Science education in Ghana: Challenges and prospects. *International Journal of Scientific and Research Publications*, 7(4), 231-236.
9. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101.
10. Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.

11. Ghana Education Service. (2019). Basic Education Curriculum for Ghana. Retrieved from <https://www.ges.gov.gh/wp-content/uploads/2019/01/BEC-Final-Curriculum-2019.pdf>
12. Kumar, P., & Al-Amin, A. Q. (2017). Factors affecting the quality of science education in developing countries. *International Journal of Science Education*, 39(6), 717-732.
13. Ministry of Education. (2018). *Teacher Education Curriculum Framework for Pre-Tertiary Teacher Education in Ghana*. Accra: Ministry of Education
14. Ogunniyi, M. B. (2020). The challenges of teaching and learning of basic science in Nigerian schools. *European Journal of Education Studies*, 7(8), 156-165.
15. Otiende, J. E., & Mireri, C. (2020). Assessing pre-service teachers' competencies in the teaching of science using lesson plans in Kenyan universities. *Journal of Education and Practice*, 11(30), 105-116.
16. Owusu-Ansah, E. K., & Tawiah, A. T. (2019). Assessing pre-service teachers' competencies in the teaching of the integrated science curriculum in Ghana. *Journal of Science and Mathematics Education in Southeast Asia*, 42(2), 155-168.
17. Owusu-Ansah, J. (2017). Assessment of pre-service teachers' competence in the teaching of science in basic schools in Ghana. *Journal of Education and Practice*, 8(4), 17-24.
18. Oyoo, S. O., & Indoshi, F. C. (2018). Pre-service teachers' content knowledge and pedagogical content knowledge of light in Kenya. *Journal of Science Education and Technology*, 27(3), 243-256.
19. UNESCO. (2021). Science education. Retrieved from <https://en.unesco.org/themes/science-sustainable-development/science-education>