INSTRUCTIONAL COMPETENCE OF JUNIOR HIGH SCHOOL SCIENCE TEACHERS: EXPLORING THE GAPS FOR SUSTAINABLE IMPROVEMENT IN SCIENCE TEACHING AND LEARNING IN THE AKUAPEM SOUTH MUNICIPALITY OF THE EASTERN REGION-GHANA

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ABSTRACT

The instructional competence of a teacher is critical to students' positive engagement and learning outcomes. This study explored the instructional competence of the Junior High School (JHS) science teachers using quantitative research approach and cross-sectional research design. The study employed structured questionnaire to collect self-report inventory from a sample of 70 randomly selected JHS science teachers in the Akuapem South Municipality of the Eastern Region. Data gathered were analysed using descriptive statistics and t-test. The results indicated that the overall mean score for JHS science teachers' instructional competences was 3.426, SD =1.4482, which fall in the category of *high* competence. The results further revealed the following trends in science teachers competences: Teaching philosophy (mean =3.7131, SD =1.39554; $t(69) = 22.692$, $p<0.05$) was rated *high*; learning philosophy (mean =3.5875, SD =1.22867; $t(69) = 21.728$, $p<0.05$) was rated *high*; knowledge of learners (mean =3.5715, SD =1.51011; $t(69) = 19.920$,$p<0.05$) was rated *high*; knowledge of subject content (mean =3.6154, SD =1.49551; $t(69) = 20515$, $p<0.05$) was rated *high*; and both knowledge of teaching methods and strategies (mean = 3.2664, SD =1.47791; $t(69) = 18.521$, $p<0.05$) and knowledge of science curriculum (mean= 2.8.026, SD = 1.58123; $t(69) = 16.007$, $p<0.05$) were rated *moderate.* Thus, knowledge of science curriculum and science teaching methods and strategies have yet to be given due attention by science teachers. These findings revealed relevant instructional *gaps* in science teaching and learning at the JHS. The study recommends that the Akuapem South Municipal Education Directorate, in collaboration with the Ghana Education Service, should organise in-service training for the JHS science teachers to update their proficiency in the science curriculum knowledge and the teaching methods and strategies to enhance effective and sustainable science teaching and learning at the JHS level.

Keywords: Science teacher, teaching philosophy, learning philosophy, curriculum knowledge, knowledge of students, subject content knowledge & teaching methods and strategies.

INTRODUCTION

The instructional competence of a science teacher is central to students' positive engagement, learning outcomes and application of the learning outcomes to solve problems. In the context of lifelong learning in the 21st century, science education at any level is challenged to re-think about how to enable students at any stage of their life to understand the body of scientific knowledge, know how the scientific knowledge is acquired and develop sustainable self-efficacy to apply the knowledge gained to solve problems. This call has been highlighted in almost all the 17 Sustainable Development Goals (SDGs) as a result of the potential of science in achieving the SDGs (United Nations Statistics Division (UNSD), 2017; SDG Report, 2019).

Science has become integral part of society and human life. According to Rull (2014), science is valued by society because its application has helped to satisfy many basic human needs including safe food, safe water, clothing, shelter, clean air and energy, and improve living standards. He further opined that practical application of scientific discoveries has freed humans from the precincts of time and distance and the pathological distress of diseases and unnecessary drudgery (Rull, 2014). Plethora studies have equally reported that science encourages and enables students to develop exploratory minds and curiosity about science and nature, acquire knowledge, conceptual understanding, and skills to solve problems and make informed decisions in scientific contexts (Sharon & Baram-Tsabari, 2020; Queiruga-Dios & López-Iñesta *et al*., 2020; Owens & Sadler *et al.*, 2020).

In spite of the numerous values of science to humanity and the environment, particularly those actively contributing significantly to the achievement of the SDGs (United Nations Statistics Division (UNSD), 2017; SDG Report, 2019), science teaching and learning at the JHS level in Ghana is not producing desire results in terms of students understanding of the scientific knowledge, students acquisition of the scientific processes, and student application of the scientific knowledge gained to solve problems. This view was espoused by a study conducted by Smith (2010) who reported that JHS students could not apply simple scientific knowledge learned to solve real life problems that confront them in the homes, schools and in their community. In support of this, the Chief Examiners Report for Integrated Science (2017, 2018, 2019 & 2020) indicated that the performance of students in integrated science over the year has been on a consistent decline. The reports further highlighted that the Basic School Certificate Examination (BECE) integrated science questions required candidates to explain how basic scientific knowledge gained could be applied to solve personal and local problems. The performance of students in these application questions, however, continues to be below proficiency level. This persistent decline in performance among the JHS students in the basic certificate examinations (BECE) continues to attract persistent public outcry in recent time.

Today, it is widely believed that these challenges have been noted to be a national school problem in Ghana and particularly observed among many JHS students. An increasing body of research strongly links the decline in students' performance in science to teachers' poor instructional competence (de Souza-Barros & Elia, 1997; Bold and Filmer *et al,* 2017; Lee and Luft, 2008). Fostering and enhancing the instructional competence of teachers can help improve students' learning outcomes (Olagbaju & Popoola, 2020). The teachers' instructional competence needed to improve students' learning outcomes have been studied extensively in Ghana (Adusei & Sarfo, 2020, Agormedah *et al.,* 2020, Amtu *et al*., (2020). However, none of these studies specifically discourse the JHS science teachers' instructional competence in the Akuapem South Municipality (ASM). Thus, the purpose of this study was to explore the gaps in instructional competence of the JHS science teachers in the ASM in six thematic areas including teachers: teaching philosophy, learning philosophy, knowledge of learners, knowledge of curriculum, subject content knowledge, and teaching methods and teaching strategies. These variables have been identified as potential characteristics influencing teacher performance (Smith, 2010).

LITERATURE REVIEW

Theoretical Foundation of the Study

Understanding the robust educational models that drive effective teaching and learning are important factors in education. This study was underpinned by constructivist and 3P (presage, process and product) learning models. These models respond to the best practices in teaching and learning requirements of the 21st century and mirror the characteristics of knowledge and learning which are fundamentally personal, social, flexible, dynamic, and complex in nature.

The constructivist approach to teaching and learning is grounded in research within subset of both cognitive and social psychology (Brandon & All, 2010). The basic tenet of the theory is that an individual learner must actively "build" knowledge and skills (Pande & Bharathi, 2020) and that information exists within these built constructs rather than in the external environment (Pande & Bharathi, 2020). The constructivist learning model therefore views the learners as active participants who construct their own knowledge rather than just being passive receivers of knowledge from the teacher. The model further considers the learners as active participants who come to the learning environment with their own pre-existing knowledge and ready to use this knowledge to construct new knowledge. New ideas are understood and interpreted in the light of the learners' pre-existing knowledge, built up out of their previous experiences. Learning from this perspective therefore entails that the learners must re-organise and re-structure their present knowledge structures; and this can only be done by the learners themselves. Each learner individually and socially constructs meaning as he or she actively interacts with the learning environment. The dramatic consequences of constructivist view are twofold. First, teachers have to focus on the learner in thinking about learning, not on the subject or the lesson to be taught: second, there is no knowledge independent of the meaning attributed to experience by the learner, or community of learners. Therefore, any effort to teach must be connected to the state of the learner, and must provide a path into the subject for the learner based on that learner's previous knowledge (Adam, Alzahri, Cik Soh, Abu Bakar, & Mohamad Kamal, (2017).

The second learning model that underpins this study is the 3P learning model. This learning model is characterized by the convergence of lifelong, informal, and personalized learning within a social context. According to the 3P learning model, classroom instructions and students' background influence students' approaches to learning process and result in various learning outcomes. The 3P learning model is organized along three points in time, namely *presage, process and product.* The *presage* refers to the pre-existing learning experiences the learner possesses before the learning engagement. The *process* refers to the student learning experiences during learning itself. And the *product* denotes **t**he overall students learning outcome.

Several researchers (Barattucci *et al.,* 2017; Hamilton & Tee, 2009; Haverila, 2011 & Zhang, 2010) have empirically tested the cogency and robustness of the 3P learning model. Barattucci *et al.* (2017) for example, used students' survey data and applied structural equation modeling to confirm or reject the nexus between *presage-process-product* categories. They reported a strong positive correlation among the three concepts. Similarly, Haverila (2011) and Zhang (2010), used students' self-report inventory data and obtained similar results using regression analyses. Thus, the 3P model delivers a teaching and learning system that shows how student factors interact with the teaching context during the learning activities and lead to the attainment, or non-attainment of the learning outcomes. Within the classroom context, the 3P model has been found to be student-centred and outcomes focused, and has been very influential in the area of teacher development relating to teaching and learning. The model further shows that personal and institutional commitments and support are necessary to promote effective learning, which Kanashiro and Iizuka *et al.*, (2020) referred to as deep learning that encourages students to reflect on their personal values, behaviours and attitudes to acquire analytical skills aimed at solving personal, social, environmental and economic problems.

The present study adopts the constructivist and the 3P learning models to explore and understand better the JHS science teachers' instructional competences in six thematic areas including teachers: teaching philosophy, learning philosophy, knowledge of learner, knowledge of science curriculum, knowledge of science content, and the knowledge of science teaching methods and teaching strategies.

Empirical Literature Review

The empirical review focuses on six themes including science teachers: teaching philosophy, learning philosophy, knowledge of the learner, teacher pedagogy, curriculum knowledge, and knowledge of teaching methods and strategies that are relevant for effective and efficient science teaching and learning.

The first teacher competence variable measured in this study is the science teachers teaching philosophy statement. A systematic and extensive literature review indicates that effective science teaching is influenced largely by the teacher's teaching philosophy statement (TPS) (Aytaç, & Uyangör, 2020). Teaching philosophy is a re-thinking process amply recognized in the educational literature as innovative practice (Beatty, Leigh, & Lund Dean, 2009; Goodyear, & Allchin, 1998). According to Chism (1998), and Gregory, *et al.*, Burbage, (2017), TPS describes the thoughts of the teacher on how learning takes place, how they can intervene in the process, what the expected goals for students are, and what actions to implement their intentions. While Schönwetter *et al.* (2002) identify elements in TPS as: definitions of teaching and learning, perspectives on learner development, student-teacher relationships, teaching methods and evaluation, Yeom, Miller & Delp (2018) relates TPS to the alignment of educational concepts found in the institutional framework to one's beliefs, likes, and expectations regarding teaching and learning. Every teacher, irrespective of sex, teaching experience or level of teaching, has distinct TPS which is a self-reflective statement of beliefs about teaching and learning. These school of thoughts opined that TPS conveys one's core beliefs and ideas about being an effective teacher in the context of your discipline. Teaching philosophy is therefore a statement that articulates teacher's beliefs about what makes effective learning happen (Laundon & Cathcart *et al.*, (2020). They can be powerful tools in identifying assumptions about teaching, articulating our values as educators. As Coppolla (2002 p.450) puts it, "developing your teaching philosophy is important because the teaching statement gives you a starting point for examining your teaching practices, allows you to share your ideas with others, and allows you to monitor the progress of your own development as a teacher." Teaching philosophy therefore has specific goals like reflecting about your teaching, your students, your methodology, your ideals as a teacher, level of professionalism, personal learning, involvement, teaching beliefs, and values among other things. A teaching philosophy is a great organizer of the teacher's teaching (Coppolla, 2002); a communicator of personal beliefs about teaching, and therefore resides within an individual and enables them to act in a particular manner to achieve specific goals and objectives. Teaching philosophy, thus, clarifies what effective teaching is, guide teaching behaviours, organizes the evaluation of teaching, promotes personal and continuous professional development, and encourages the dissemination of effective teaching.

Drawing inference from the above discussions, teaching should be founded on the idea of individual inquiry. This principle makes education a learner centred process, not one that is teacher centred. The teacher is a guide, facilitator, and co-explorer, motivator, positive role model, who encourages learners to question, challenge and formulate their own ideas, opinions and conclusions (Ahmed & Rahman *et al.,* 2022; Üstün, 2021; & Ebaid, 2020). The teacher should consider student interests, expectations, needs, and reasons for study. According to Wallace (2000), the central goal of teaching is to empower students in their education by providing dynamic learning situations and exciting research opportunities that challenge them to learn. Teacher's teaching philosophy statement is dynamic and therefore changes as one gains more experience and skills. For a "stagnant" teacher is no good to the class – a teacher is not just a teacher but a lifelong learner. Therefore, he/she must also continue to build his/her wealth of professional knowledge.

Apart from teacher's teaching philosophy, another factor that can predict students' learning outcomes is the teacher's learning philosophy. Learning is a complex phenomenon involving processes of change and adaptation. According to Adom and Yeboah, *et al*., (2016), learning is an active process in which the learner uses meta-sensory input and constructs meaning out of it. It is therefore very important for a teacher to know theories of learning. Knowing this will guide him in determining the goals of his teaching. Science education must provide learners with opportunities to expand, change, enhance and modify the ways in which they view the world. It should be pivoted on a learner-centred approach to teaching that engages learners physically and cognitively in the knowledge-acquisition process, in a rich and rigorous inquiry-driven environment. The fundamental nature of science is embedded in inquiry-based learning. Understanding the inquiry-based learning provides the science teacher with a better grasp of the concepts and processes of science. Inquiry-based learning in the science classroom combines a variety of skills and science processes. According to Tan (2022) students in an inquiry-driven environment ask questions; make observations; plan and conduct experiments; gather and analyze data; use critical thinking; develop explanations, conclusions, and predictions; and communicate their findings to others. Science learning is therefore seen as an active contextualized process of constructing knowledge based on learners' experiences rather than acquiring it. The significance of inquiry learning strategies has been documented in increased science achievement and cognitive development for students (Özgelen (2012); Rumjaun, & Narod (2020).

According to constructivist learning theory, learners construct knowledge for themselves. That is each learner individually constructs meaning as he or she learns. There is no knowledge independent of the meaning attributed to experience by the learner, or community of learners. Learners are information and knowledge constructors who operate as researchers (Ozdem-Yilmaz & Bilican, 2020). Teachers serve as facilitators by providing the enabling environment that promotes the construction of learners' own knowledge, based on their prior experiences (Dole, Bloom, & Kowalske, 2016). This makes learning more relevant and meaningful to the learner and leads to the development of critical thinkers, problem solvers and innovators (Dole, Bloom, & Kowalske, 2016). Further, science learning should be inquiry-based and self-construction of knowledge about nature. Although traditional lectures remain an important part of teaching and learning, a bulk of research on students' learning demonstrated that the students learn more effectively when they construct their own understanding through the combination of guided enquiry-based activities (Byrne & & Cheek, 2016). One most important learning process is where students formulate their own questions, solve problems, perform experiments and look for their own answers in a safe and inclusive environment. The steadily growing confidence in the students' ability to accumulate the knowledge is the best motivator in their future studies (Syauqi, Munadi, & Triyono, 2020). According to Brophy (2004) student become a good learner by being open to criticism and being ready to change. He further argues that criticism does not only encourages critical thinking and problem-solving skills, which are necessary for success in any field, but it also helps students gain confidence by providing them with learning tools to improve their performance on assignments or tests.

The above literature suggests that learning involves understanding, relating ideas and making connections between prior and new knowledge, independent and critical thinking and ability to transfer knowledge to new and different contexts. Heedlessly of the field of study, students need to have significant opportunities to develop and practice intellectual skills/thinking processes such as problem-solving, scientific inquiry, among others, that are important to their fields of study. Effective learning produces a set of preferable outcomes, the most important of which is enabling learners to acquire knowledge together with critical thinking skills (Voogt & Roblin, 2012). When teachers emphasize judgment and critical thinking, it is typically because they view investigation and inquiry of what is worthwhile learning important in the process of learning itself.

Besides teacher's teaching and learning philosophies, teacher's knowledge of the learner has also been found to influence students' learning outcomes. A learner is described as someone trying to gain knowledge or skill in something by studying, practicing, or being taught. Knowing the learner involves understanding that language, identity, and culture are very important. It is essential that teachers respect and value learners' background characteristics comprising who they are, where they come from, and what they bring with them from their experiences. One previous study (Dewi, & Dalimunthe, 2019) demonstrated that teaching and learning become very effective when teachers have knowledge about how learners learn. Learners' own emotionality may also affect their ability to learn. Their inner motivation, persistence to complete assignments, ability to take responsibility for their own behaviour and work, or the opportunity to do things in their own way may all play a significant role in how a learner best learns (Abdelrahman, 2020).

Teachers need to be aware of the learners' learning styles under various conditions. Abdelrahman (2020) found some sociological factors affect learning. According to him, variations that influence learning may include learning alone, in pairs, in small groups, as part of a team, and wanting variety as opposed to patterns and routines. Physiological characteristics, which refers to when and how learners learn best, time of day, outside stimulation, energy level, and mobility while studying also affect learners' learning. These characteristics will let teachers help learners learn based on their perceptual strengths and encourage them to study at their best time of day.

According to Aliakbari and Parvin *et al.,* (2015) learners also react differently to external stimulation when they concentrate on studies. For example, some learners like to eat, chew gum, or drink while learning; whilst others may study better or work better in a classroom situation if they can move around while learning and not be confined to one desk space (Dunn, & Dunn, 1992).

Another study conducted by Olurinola & Tayo (2015) also argues that the way learners' process information affects their learning abilities (Olurinola, & Tayo, 2015). The authors explained that some learners are more analytical processors who tend to be persistent. They may not always start an assignment immediately, but once they do begin, they have a strong emotional urge to continue until the task is done or until they come to a place where they feel they can stop. The impulsive students will not spend much time in learning. A reflective student will spend time thinking about the information, understanding the content being taught (Dunn, & Dunn, 1992). The above discussions suggests that when a science teacher has adequate knowledge of the learners, regarding knowledge processing and accommodation they can help create the necessary learning environment for learners to understand concepts and apply them to real life situations in their environment.

Another important instructional competence the science teacher is expected to have in order to be effective is the subject content knowledge. The subject content knowledge refers to the body of knowledge and information that teachers teach and that students are expected to learn in a given subject such as Science, English language, Arts, Mathematics, or social studies. The content knowledge comprises the facts, concepts, theories, and principles that are taught and learned in specific academic courses, rather than to related skills. The content knowledge is therefore specific to a discipline or content area, which is the type of knowledge that science teachers should possess to provide effective instruction to learners with varied backgrounds. The content knowledge has been documented in plethora studies (Cochran, DeRuiter, & King, 1993; Grossman, 1990; Smith & Neale, 1989, Tamir, 1988; Magnusson, Krajcik, and Borko, 1999; and Hill, Ball and Schilling, 2008). According to Shulman (1986), for example, teachers need to possess the content knowledge to be effective in presenting knowledge to the learners.

For science teachers' the subject content knowledge is more than information and facts about the discipline. The content knowledge of the subject includes the substantive and syntactic structures of a discipline. The substantial knowledge is an understanding of the different ways the basic concepts and principles of a discipline are organised. The syntax of a discipline is the set of ways scientists establish the truth or falsehood, validity or invalidity of a new or extent knowledge claims. Within the global environment, the subject matter knowledge plays an important role about what teachers should know and how the subject matter knowledge should be taught or presented to enable learners understand it. What science teachers need to know beyond that is more complex and subject to more debate but early formal teacher education programmes, certainly included a high proportion of subject matter knowledge as part of the curriculum (Rollnick, & Mavhunga, 2016).

Thorough understanding of the subject requires a depth study of all aspects of the subject from a variety of perspectives, to think of ideas and information, to enrich classroom situation, of various ways of presenting and explaining material to students and show students how various concepts and facts throughout the course relate to each other.

Another factor that has been found to influence students learning outcome is the teachers' knowledge of the teaching methods and teaching strategies. The term teaching method refers to the general principles, pedagogy and management strategies used for classroom instructions. According to Burden (2020), teaching method are the principles and approaches used by teachers to enable students learning. Teaching methods can be categorized into two broad types including teacher-centred methods, and learner-centred methods (Burden, 2020). According to Precious *et al.,* (2020) the teacher-centered approach takes place inside the classroom and encourages the learners to focus completely on the teacher. The teacher does almost all the talking while students continue to listen and remain silent. The teacher is the center of knowledge and in charge of learning; students are usually passively receiving information; the instructor's role is to be the primary information giver and primary evaluator; students are viewed as "empty vessels" who passively receive knowledge from their teachers through lectures and direct instruction, with an end goal of positive results from testing and assessment. Under the premises of the direct instruction model, the teachers act as the sole provider of knowledge; they often utilize systematic and pre-scripted lesson plans and assessments are in many cases only carried out as summative and not formative evaluations and they rarely address qualitative issues of the learner's progress. Taken to its most extreme interpretation, teachers are the main authority figure in a teacher-centered instruction model.

In this 21st century, the needs for a shift from teacher-centered methods of instruction to learner-centered pedagogy has been documented in many studies (Brown, 2003; Crick & McCombs, 2006; Harris & Cullen, 2008). The learner-centered strategy is the learning strategy in which the teachers create a learning environment encouraging students to actively engage in and take ownership of their learning experiences, an environment inspiring learner to think deeply about how they might apply what they are learning to their future practice. Learner-centered teaching, uses a learner's interests and strengths to create a customized learning experience. This method revolves around the ideas of classroom community development and capitalizing on student strengths through cooperative learning. According to Wright (2011), the use of learner-centered pedagogy favours a democratic approach to teaching that shifts the teachers' role from the center of the learning environment to a more peripheral position. This shift is achieved by increasing students' opportunities to actively participate in the classroom and engage in self-directed learning outside the classroom, as well as providing forums through which they can share learned information with peers.

According to Messiou and Ainscow *et al.* (2016)**,** teaching strategies are techniques teachers use to support learners to become independent strategic learners. These strategies become learning strategies when students independently select the appropriate ones and use them effectively to accomplish tasks or meet goals. Studies demonstrate that when teaching strategies are properly used, it can motivate learners and help them focus attention, organize information for understanding and remembering and monitor and assess learning (Leopold, & Leutner (2015). To become successful strategic, learners need: step-by-step strategy instruction; a variety of instructional approaches and learning materials; appropriate support that includes modelling, guided practice and independent practice; opportunities to transfer skills and ideas from one situation to another; meaningful connections between skills and ideas, and real-life situations; opportunities to be independent and show what they know; encouragement to self-monitor and self-correct; tools for reflecting on and assessing own learning.

The last competence variable measured is the teachers' knowledge of the curriculum. According to Carl (1995) curriculum is the planned interaction of pupils with instructional content, materials, resources, and processes for evaluating the attainment of educational objectives. In the province of Barrow (2015), curriculum means all the planned learning which is guided by the school, whether it is carried in groups or individually, inside or outside the school. Generally, the teachers depend upon the curriculum planned by an external agency, instructional plans and materials used by their own teachers and on doing well in the external examinations. The teachers should always involve learners in the process of learning. Thus, the teachers must always attempt to best utilize their knowledge and understanding of the curriculum content to design a teaching plan that meets the needs and interests of the students. The teachers' knowledge of these curriculum contents will help him deliver the right contents to the learners which will enable them to apply the concept to real life situations (Stavroula Valiandes, Lefkios Neophytou & Christina Hajisoteriou, 2018).

METHODOLOGY

Study Area

The study was conducted in the Akuapem South Municipality (ASM) of the Eastern region between April 2022 and June 2022. The Akuapem South Municipality is located at the south eastern part of the Eastern Region of Ghana between latitudes 5.45^0N and 5.58^0N, and Longitudes 0.0W and covers a land area of about 229.4 kilometres square and with a population of 76, 922 with 37,101 (48.2%) males and 39,821 (51.8%) females (GSS, 2021). This municipality was selected as the study area as it was a newly carved municipality which is thriving hard to harness both human and educational resources to promote effective teaching and learning in its basic schools.

The objective of the study was to explore the instructional competence of the JHS science teachers and provide research recommendations related to teacher competence and effectiveness, specifically addressing the area of science teacher competency gaps to improve students' learning outcomes and achievements in the JHS in the municipality. The study employed quantitative approach and school based cross-sectional research design. The quantitative research approach was adopted because it is both scientific in nature and objective in epistemological orientation (Creswell, 2009); and the use of scientific methods for data collection and analysis make generalization possible with this type of approach. The cross-sectional design was also adopted because the measurements for a sample member are obtained at a single point in time, thus, making the use of the design generally quick, easy, and cheap (BMJ, 2014).

Study Participants, Sample Size Determination and Sampling Procedure
The study participants comprised 192 JHS science teachers in Akuapem South Municipality. The sample size for the study was determined using statistical formula developed by Krejcie & Morgan (1970) and stated below.

$$n = \frac{x^2 N\rho(1-\rho)}{e^2(N-1) + x^2\rho(1-\rho)}$$

Where: *n* represents required sample size, *x* represents Chi-square of degree of freedom and confidence interval at 95%, *N* represents population size,ρ represents expected proportion of population, and *e* represents margin of error.

Employing the formula gives a sample size of 70 science teachers consisting of 38 (54.3%) males and 32 (45.7%) females who were drawn from a sampling frame consisted of 192 science teachers using simple random sampling technique. According to Bernard (2013) and Saunders, *et al*., (2012) random sampling is a part of the sampling technique in which each sample has an equal probability of being chosen. A sample chosen randomly is meant to be an unbiased representation of the total population.

The general t-test equation model as outlined by (Gerald, 2018) and presented below was used to find out if there are statistically significant differences in science teachers' own perspectives on *teaching philosophy, learning philosophy, knowledge of learners, curriculum knowledge, subject content knowledge and knowledge of teaching methods and teaching strategies.*

Data Collection
Quantitative method approach comprising the use of structured questionnaire were adopted for the study. The primary measure for instructional competence was defined as *essential practices that science teacher must master for effectively instructing and engaging students to maximize learning outcomes (*Kunter, Klusmann, Baumert, Richter, Voss, & Hachfeld, 2013). The selected instructional competence variables that were assessed were based on both extensive theoretical and empirical literature reviewed and expert opinions. The category variables and the number of sub-variables used to assess the JHS science teachers' instructional competencies are presented in Table 1 below.

Table 1: JHS Science Teachers' Instructional competencies Assessed

Competence Variables Measured	No: of Sub-variables used to Measure Each Competency Variable	Competence Variable Codes
Teaching Philosophy	9	**TP**
Learning Philosophy	10	**LP**
Content Knowledge	14	**KL**
Knowledge of Learner	5	**C_uK**
Knowledge of Science Curriculum	10	**CK**
Teaching Methods and Strategies	28	**TMS**
Total	**76**	

Alpha reliability coefficient of total and subscales of teachers' performance (n=70)

Data were collected from the 70 JHS science teachers using a 5-point Likert type questionnaire adapted from Third International Mathematics and Science Study (1999). Each item on the questionnaire had response opinions that were rated on a five-point scale, anchored at 5 = strongly disagree; 4 = disagree; 3 = don't know; 2 = agree; and 1 = strongly agree (Creswell, 20013, Singleton, & Straits, 2018). The participants responded to each item by choosing one alternative that best describes their vox populi. The internal validity and reliability of the structured questionnaire items were ascertained using Cronbach's Alpha-coefficient (1920). The Cronbach's alpha value above 0.6 (60%) were considered acceptable.

To ensure that the items reflected the range of teachers' instructional competence, a pilot test was carried out with 13 science teachers randomly selected from five JHS in the Akuapem North Municipality of the Eastern Region, all sharing similar characteristics. These teachers were, however, excluded from the main research processes. The feedback from the pilot study was used to modify some items and scales in terms of word choice and phrasing. These improved the final survey. The questionnaire was then administered to the 70 JHS science teachers in their various schools during the break period with the assistance of level 200 pre-service teachers who were on supported teaching in school programme in the schools. The break period was used to avoid interruption of academic work of the schools. The 70 copies of the questionnaires administered were returned, resulting in a 100% response rate.

Data Analysis

The study operationalized JHS science teachers' instructional competence in six thematic areas. Table 2 presents operational definitions of the six variables used to assess the instructional competence of the JHS science teachers and upon which the analysis of the data collected were based.

Table 2: Operational Definitions of Variables used to Measure Teachers Instructional Competence

Instructional Competence Variables	Standard (Operational) Definitions	References
Teaching Philosophy	Teaching philosophy describes the thoughts of the teacher on how teaching takes place, how they can intervene in the process, what the expected goals for learners are, and what actions to implement their intentions.	Laundon, *et al.*, (2020). NaCCA/Ministry of Education, 2020.

Learning Philosophy	Learning refers to an active contextualised process of constructing knowledge based on learners' experiences rather than acquiring it; teacher serve as facilitator by providing the enabling environment that promotes the construction of learners' own knowledge, based on their prior experiences.	Chism (1998); NaCCA/Ministry of Education, 2020.
Content Knowledge	Content knowledge refers to the body of knowledge and information comprising facts, concepts, theories, and principles that teachers teach and that students are expected to learn in a given subject.	Shulman (1986); Cochran, DeRuiter, & King (1993).
Knowledge of Learner	Knowledge of the learner denotes the understanding that language, identity, and culture of the learner are very important in the teaching learning process.	Dewi, & Dalimunthe (2019)
Knowledge of Science Curriculum	Knowledge of science curriculum refers to the science teacher's ability to apply theoretical principles and behaviours associated with planning, implementing, and evaluating the curriculum in differentiating instruction and in enhancing the capacity for responsiveness to the social context.	Stavroula Valiandes, Lefkios Neophytou & Christina Hajisoteriou (2018).
Teaching Methods and Teaching Strategies	Teaching method refers to the general principles, pedagogy and management strategies used for classroom instructions. Principles and approaches used by teachers to enable students learning. The teacher's knowledge of how to convey knowledge and skills to learners.	Green and Stormont (2018); Burden (2020)

Quantitative data gathered using the Likert scale type questionnaire were collated, cross-checked against the items on the instruments used, coded and entered into SPSS Version 26 IBM for windows (SPSS Inc, Chicago, USA). The data gathered were then subjected to descriptive statistics and student t-test statistics at 5% level of precision (95% confident interval) with p-values reported in two tailed significant levels. The descriptive statistics was used to summarise the data into means and standards deviation whilst the t-test statistics was used to find out if there are statistically significant differences in science teachers' responses to each of the six categories of the teachers' instructional competencies measured. Relevant statistical tables were generated using Microsoft Excel Software Version 12.

Employees' Behavioural Competence Standard Framework Scale

This study used employees' behavioural competence/job performance standard framework scale developed by Bhat and Beri (2016). The framework scale is conceptualized in terms of behavioural competence. The scale ranged from 1.0-5.0 with values ranging from: 1.0-1.80 regarded as *lowest* competence; 1.81-2.60 regarded as *low* competence; 2.61-3.40 regarded as *moderate* competence; 3.41-4.20 regarded as *high* competence; and 4.21-5.0 regarded as *highest* competence (Bhat and Beri, 2016). This scale has been utilized to determine the competency of teachers in educational institutions (Kocabas & Erbil, 2017; Beena, & Suresh, 2022; Petre, 2021).

RESULTS

This section presents the results of the study with participants demographic information presented first, followed by the main results.

Demographic Information of JHS Science Teachers

Table 6 shows the results of the JHS Science teachers' demographic information.

Table 3: Demographic Information of JHS Science Teachers

Demographic Characteristics	Frequency/Percentage Distribution of Choice Category in the Sample	
Location of school	Frequency	Percentage (%)
Rural	41	58.6
Urban	29	41.4
Total	**70**	**100**
Mean Location: 1.4143 SD±: 04962		
Sex		
Male	38	54.3
Female	32	45.7
Total	**70**	**100**
Mean Sex: 1.457 SD±: 05018		
Age		
15-19	14	20
20-25	14	20
26-31	15	21.4
32-37	14	20
38 & above	13	18.6
	70	**100**
Total		
Mean Age: 1.457 SD±: 05018		
Teaching experience		
0-5	19	27.1
6-10	24	34.3
11-15	10	14.3
16 & above	17	24.3
Total	**70**	**100**
Mean Teaching Experience: 2.371; SD±: 1.157		

Source: Field data, 2023.

Table 3 results above showed that out of the 70 science teachers who participated in the study, majority were male (n=38; 54.3%) as females were 32(45.7%); and 41 teachers (58.6%) teach science in rural JHS and the rest 29 (41.4%) teach science in the urban JHS. In terms of age distributions, majority of teachers 43(61.4%) were within the age bracket of 15-31 years; whilst 13 (18.6%) were 38 years and above. For teaching experience, greater number of the teachers have been teaching science in the JHS for 6-10 years.

Table 4: Descriptive Statistics for Science Teachers' Perspective on Teaching Philosophy

Constructs	Descriptive Statistics		Sample size (n) =70 ; df=69				
			Inferential Statistics			95% Confidence Interval of the Difference	
Science Teachers' Perspective on Teaching Philosophy	Mean	SD	t	P values	Mean Difference	Lower	Upper
• Science Teachers should teach how they were taught in college or at the university.	3.0857	1.47189	17.540	.000	3.08571	2.7348	3.4367
• Science teaching should give learners the opportunity to construct their own knowledge	3.4000	1.53604	18.519	.000	3.40000	3.0337	3.7663
• Science teaching should involve learners in meaningful "hands-on" activities.	3.5429	1.62129	18.283	.000	3.57143	3.1563	3.9294
• Science teaching should always be conducted through inquiry-based activity	3.7000	1.46802	21.087	.000	3.70000	3.3500	4.0500
• Science teaching should arise from learners' desire to understand the world around them	3.4286	1.56568	18.321	.000	3.42857	3.0552	3.8019
• Science teaching should help learners to identify their misconceptions and correct them.	4.0000	1.28537	26.036	.000	4.0000	3.6935	4.3065
• Science teaching should allow learners to ask questions for the teacher to provide answers to them.	3.7571	1.42885	22.000	.000	3.75714	3.4164	4.0978
• Building science instructions around learners' problems promotes understanding of scientific concepts and skill development.	4.0857	1.17637	29.058	.000	4.08571	3.8052	4.3662
• Science teaching should encourage acquisition of scientific knowledge by learners through self-discovery.	3.9000	1.35294	24.118	.000	3.90000	3.5774	4.2226

**t-value is statistically significant at $p < 0.05$*

Science Teachers Perspective on Learning Philosophy

After ascertaining the science teachers teaching philosophy, the researcher assessed their learning philosophy. Table 5 presents the descriptive and t-test results of science teachers' perspective on learning philosophy.

Table 5: Results of Descriptive and T-test Analyses of Science Teachers' Perspective on Learning Philosophy

Constructs	Descriptive Statistics		Inferential Statistics (Sample size (n) =70; df=69)			95% Confidence Interval of the Difference	
Science Teachers' Perspective on Learning Philosophy	Mean	SD	T	P values	Mean Difference	Lower	Upper
• Learners should learn science through inquiry-based activity.	3.6857	1.42994	21.565	.000	3.68571	3.3448	4.0267
• Learning is best achieved when the teacher facilitates the learning process by providing a variety of experiences.	4.3286	1.04565	34.635	.000	4.32857	4.0792	4.5779
• Presenting science instructions around personal and societal problems make it difficult for learners to understand the science concepts.	3.7429	1.49090	21.004	.000	3.74286	3.3874	4.0983
• In science lessons, learners find it difficult to think of solutions to practical problems themselves.	3.4571	1.51021	19.153	.000	3.45714	3.0970	3.8172
• The most important single factor influencing learning is what the learner already knows	3.4429	1.50010	19.202	.000	3.44286	3.0852	3.8005
• Learning becomes more productive when learners find answers to their own questions rather than teachers providing the answers.	3.6571	1.52169	20.108	.000	3.65714	3.2943	4.0200
• When teachers build high self-efficacy levels in their learners, learning becomes effective.	3.8714	1.51247	21.416	.000	3.87143	3.5108	4.2321
• As children continue through adolescence toward adulthood, they need to assume responsibility for themselves in all aspects of life	3.7571	1.43896	21.845	.000	3.75714	3.4140	4.1003
• Learners learn a great deal simply by observing others.	3.8857	1.35714	23.955	.000	3.88571	3.5621	4.2093
• Allowing learners to experiment with their newly formed concepts and experiences is not necessary since it does not result in learning.	2.0857	1.46201	11.936	.000	2.08571	1.7371	2.4343

t-value is statistically significant at p <0.05

Science Teachers Subject Content Knowledge

After knowing the detailed demographic information of science teachers, the researcher also let them self-assess their subject content knowledge. Table 6 highlights their self-assessed mean scores and standard deviations as well as the t-test results.

Table 6: Analysis Results of Descriptive and T-test of Science Teachers' Subject Content Knowledge

Constructs	Descriptive Statistics		Inferential Statistics (Sample size (n) =70; df=69)			95% Confidence Interval of the Difference	
Science Teachers Subject Content Knowledge	Mean	SD	T	P values	Mean Difference	Lower	Upper
• Understanding the subject matter of science course is very important to me.	3.4857	1.66588	17.506	.000	3.48571	3.0885	3.8829
• While studying to obtain my bachelor's degree, my major area of study is science.	3.9000	1.42595	22.883	.000	3.90000	3.5600	4.2400
• As science teacher it is important to me to think that teachers should understand how scientific concepts related.	3.8571	1.47723	21.846	.000	3.85714	3.5049	4.2094
• As a science teacher, I know that science is primarily an abstract subject.	3.4857	1.52983	19.063	.000	3.48571	3.1209	3.8505
• Science is primarily a practical knowledge for addressing real world problems	3.4000	1.59164	17.872	.000	3.40000	3.0205	3.7795

• As science teacher, I know that knowledge in the science contents affect how I interpret the content goals I expected to reach with my students.	3.3857	1.67931	16.868	.000	3.38571	2.9853	3.7861
• As science teacher, I know that knowledge in science contents affect the types of questions I ask in class.	3.3429	1.54999	18.044	.000	3.34286	2.9733	3.7124
• I have adequate knowledge and understanding of instructional practices in my main subject field	4.1143	1.14895	29.960	.000	4.11429	3.8403	4.3882
• As science teacher, I know that knowing the content knowledge affects my ability to explain concepts clearly to learners.	3.4571	1.42122	20.352	.000	3.45714	3.1183	3.7960
• As science teacher, I know that knowledge in science contents affect how I respond to students' questions in class.	3.9429	1.37140	24.054	.000	3.94286	3.6159	4.2699
• I enjoy attending science teachers' conferences to learn about new ideas in science teaching.	3.4143	1.60156	17.836	.000	3.41429	3.0324	3.7962
• Science is a subject where misconceptions can form very easily, due to science's abstract nature.	3.8286	1.43427	22.333	.000	3.82857	3.4866	4.1706
• If teachers have misconceptions about any topic in science, there is a good chance that the students hold these as well.	3.3857	1.54444	18.341	.000	3.38571	3.0175	3.7540
• While studying to obtain your bachelor's degree, what was your major or main area of study?	3.4143	2.27458	12.559	.000	3.41429	2.8719	3.9566

**t-value is statistically significant at p <0.05*

Science Teachers Curriculum Knowledge

The descriptive and t-test results of science teachers' perception on curriculum knowledge is presented in in Table 7 below.

Table 7: Analysis Results of Descriptive and T-test of Science Teachers' Curriculum Knowledge

Constructs	Sample size (n) =70; df=69						
	Descriptive Statistics		Inferential Statistics			95% Confidence Interval of the Difference	
Science Teachers Curriculum Knowledge	Mean	SD	t	P values	Mean Difference	Lower	Upper
• I make no contribution to subject content to be taught in the JHS.	3.0000	1.56038	16.086	.000	3.00000	2.6279	3.3721
• I have no influence on specific textbooks to be used in science teaching in the JHS.	2.9857	1.56495	15.962	.000	2.98571	2.6126	3.3589
• My biggest challenge in science teaching is how to relate curriculum contents to learners' lives and needs.	2.8286	1.55080	15.260	.000	2.82857	2.4588	3.1983
• As a science teacher, I have no influence on the contents of the science curriculum.	3.2143	1.58702	16.945	.000	3.21429	2.8359	3.5927
• During science lessons, learners are largely restricted to contents in their science textbooks.	3.1000	1.64317	15.784	.000	3.10000	2.7082	3.4918

** t-value is statistically significant at p <0.05*

Science Teachers Knowledge of Learners

The descriptive and t-test results of science teachers' perception on knowledge of learners is reported in Table 8 below.

Table 8: Analysis Results of Descriptive and T-test of Science Teachers' Knowledge of the Learners

Constructs	Descriptive Statistics		Sample size (n) =70; df=69				
			Inferential Statistics			95% Confidence Interval of the Difference	
Science Teachers Knowledge Of The Learners	Mean	SD	t	P values		Lower	Upper
• Knowing the background of the learners promotes effective teaching of science.	3.6000	1.55480	19.372	.000	3.60000	3.2293	3.9707
• An understanding of learners is essential for teaching science.	3.6143	1.55380	19.462	.000	3.61429	3.2438	3.9848
• Some learners have a natural talent for science and others do not.	3.6286	1.42617	21.287	.000	3.62857	3.2885	3.9686
• Learners learn best by finding solutions to problems on their own.	3.7286	1.39275	22.398	.000	3.72857	3.3965	4.0607
• In my science lessons, learners work individually without assistance from the teacher.	3.1429	1.55373	16.924	.000	3.14286	2.7724	3.5133
• In my science lessons, learners work individually with assistance from the teacher.	3.2571	1.53873	17.710	.000	3.25714	2.8902	3.6240
• In my science lessons, learners work together as a class with the teacher teaching the whole class.	3.6857	1.45007	21.266	.000	3.68571	3.3400	4.0315
• In my science lessons, learners work in small groups without assistance from the teacher.	3.0429	1.56442	16.273	.000	3.04286	2.6698	3.4159
• In my science lessons, learners work in small groups with assistance from the teacher	3.9000	1.46604	22.257	.000	3.90000	3.5504	4.2496
• Generally, JHS learners are too young to apply scientific knowledge acquired to solve problems in their homes and the school community.	2.9000	1.64317	14.766	.000	2.90000	2.5082	3.2918

*t-*value is statistically significant at p <0.05*

Science Teachers Knowledge of Teaching Methods and Teaching Strategies

Data presented in Table 9 below described the science teachers' knowledge of teaching methods and teaching strategies. The results showed that the large class size do not allow teachers to individualize teaching. Also, period allocated for science do not allow teaching science using the field trip method.

Table 9: Analysis Results of Descriptive and T-test of Science Teachers' Knowledge of Teaching Methods and Teaching Strategies

Constructs	Sample size (n) =70; df=69						
	Descriptive Statistics		Inferential Statistics			95% Confidence Interval of the Difference	
Science Teachers Knowledge of Teaching Methods and Strategies	Mean	SD	t	P values	Mean Difference	Lower	Upper
• Every school environment has wealth of resources that can be used to teach science	3.2429	1.51739	17.880	.000	3.24286	2.8810	3.6047
• The period allocated for science do not allow teaching science using the field trip method.	3.8571	1.29978	24.828	.000	3.85714	3.5472	4.1671
• Science teaching should allow learners to give examples of concept learned that are not included in the learner's science books.	3.4571	1.48114	19.529	.000	3.45714	3.1040	3.8103
• The large class size does not allow me to individualize my teaching.	4.0000	1.28537	26.036	.000	4.00000	3.6935	4.3065
• The large class size always prevents me from sending learners outside the classroom to learn.	3.5143	1.41158	20.830	.000	3.51429	3.1777	3.8509
• Large class size limits science practical lessons in my school.	3.0714	1.57260	16.341	.000	3.07143	2.6965	3.4464
• Large class size does not allow me to provide frequent feedback to learners.	2.5714	1.39950	15.373	.000	2.57143	2.2377	2.9051
• Reflecting on what learners find difficult is a key strategy science teachers can adopt to promote knowledge application.	3.3429	1.54062	18.154	.000	3.34286	2.9755	3.7102
• Science instructions should allow learners to discuss local problems.	3.4286	1.36808	20.968	.000	3.42857	3.1024	3.7548
• Linking classroom lessons to community problems is a big challenge in my school.	3.2571	1.44147	18.905	.000	3.25714	2.9134	3.6009
• As a science teacher, it is important for me to give learners directions for doing science experiments.	3.4714	1.55779	18.644	.000	3.47143	3.1000	3.8429
• Science teaching is about helping learners to apply the knowledge they have acquired to solve problems they encounter in everyday lives.	3.6000	1.60072	18.816	.000	3.60000	3.2183	3.9817
• Linking understanding and application of scientific knowledge is a challenging task for me.	2.6714	1.52962	14.612	.000	2.67143	2.3067	3.0362
• My biggest challenge in science teaching is how to adapt teaching procedures to learners needs.	2.8571	1.46738	16.291	.000	2.85714	2.5073	3.2070
• I have difficulty in identifying problem-solving activities for learners in the science classroom	2.7571	1.48846	15.498	.000	2.75714	2.4022	3.1121
• In my science teaching, I assign science homework on small investigation(s) or gathering data.	3.0571	1.45349	17.598	.000	3.05714	2.7106	3.4037
• In my science lessons, I usually assign science homework, collect, mark and use the scores as a basis for class discussion.	3.1714	1.46427	18.121	.000	3.17143	2.8223	3.5206
• In my science lessons, I usually assign science homework, collect, mark and give feedback on homework to the whole class.	3.6143	1.43752	21.036	.000	3.61429	3.2715	3.9570
• In my science teaching, I use the assessment information gather from learners to diagnose learners' learning problems.	3.6286	1.28730	23.583	.000	3.62857	3.3216	3.9355
• In my science teaching, the assessment information gathers from learners help me to plan for future lessons.	2.9714	1.56011	15.935	.000	2.97143	2.5994	3.3434
• Period allocated for science lessons is adequate to allow learners to identify problem in the classroom or the community and investigate them through project work	2.9857	1.39868	17.860	.000	2.98571	2.6522	3.3192
• My school has no resources that will help provide learners with practical problems to solve	2.9571	1.53638	16.104	.000	2.95714	2.5908	3.3235
• Giving learners an opportunity to identify local problems and design strategies to solve them is a challenging task for me.	2.6143	1.39661	15.661	.000	2.61429	2.2813	2.9473
• Giving groups project to learners to do and present their reports to the class for discussions is a difficult task for me.	2.9857	1.51794	16.457	.000	2.98571	2.6238	3.3477
• Building upon the knowledge learners already bring to class about a topic promotes effective transfer of knowledge.	3.4286	1.43023	20.057	.000	3.42857	3.0875	3.7696
• Engaging learners in the selection and organisation of learning experiences make them assess their own learning outcomes	3.5143	1.36989	21.463	.000	3.51429	3.1876	3.8409

• During science lessons, I share the purpose of a learning activity clearly with the learners.	2.8143	1.46745	16.045	.000	2.81429	2.4644	3.1642
• Designing activity to help learners apply scientific knowledge learned to solve problems has been my challenge in science teaching.	3.3571	1.85750	15.121	.000	3.35714	2.9142	3.8000

* t-value is statistically significant at p <0.05

Tables 10 below presents overall mean summary results of descriptive and T-statistics for JHS science teachers' instructional competence assessed. To facilitate comparisons and interpretation of the mean scores of science teachers' views, the mean scores of each of the six teacher competence variables assessed were compared with employee's behavioural competence or performance standard framework scale developed by Bhat and Beri (2016)*.

Table 10. Descriptive Statistics for JHS Science Techers Instructional Competence Assessed

Areas of JHS Science Teachers' Instructional Competencies	Variable Codes	No. of Items used to Measure Each Competence Variable	Descriptive Statistics		T-test statistics (n =70; df = 69)	
Variable			Mean (M)	SD±	t-values	p-value
Teaching philosophy	TP	9	3.7131	1.3955	22.692	0.000
Learning philosophy	LP	10	3.5875	1.2287	21.728	0.000
Knowledge of learners	KL	14	3.5714	1.5101	19.920	0.000
Curriculum knowledge	C_uK	5	2.8026	1.5812	16.007	0.000
Content knowledge	CK	10	3.6154	1.4955	20.515	0.000
Teaching methods & strategies	TMS	28	3.2664	1.4779	18.521	0.000
Total		**76**	**3.426**	**1.448**		

• *T-value is statistically significant at p <0.05*

The results in Table 10 above showed that the teachers' teaching philosophy has the highest mean score (M=3.7131, SD=1.3955), followed by teachers' content knowledge (M =3.6154, SD =1.4955) both in instructional competence. The curriculum knowledge with mean scores of 2.8026 and SD of 1.58123 formed the least in instructional competence. The aggregate mean score for teachers' instructional competences assessed was 3.426, with SD of .4482 which is regarded as High instructional competence.

Looking at the t-test values for all the competence variables assessed, all the six variables were found statistically significant (TP: t (69) = 22.692, $p<0.05$); (LP: t = 21.728, $p<0.05$); (KL: t (69) = 19.920, $p<0.05$); (C_uK: t (69) = 16.007, $p<0.05$); (CK: t (69) = 20.515, $p<0.05$); (TMS: t (69) = 18.521, ($p<0.05$), suggesting differences in science teachers own perspectives on *teaching philosophy, learning philosophy, knowledge of learners, curriculum knowledge, subject content knowledge and knowledge of teaching methods and teaching strategies.*

Table 11 below compared the descriptive statistics results of JHS science teachers' instructional competence and the behavioural competence/performance standard scale developed by Bhat and Beri (2016)*

Table 11: Descriptive Statistics Results for JHS Science Techers' Instructional Competence Assessed

Instructional Competencies Variables	Variable Codes	Descriptive Statistics		Behavioural Competence/Performance Standard	
		Mean (M)	SD±	Descriptive Rating of Mean Values	
				Standards Rating Scale	Interpretation of Standard Rating Scale
Teaching philosophy	TP	3.7131	1.3955	3.41-4.20	High competence
Learning philosophy	LP	3.5875	1.2287	3.41-4.20	High competence
Knowledge of learners	KL	3.5714	1.5101	3.41-4.20	High competence
Curriculum knowledge	C_uK	2.8026	1.5812	2.61-3.40	Moderate competence
Content knowledge	CK	3.6154	1.4955	3.41-4.20	High competence
Teaching methods & strategies	TMS	3.2664	1.4779	2.61-3.40	Moderate competence
Total		**3.426**	**1.4482**		

* [4.21-5.00 (Highest competence); 3.41-4.20 (High competence); 2.61-3.40 (Moderate competence); 1.81-2.60 (Low competence); 1.00-1.80 (Lowest competence]. Behavioural Competence/Job Performance Framework Scale Developed by Bhat & Beri (2016].

The total mean score for teachers' instructional competences measured was 3.426, with SD of .4482 and this falls in the category of *high* competence. Teaching philosophy with mean score of 3.7131 and SD of 1.39554 rated *high* in competence and slightly ahead of the other five variables (LP, KL, CuK, CK & TMS). Both curriculum knowledge with mean scores of 2.8026, and SD of 1.58123 and the teaching methods and strategies with mean score of 3.267 and SD of 1.4779 were rated *moderate* in competence.

DISCUSSION

The study explored the level of JHS science teachers' instructional competence using constructivist and 3P theoretical framework. The study permitted a detailed analysis of instructional competences of the JHS science teachers and in turn, inferences were made regarding teachers: demographic information; and the level of instructional competence in six thematic areas including the teachers: teaching philosophy, learning philosophy, knowledge of subject contents, knowledge of learners, knowledge of science curriculum, and knowledge of teaching methods and teaching strategies.

Regarding the demographic information of study participants, the study found males constituting the majority (54%) of the JHS science teachers and the female forming 46%. This result is not surprising as plethora studies (Hyde & Fennema etal., 1990; Jones & Howe *et al.,* 2000; Kahle & Lakes, 1983) show that science teaching profession has been found to be male-dominated field than females. These studies further explained that though boys and girls enter high school with roughly equal levels of science problem solving ability, a gender gap favoring boys' have been found to increases in high schools and in colleges. In terms of teaching experience, the study found that 34% of the science teachers have been teaching in the JHS for more than six years, suggesting that the JHS science teachers possess what it takes to provide classroom interactions that enhances students learning outcomes. Studies show that teaching experience is positively associated with teacher performance and student achievement gains. (Podolsky, Kini, & Darling-Hammond, 2019; Graham, White, Cologon, & Pianta, 2020).

Regarding the composite instructional competence of the JHS science teachers, the results showed the overall mean score of 3.426 which fall in the category of *high* competence. This finding is consistent with the employee's behavioural competence or performance standard score of 3.41-4.20 described as high performance *(*Bhat and Beri, 2016). (**Table 11).**

Reference to the science teachers' perspective on teaching philosophy, the results of the study revealed that the JHS science teachers have *high* level of relevant teaching philosophy. The greater number of the teachers belief that science teaching should help learners to identify their misconceptions and correct them (highest mean = 4.0000, SD =1.28537; t (69) = 26.036, p<0.05). They further stated that when teachers base their teaching on experiences that help learners to identify their misconceptions and correct them, learning becomes effective. **(Table 4).** It was also evident from **Table 4** that when teachers build their science instructions around learners' problems it promotes understanding of scientific concepts and skill development (mean = 4.0857, SD = 1.17637; t (69) = 29.058, p<0.05). Studies show that having teaching philosophy has many possible benefits for teachers. According to Chism *et al*., (1998); and Zauha (2008), TP promotes intentional, worthwhile practices and help teachers connect theory to practice. Similar study (Beatty *et al.,* 2009; Hegerty, 2015) also reported that teachers who have teaching philosophy and regularly referring to it makes their teaching more rigorous and meaningful.

On the subject of science teachers' perspective on learning philosophy, the result of the study showed that the science teachers have *high* competence knowledge of how learning occurs. According to them learning is best achieved when the teacher facilitates the learning process by providing a variety of experiences (highest mean = 4.3286, SD = 1.04565; t (69) 34.635, p< 0.05). **(Table 5).** One previous study (Levy & Petrulis, 2012) shows that science learning is an active contextualised process of constructing knowledge based on learners' experiences rather than acquiring it. This makes learning more relevant and meaningful to the learner and leads to the development of critical thinkers, problem solvers and innovators.

Knowing the learner involves understanding the learning styles of the learner as well as understanding that language, identity, and culture are very important in learning. The present study found that the JHS science teachers' knowledge of the learners rated *high.* This finding agrees with one earlier study (Dewi, & Dalimunthe, 2019) which found that teaching becomes very effective when teachers have adequate knowledge of the learners and how they learn. This suggests that teachers need to be aware of the learners' learning styles under various conditions. This further suggests that when a science teacher has adequate knowledge of the learners, regarding knowledge processing and accommodation they can help create the necessary learning environment for learners to work in to understand concepts and apply them to real life situations in their environment.

Like other disciplines, the content knowledge of science is of great importance to science teachers in the practice of their profession. Syarifuddin and Atweh (2022) listed the teachers' subject content knowledge to included facts, concepts, and practices and described them as 'what' and the 'how' of teacher education. The study found that the JHS science teacher have *high* content knowledge in science. The study further revealed that most of the JHS science teachers have bachelor's degree as their highest qualification, and this places them in a better position to teach the subject effectively. This finding provides a strong support to Kind and Chan (2019) who found that insufficient content knowledge contributes to teachers'low self-confidence for teaching science, and thus low-quality lessons. They argued that self-confidence can be enhanced when a science teacher has adequate knowledge of the subject matter. Saputro and Atun *et al.,* (2020), however, noted that this alone would not guarantee a teacher's instructional competence. These findings have drawn similar results with Arzi and White (2007) who reported that teachers teaching their specialist subjects are more likely to develop and retain good subject content knowledge than those used to teach a range of subjects. Hence these authors suggest that forcing teachers to teach outside their specialist subjects could prove counterproductive in achieving good student outcomes.

Closely linked to content knowledge is teachers' curriculum knowledge. The curriculum is viewed as a vital tool for addressing societal problems (Udom, 2013). It guides teachers in instilling and equipping learners with the essential skills and experiences needed to solve issues within their environment and society at large. Consequently, it is crucial that science teachers possess a comprehensive understanding of the science curriculum content. This perspective is supported by Amin et al. (2015), who argued that teachers' adequate knowledge of the curriculum enables them to deliver accurate content, helping students understand and apply knowledge to solve real-life problems.

However, the present study revealed that a significant proportion of JHS science teachers have only a moderate level of knowledge of the JHS science curriculum. A similar study by Twumasi et al. (2021) assessed curriculum knowledge among JHS teachers and found that many possessed weak understanding of curriculum content. The study indicated that teachers who cannot analyze curriculum materials may make unnecessary changes or fail to implement necessary modifications, which negatively impacts student learning outcomes. Tobin (1987) suggested that the root cause of low learning outcomes in JHS could be related to teachers' knowledge of the science curriculum—specifically, what to teach, how to teach it, how students learn, and what to assess—rather than external examinations or prescriptive curricula.

Further, the results showed that most science teachers felt they had little influence over curriculum content (mean=3.2143, SD=1.58702; $t(69)=16.945$, $p<0.05$) (see Table 7). This perception appears to limit teachers' ability to modify or adapt curriculum content, leading them to primarily restrict learners to the contents of their science textbooks. Such restrictions may hinder divergent thinking, which involves exploring multiple solutions and ideas, and instead promote convergent thinking, where learners focus on finding a single correct answer (Cortes, Weinberger, Daker, & Green, 2019). Divergent thinkers are capable of identifying gaps and inconsistencies in real-world situations and applying their intelligence to address those gaps (O'Byrne, Radakovic, Hunter-Doniger, Fox, Kern, & Parnell, 2018). Divergent thinking fosters the generation of diverse ideas within a framework where many correct solutions are possible.

Regarding instructional methods and strategies—referred to as pedagogical content knowledge—these significantly influence science teaching and learning. Effective pedagogical strategies involve the teacher's competence in delivering concepts through relational understanding and adaptive reasoning (Kathirveloo et al., 2014). Teaching is thus regarded as a knowledge-intensive profession, with teachers acting as 'learning specialists.' The current study found that JHS science teachers possessed only a moderate level of knowledge about teaching methods and strategies used to present scientific concepts. Understanding effective teaching methods is particularly important because they contribute to high-quality teaching behaviors. Previous research by Gusthardt and Sprigings (1989) indicated that expert teachers, with high knowledge of teaching methods and strategies, provide more opportunities for skill practice, ultimately enhancing student learning. Therefore, designing activities aligned with specific teaching methods can accommodate students with different learning styles, promoting better understanding and engagement.

CONCLUSIONS

This study explored the instructional competence of JHS science teachers in the ASM across six thematic areas, including teaching philosophy, learning philosophy, knowledge of learners, curriculum knowledge, subject content knowledge, and teaching methods and strategies. The findings indicated that JHS science teachers demonstrated a high level of competence in the areas of teaching philosophy, learning philosophy, knowledge of learners, and subject content knowledge. However, their curriculum knowledge, as well as their teaching methods and strategies, were found to be at a moderate level. Consequently, this study provides important insights into the current state of instructional competence among JHS science teachers and highlights specific gaps that need to be addressed to enhance science teaching and learning at the JHS level.

RECOMMENDATIONS

Based on the findings, the study recommends that JHS science teachers should continually update their knowledge across all thematic areas to sustain or further improve their instructional competencies, recognizing that knowledge is dynamic. Given the diverse backgrounds of students in the 21st century, largely driven by technological advancements and the resulting explosion of information, ongoing professional development is essential. The study also advises that the Ghana Education Service should organize in-service training programs for JHS science teachers to enhance their understanding of the JHS common core science curriculum, thereby promoting more effective science teaching and learning within the municipality.

STUDY'S CONTRIBUTION TO KNOWLEDGE

Beyond the existing understanding of science teachers' instructional competence, the findings of this study provide valuable insights relevant to science teaching and learning at the Junior High School (JHS) level. The interpretation of these results has significantly enhanced our understanding of the current proficiency levels of JHS science teachers and highlighted gaps in their curriculum knowledge, as well as their teaching methods and strategies. These findings offer comprehensive information that can inform evidence-based professional development initiatives and support sustainable improvements in the instructional competence of JHS science teachers, ultimately aiming to boost students' learning outcomes in science.

However, the study did not investigate the specific effects of the current competence levels of JHS science teachers on students' academic performance and learning outcomes. Additionally, it did not incorporate classroom observations to verify teachers' lesson delivery, student engagement, and learning achievements. These areas warrant further research.

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CONFLICT OF INTEREST

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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