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Research Article

Influence of Professional Learning Communities (PLCs) on Science Teachers' Instructional and Assessment Practices

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ABSTRACT

The purpose of the study was to determine the effect of Professional Learning Communities (PLCs) on science teachers' instructional practices and assessment practices. Based on the pragmatist's paradigm and mixed methods approach, the study used the Convergent parallel mixed methods design. Professional Learning communities (PLC) and Instructional and Assessment Practices Questionnaire (PLCIAQ) were used to collect data. The sample consisted of 17 in-service science teachers who participated in weekly PLC sessions in their schools for two years. The sample was purposively selected to include only science teachers. It was found that most of the teachers (76.5%) stated that PLCs positively affected their instructional practices. PLCs have a moderate effect on science teachers' instructional practices (M = 3.71, SD = 0.92). It was found that PLCs have more effect on science teachers' instructional practices (M = 3.94, SD = 1.03) followed by their classroom management practices (M = 3.88, SD = 1.27), student grouping practices (M = 3.82, SD = 1.13), science content taught (M = 3.71, SD = 1.26), teaching materials (M = 3.65, SD = 1.37), teaching methods (M = 3.65, SD = 1.41). It was also revealed that most of the science teachers (88.2%) think that PLCs positively affected their assessment practices. PLCs have a moderate effect on science teachers' assessment practices (M = 3.73, SD = 0.71). It was found that PLC has influenced more on summative assessment (M = 3.94, SD = 0.75), followed by formative assessment (M = 3.82, SD = 1.07), and the kinds of questions asked (M = 3.71, SD = 1.05). Also, PLCs least affected frequency of assessments (M = 3.65, SD = 0.86) and assessments by collaborative teams (M = 3.41, SD = 1.12). Paired samples t-test revealed no statistically significant difference in science teachers' instructional practices (M = 3.71, SD = .92) and their assessment practices (M = 3.74, SD = .71), t (16) = -.629, p = .791. However, Pearson's correlation reveals a significant high correlation between science teachers' instructional and assessment practices (r = .851, p = 0.000).

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Background

In the 21st century, rapid societal changes accelerate the necessity to foster students' competence in learning how to learn and become lifelong learners. To address the new challenge, teachers need to engage in continuous learning. By participating in ongoing professional development in the workplace, teachers can exchange expertise and experience with colleagues, improving their instructional practice (Pan & Cheng, 2023).

Professional learning communities (PLCs) are mechanisms that enable educators to join forces to promote ongoing growth and improvement for themselves and their students. PLCs are based on the premise that learning results from the varied perspectives and experiences that members share with one another as they work toward common goals (Barton & Stepanek, 2012). PLCs have helped teachers learn together as they rethink their practice, challenge existing assumptions about instruction, and re-examine their students' learning needs. This collaborative approach to professional development helps teachers to work in teams and to solve classroom problems (Thessin & Starr, 2011; Barton & Stepanek, 2012).

Teachers' PLCs support their professional development among their peers (Blonder & Vescio, 2022). Teacher professional development (PD) is a fundamental means for improving teachers' content knowledge as well as developing their pedagogical practices in order to help them teach to high standard. For several years, Professional Learning Communities (PLCs) have been an effective form of teacher professional development (Blonder & Vescio, 2022). The characteristics of PLCs make them appealing as a model for professional development because teachers collaboratively work together on their problems of practice to improve teaching and learning (Blonder & Vescio, 2022).

Firstly, PLCs operate under a shared set of norms and values that are developed by their participants to provide a foundation for the work to be done in a PLC. Members of PLCs have a

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collective responsibility for and focus on student learning. Third, members of PLCs engage in a reflective dialogue about their teaching and student learning. The fourth characteristic is an underlying focus on collaboration. Finally, members of PLCs must make public their own teaching practices (Vescio et al., 2008; Blonder & Vescio, 2022). These features of PLCs work in tandem to create a theoretical foundation for successful teacher professional development (Blonder & Vescio, 2022).

According to Bolam et al. (2005), an effective professional learning community fully exhibits eight key characteristics: shared values and vision; collective responsibility for pupils' learning; collaboration focused on learning; individual and collective professional learning; reflective professional inquiry; openness, networks, and partnerships; inclusive membership; mutual trust, respect, and support. Students' learning is the foremost concern of people working in PLCs, and the more developed a PLC, the more positive the association between achievement and professional learning (Bolam et al., 2005). Teachers in more developed PLCs adopt a range of innovative practices to deal with the inhibiting and facilitating factors in their particular contexts (Bolam et al., 2005).

PLCs function through four key operational processes: optimising resources and structures; promoting individual and collective learning; explicit promotion and sustaining of the PLC; and leadership and management. Quality assessment is a component of learning that facilitates students' learning (Edwards, 2013). Thus, it is important that science teachers understand and use high-quality assessment processes (Edwards, 2013). Assessment involves teachers applying their understandings of how students develop skills and knowledge, attitudes, and values in a subject domain to understand what students are learning or have learned. Interpretations of assessment data enable informed educational decisions (Harlen, 2007).

Assessment practice affects students and teachers at various levels, including the way curriculum is presented and the ways teachers operate in classrooms (Edwards, 2013). Knowledge of assessment of science learning has been identified as an important component of PCK (Park & Oliver, 2007; Edwards, 2013).

Statement of the Problem

STEM (Science, Technology, Engineering, and Mathematics) has become a popular term in education worldwide. There is a need to have a workforce with adequate STEM knowledge and skills to meet the challenges in the future (Gao, Li, Shen & Sun, 2020). STEM teaching is more effective and student achievement increases when teachers join forces to develop strong professional learning communities in their schools. When teachers team up with their colleagues, they can create a culture of success in schools, leading to improved academic performance (Fulton & Britton, 2011).

To meet the needs of today's learners, the tradition of artisan teaching in solo-practice classrooms will have to give way to a school culture in which teachers continuously develop their content knowledge and pedagogical skills through collaborative practice that is embedded in the daily fabric of their work (Fulton & Britton, 2011). Teacher collaboration supports student learning, and teachers who work in powerful learning communities are more satisfied with their careers (Fulton & Britton, 2011).

Strong professional development and support are required to help teachers examine and change their instructional practice and confidently make effective instructional decisions within the increased demands and complexity of teaching the diverse range of students found in classrooms today (Betts, 2012). A professional learning community is "an organisation composed of collaborative teams whose members work interdependently to achieve common goals linked to the purpose of learning for all" (DuFour et al., 2006, p. 3).

Key features of a professional learning community include a shared vision, a collaborative culture, a focus on learning rather than teaching, collective inquiry, an action orientation, a focus on results, and a mind-set of continuous improvement. While collaboration is essential for a team of teachers to function as a professional learning community, it is the focus on actual results of student learning that distinguishes professional learning communities from other collegial and collaborative groups of teachers that come together to discuss curriculum and instruction (DuFour et al., 2006), cited in (Betts, 2012).

Teachers working in a PLC need access to accurate measures of student learning that are timely and tied to the actual curriculum. Standardised tests cannot provide this information because they rarely measure the actual curriculum and are administered too infrequently (Betts, 2012). Researchers contend that only formative assessments can provide the critical data that is used to help teachers and/or students make mid-course corrections. Formative assessment represents one of the most powerful instructional tools for advancing achievement levels (Guskey, 2007; Betts, 2012). Research affirms that formative assessment is a central feature of effective teaching (Black, 2017). A teacher ought to start any lesson on a new topic with a question designed to explore what the pupils already know and understand about the topic (Black, 2017).

Professional development is learning and keeping up-to-date in one's area of expertise (Murphy-Latta, 2008). Quality professional development is the most important component in improving education (Guskey, 1986). Among the essential characteristics of a successful PLC are a focus on learning, a collaborative culture with a focus on learning for all, collective inquiry into best practice and current reality, action orientation, a commitment to continuous improvement, and results orientation (DuFour et al., 2010). Fullan (2006) included collaboration focused on student learning, discussion of formative assessments, focusing on results, and data study as characteristics common to successful PLCs. Accepting professional learning communities as part of the overall school culture is an important aspect of the success of their implementation (Bond, 2019).

A common perception in the literature and among practitioners is that PLCs are successful in improving teaching practice and student achievement (Hord, 1997, Stoll & Louis, 2007, Wood, 2007). Despite the established role of PLC in teacher development, studies suggest that the mere inclusion of PLC in policy documents does not guarantee its practice at the school level, district level, or regional level Vajarintarangoon et al., (2019) cited in Dampson (2021). Hairon and Dimmock (2012) established that even though policy documents have always made provisions for the implementation of PLCs, its practice has been slow, thereby affecting the teachers' pedagogical practices in the classroom (Dampson, 2021).

Ghana is keen to improve educational provisions, with a particular emphasis on quality education for all (MOE, 2018). Thus, the Government of Ghana introduced the new standards based SHS/SHTS/STEM curriculum to replace the objectives-based curriculum. As part of the preparation for the new curriculum, Senior High Schools organise weekly PLC sessions intended to equip teachers to implement the new standards-based SHS/SHTS/STEM curriculum. The PLC sessions were expected to improve quality and relevance of teaching and learning through experiential sharing and strategies which also incorporate Gender, Equality and Social Inclusion (GESI), Social and emotional learning (SEL), Information and Communication Technology (ICT) and 21st Century Skills.

Since the introduction of the standards-based curriculum and PLC in the senior high schools in Ghana, little or no empirical studies have been conducted to ascertain the effectiveness of the PLCs. Again, there are very few studies on PLC and its effect on instructional, professional and assessment practices in Ghana. Thus, this study sought to answer the following questions: (1) What is the effect of Professional Learning Communities (PLCs) on science teachers' instructional practices? (2) What is the effect of Professional Learning Communities (PLCs) on science teachers' assessment practices? (3) is there any statistically significant difference in science teachers' instructional and assessment practices? Is there any correlation between science teachers' assessment and instructional practices?

Theoretical framework

Professional Learning Community (PLC) holds the potential for school reform (Giles & Hargreaves, 2006). The PLC model of DuFour et al. (2002) drives staff development in order to improve student learning. PLCs acquired prominence through their potential to impact student achievement. The term PLC has transformed from learning communities to professional learning communities (Hayden, 2022).

According to DuFour (2007), PLCs have transformed students' learning. PLCs operate within a supportive, self-created community where a group of professionals engages in learning (Hayden, 2022). PLCs are a group of professionals who share and discuss their practice and student learning in a systematic, continuous, collaborative, and reflective manner (Dufour, 2004; Louis et al., 1996; Morrissey, 2000). Again, according to Morrissey (2000), the PLC community provides a setting that is richer and more stimulating when new ideas are processed through interaction with others who are knowledgeable in pedagogy and ideas. The concept of an environment in which "people are continually learning how to learn together" (Senge, 1990, p. 3) was later modified to 'learning communities' (Hamos et al., 2009).

PLCs have become engrained into efforts of professional development around the globe and have become an international approach to teachers' professional development (Dogan, Tatık, & Yurtseven, 2017; Dogan et al., 2016). PLCs have six dimensions (Dogan et al., 2017); these are: i. shared and supportive leadership, ii. shared values and vision, iii. collective learning and application, iv. shared personal practice, v. supportive conditions: relationships, and vi. supportive conditions

PLCs provide schools with a framework to meet the goals of school reform, student achievement enhanced teacher knowledge, instructional practices, and school performance. Dufour and Marzano's (2011) model for PLCs answers four questions: (1) What do we want our students to learn? (2) How will we know if each student is learning each of the skills, concepts, and dispositions we have deemed most essential? (3) How will we respond when some of our students do not learn? (4) How will we enrich and extend the learning for students who are already proficient? (Hayden, 2022, p. 22).

Characteristics of PLCs

Shared and supportive leadership: an interaction in which both school heads and teachers participate to make collective decisions within a safe environment (Hord, 1997). As school heads equally distribute their power, authority, and decision making, leadership becomes "supportive and shared" (cited in Dogan, Tatık et al., 2017).

Shared Values and vision: the sense of common purpose, belief, value, and/ or mission among staff in the school. According to Kruse et al. (1995), without common purposes, practices, and behaviours, PLCs cannot emerge. They argued that an effort that lacks a shared goal could cause misunderstanding, conflict, and mistrust among staff (cited in Dogan et al., 2017).

Collective Learning and Application: PLCs are mechanisms to promote both individual and collective types of learning, as all teachers are learners with their colleagues (Louis et al., 1995). Collective learning is manifested through knowledge creation, and PLCs both cultivate and foster this type of learning (Bolam et al., 2005). The essential purpose of collaboration in PLCs is to establish a common purpose and engage staff through collaborative activities and dialogue in order to accomplish this shared goal between accomplishment of common purpose and collaborative activities in which staff are engaged in (Bolam et al., 2005), cited in Dogan et al. (2017).

Shared Personal Practice: Shared personal practice is collaborative work in which members of PLCs engage in conversation focused on students and instruction. These collaborative discussions help identify specific challenges, propose potential solutions, and can create a blueprint for the application of new knowledge (Louis et al., 1995). It also includes a regular review or examination of individual teachers' professional behaviours, both by class observation and case studies, to improve the teaching practice of those teachers (Kruse & Louis, 1993; Dogan et al., 2017).

Inquiry-Based Science Education

In recent years, there has been a rapid expansion of interest in inquiry-based science education. Classroom and laboratory practices and materials which encourage students to take an active part in making sense of events and phenomena in the world around are being promoted and developed (Harlen, 2013). Embracing inquiry-based education recognises its potential to enable students to develop the understandings, competences, attitudes and interests needed by everyone for life in societies increasingly dependent on applications of science. Inquiry leads to knowledge of the particular objects or phenomena investigated, but more importantly, it helps to build broad concepts that have wide explanatory power, enabling new objects or events to be understood. It also engenders reflection on the thinking processes and learning strategies that are necessary for continued learning throughout life (Harlen, 2013). Inquiry is a term used both within education and in daily life to refer to seeking explanations or information by asking questions. Inquiry is not a new concept in education, being based on the recognition of children's active roles in developing their ideas and understanding (Harlen, 2013).

Assessment

The term "assessment" is used to refer to judgements on individual student performance and achievement of learning goals. It covers classroom-based assessment and large-scale, external tests and examinations. Although the terms assessment and testing are sometimes used interchangeably, there is an important distinction between them. Testing may be regarded as a method of collecting data for assessment; thus, assessment is a broader term, covering other methods of gathering and interpreting data and testing (Harlen, 2013). For assessment to be used to help learning means that teachers incorporate formative assessment strategies as part of their pedagogy rather than adding a series of mini-summative assessment events. For summative assessment, tests are commonly used for checking performance at the end of topics or courses and for producing reports on progress at regular intervals.

Assessment involves the generation, interpretation, communication and use of data for some purpose. There is room for an enormous range of different activity, but each will involve a) students being engaged in some activity, b) the collection of data from that activity, c) the judgement of the data by comparing them with some standard and d) some means of describing and communicating the judgement. There are several forms that each of the components of assessment can take (Harlen, 2013).

Assessment for learning (AfL)

Assessment for Learning is defined as 'seeking and interpreting evidence for use by learners and their teachers to decide where learners are in their learning, where they need to go and how best to get there.' (Hodgson & Pyle, 2010). The goal of assessment for learning (AfL), requires a prospective view of learning in which the concern is not solely with the actual level of performance but with anticipating future possibilities. AfL is an approach to pedagogy that allows students to discuss and share their ideas with others.

It is not sufficient that students merely learn how to address their immediate learning challenges. AfL needs to enable and empower students to learn how to learn and to motivate them to keep on learning (Harrison, 2015). It is based on the premise of feedback and the aim is to strengthen and facilitate feedback through a variety of routes in the classroom, from promoting discussion to providing comments on pieces of student work and supporting learners in peer and self-assessment scenarios (Harrison, 2015).

The major drive of AfL in science is the need to discover what pupils know, what they do not know, and what they partly know (misconceptions) and to develop teaching that will move their understanding on. The literature explores the need for a range of questioning, the importance of talk and discussion and the provision of feedback, all of which can involve and contribute towards self- and peer-assessment (Harrison, 2015). The use of specific tools, such as concept maps and concept cartoons, can assist in learners' understandings (Hodgson & Pyle, 2010). Thus, classroom climate is important; a co-constructivist, non-threatening environment must be established in order for learners to express their ideas and allow the teacher to establish what they know, what they do not know and what they partly know (Hodgson & Pyle, 2010).

METHODOLOGY

Design

Based on the pragmatist's paradigm and mixed methods approach, the study used the convergent parallel mixed methods design. A convergent parallel design entails that the researcher concurrently conducts the quantitative and qualitative elements in the same phase of the research process, weighs the methods equally, analyses the two components independently, and interprets the results together (Creswell & Pablo-Clark, 2011). Convergent parallel design is a mixed methods design in which quantitative and qualitative data are collected simultaneously but analysed separately, and the results are merged or integrated.

A mixed-methods design offers benefits to approaching complex research issues as it integrates philosophical frameworks of both post-positivism and interpretivism, interweaving qualitative and quantitative data in such a way that research issues are meaningfully explained (Dawadi et al., 2021). It also offers a logical ground, methodological flexibility, and an in-depth understanding of smaller cases, cited in Dawadi et al. (2021).

Instruments

The Professional Learning Communities (PLC) and Instructional and Assessment Practices Questionnaire (PLCIAQ) (Bond, 2019) were used to collect data. The questionnaire was in two sections; section A consisted of 14 Likert-type questions to measure the effect of PLCs on teachers' instructional practices (8 items) and assessment practices (6 items). Cronbach's alpha reliability coefficient was 0.918, which signifies that the instrument is reliable.

Section B consisted of four open-ended questions on the effect of PLC on teachers' instructional, professional, and assessment practices. The open-ended questions are:

1. *What do you say concerning the effect of PLCs on your instructional practice?*
2. *What do you say concerning the effect of PLCs on your collaboration with other teachers to teach science?*
3. *What do you say concerning the effect of PLCs on your assessment practice?*
4. *Please describe your impressions about the usefulness of PLCs, as they may have affected your professional practice.*

Data was analysed using SPSS-26 and QDA Miner-Lite. Descriptive and inferential statistics were used. Means and standard deviations of the items of each subscale were computed and categorised as: no effect (10-2.9), moderate effect (3.0-3.9) and high effect (4.0-5.0). The open-ended data was analysed using content analysis. Data was coded and categorised into themes based on the research questions.

Sample and Sampling Procedure

The sample consisted of 17 in-service science teachers who participated in weekly PLC sessions in their schools for two years. The sample was purposively selected to include only science teachers in the Kassena-Nankana Municipality in Ghana.

RESULTS AND DISCUSSION

Demographic characteristics of teachers

Table 1 presents the sex of the respondents. Thirteen (76.5%) of the teachers were male and four (23.5%) were female.

Table 1: Sex of respondents

Sex	Frequency	Percent
Male	13	76.5
Female	4	23.5
Total	17	100.0

The Effect of PLCs on Science Teachers' Instructional Practices

Table 2 presents the means and standard deviations of aspects of instruction on the instructional sub-scale. PLCs have a moderate effect on science teachers' instructional practices (M = 3.71, SD = 0.92). It was found that PLC has the highest effect on science teachers' instructional practices (M = 3.94, SD = 1.03), followed by their classroom management practices (M = 3.88, SD = 1.27), student grouping practices (M = 3.82, SD = 1.13), science content taught (M = 3.71, SD = 1.26), teaching materials (M = 3.65, SD = 1.37), and teaching methods (M = 3.65, SD = 1.41). PLCs have the least effect on teachers helping students to learn (M = 3.59, SD = 1.18) and understanding the academic needs of students (M = 3.47, SD = 1.33).

Table 2: Means and Standard Deviations of Items on the Instructional Scale.

Aspect	N	M	SD
1. Classroom instructional practices	17	3.94	1.03
2. Classroom management practices	17	3.88	1.27
3. Student grouping practices	17	3.82	1.13
4. Content being taught	17	3.71	1.26

5.	Teaching materials	17	3.65	1.37
6.	Teaching methods	17	3.65	1.41
7.	Helping students to learn	17	3.59	1.18
8.	Understanding the academic needs of students	17	3.47	1.33
Overall mean		**17**	**3.71**	**0.92**

The results of the open-ended data also revealed that most of the teachers (76.5%) stated that PLCs positively affected their instructional practices. The following are excerpts of what the teachers said about the effect of PLC on their instructional practice:

'PLCs have actually helped improve my lesson delivery in the classroom and how my learners are grouped to enable them to understand whatever is going on' (#11, male).

'I believe the effect of the PLC on my instructional practices has been positive, just that if care is not taken, you might not achieve your lesson objectives before the end of the lesson. This is because PLC is time consuming' (#14, male).

'PLCs have helped me improve upon how I used to conduct instructional activities.' (#13, male)

'PLC Positively affected my instructional practice' (#4, male).

'PLC has created an enabling environment for inclusion and effective teaching and learning' (#16, male)

'PLC has enhanced my instructional practice' (#9, male).

'PLC has helped make my instructional practice effective' (#7, male).

'PLCs have helped me to improve my instructional practices through the use of appropriate pedagogical strategies, classroom management techniques and assessment strategies' (#12, male).

'PLC has helped me to improve on my instructional practices to cater for the needs of various learners' abilities' (#15, male).

"Through PLC, there is a significant improvement in my instructional practice, especially group discussions," (#6, male).

"PLCs have equipped me a lot on varied instructional practice which assist learners of different levels to understand," (#10, male).

However, some teachers (23.4%) think that PLC did not influence their instructional practices.

"PLC has not affected my instructional practice. It is a Waste of time," (#5, female).

"PLC has affected teaching and learning negatively because of the time teachers spend to complete several PLC sessions," (#2, female).

"There are many challenges with the PLC as the school lacks certain basic ICT tools to develop 21st century skills. The low level of understanding of the learners is also discouraging," (#17, male).

"To me, the effect is neutral because nothing has changed. The instructional practice and method remain the same. The only change has to do with ICT tools and also, taking into consideration GESI and SEL," (#1, female).

The majority (94.1%) of the teachers think that PLC has influenced their collaboration with other science.

"PLC has helped my collaboration with other teachers to teach science to improve since I understand better the need to collaborate with others to deliver my lesson for better understanding of my learners." (#15, male).

"PLC has created room for all teachers to serve as critical friends, which has covered gaps which would have been created. Critical friends provide support in areas where challenges arose to aid effective lesson delivery and understanding," (#16, male).

"I have learned a lot from the interactions with other teachers during PLC sessions. This helped me to teach science lessons effectively" (#10, male).

"PLC has enhanced my professional practice" (#4, male).

"PLCs made me aware that teaching and learning involve collaborative effort between teachers to make it more effective. For that matter, I consult my colleagues for assistance to prepare well before the lesson," (#13, male).

"PLC has deepened positive collaborations with my colleagues" (#9, male).

"During PLC, as we collaborate with each other, we get to know each other's weaknesses and strengths. It also kills the spirit of laziness and makes you critical thinker very forward for instructional practice and confident in all your dealings. You become a vibrant teacher." (#1, female).

"PLC has made my collaboration with other science teachers highly effective" (#7, male).

"PLC has helped a lot in collaboration with other teachers to plan challenging topics, resources and personnel" (#3, male).

PLCs have helped me collaborate with other teachers to come up with best instructional practices to enhance the teaching of science by sharing ideas amongst ourselves during PLC sessions" (#12, male).

"It is much more effective because it creates room for collaborating with other teachers for teaching and learning resources, seeking for better techniques suitable for teaching specific topics," (#14, male).

"Through the departmental PLC, facilitators in my school in the science department are now interacting weekly to share ideas and concerns on several areas in the teaching of science" (#11, male).

"PLC is good and has helped me in collaboration with a critical friend, especially on how to get a starter for some topics." (#6, male)

"PLC has enhanced my collaboration with other science teachers" (#4, male).

Again, most of the teachers (58.5%) think that PLCs have improved their professional practice.

"I think the PLC has been good and very good as far as the 21st century skills are concerned. The only challenge that will hinder the positive effect of it is the provision of the learning materials to facilitate the implementation of the PLC will be a serious issue. Since the PLC needs a lot of materials which are so expensive with the limited resources," (#14, male).

"PLC is actually helping teachers to improve on their professional practices. The departmental based PLC is helping teachers to learn more from others on their subject areas," (#15, male).

"PLC has helped me to collaborate with other teachers. It has also improved my teaching practice and helped me share my challenges and receive feedback. It has helped to be learner-

centered, shared resources and reduced my workload," (#3, male).

"PLC is very effective and helpful. The introduction of 21st century skills, GESI and SEL issues has helped in promoting quality lesson delivery and motivation to all learners to actively participate in the teaching and learning process to achieve academic goals," (#16, male).

"My professional practice has improved tremendously because of PLCs. This has improved my teaching effectively in the classroom," (#10, male).

"PLC has helped me improve on how I prepared before the lesson, taking into consideration pedagogical strategies and resources needed for the teaching and learning to be more effective," (#13, male).

"PLCs have been useful to me as a science teacher as it has help me improve on my delivery method, classroom management and assessment method." (#11, male)

However, some teachers (29.4%) think that PLCs did not influence their professional practice. They think that the teaching in the new standards-based curriculum is now student-centered.

"PLC is not different from the old curriculum. Everything remains the same except that the content that was teacher-centered or lecture-method or rote learning has now become student-centered coupled with the use of ICT tools, hands-on activities and taking into consideration SEL and GESI." (#1, female).

"The PLC session is based on exhibiting our 21st century skills, which most of the teachers lack" (#2, female). The findings agree with that of Pan and Cheng (2023), who reported that PLCs had a positive impact on teachers' professional learning beliefs, behaviours and self-efficacy. The mean scores for professional learning beliefs and behaviors are at a high-intermediate level. Prenger et al. (2019) found a moderately positive effects of networked Professional Learning Communities on teachers' knowledge (pedagogical/instructional), skills, and attitudes and their application to practice. The teachers' participation in networked professional learning communities was promising to enhance their professional learning (Prenger et al., 2019).

Again, Bond (2019) found that the majority of teachers who participated in PLCs changed their instructional practice, their collaborative practice, their data study practice, and their assessment practice because of their participation in the PLCs. In a review of research on the impact of professional learning communities on teaching practice and student learning, Vescio et al. (2008) found that well-developed PLCs have a positive impact on both teaching practice and student achievement (Bond, 2019).

The Effect of PLCs on Science Teachers' Assessment Practices

Table 3 presents the means and standard deviations of aspects of assessment on the assessment sub-scale. The results show that PLCs have a moderate effect on science teachers' assessment practices (M = 3.73, SD = 0.71). On specific aspects of assessment, it was found that PLC has the highest effect on student assessment (M = 3.94, SD = 1.14) followed by summative assessment (M = 3.94, SD = 0.75), formative assessment (M = 3.82, SD = 1.07), and kinds of questions asked (M = 3.71, SD = 1.05). PLC has the least effect on frequency of assessment (M = 3.65, SD = 0.86) and assessments by collaborative teams (M = 3.41, SD = 1.12).

Table 3: Means and Standard Deviations of Items on the Assessment Scale.

Aspect	**N**	**M**	**SD**
1. Student assessment	17	3.94	1.14
2. Summative assessment	17	3.94	0.75
3. Formative assessment	17	3.82	1.07
4. Kinds of questions asked	17	3.71	1.05
5. Frequency of assessments given	17	3.65	0.86
6. Assessments developed by collaborative teams	17	3.41	1.12
Overall mean	**17**	**3.75**	**0.71**

The results of the open-ended data also revealed that most of the science teachers (88.2%) think that PLCs positively affected their assessment practices. The following are some of their views:

"PLCs have broadened my knowledge of assessment practices to be used during teaching and learning process. PLCs have also helped me to incorporate assessment strategies that cater for varied abilities of learners" (#12, male).

"PLC has helped to improve the assessment practice in that I now see the learners as different coming from diverse homes and assess them as different individuals with different needs." (#11, male).

"PLCs by assessment practices have been positive because they centred on the learner. Most of the learners get involved, and when assessing them, it makes them active and willing to engage in the assessment," (#14, male).

"Through PLCs, I understand more on the various levels of assessment, and this has helped me to assess my students well," (#13, male).

"PLC has helped a lot concerning new assessment strategies. These assessment strategies benefited me and the learners as well," (#3, male).

"Very excellent in the sense that you can diagnose the calibre of students with whom you are dealing with in terms of weaknesses and strengths. Also, you can detect the extent to which learning has taken place in the course of your instructional period and after the instructional period. With this, you also get to know the fast learners from the slow ones," (#1, female).

"Varied assessment formats are used to meet the level of each learner. This makes effective interactions between the facilitator and the learner," (#16, male).

"PLCs have helped improve the assessment practices in the classroom. This aids learner of different levels to be assessed," (#10, male).

However, some teachers were of the view that PLC did not influence their assessment practices. The following are their views:

"PLCs have no effect on my assessment practice," (#8, male).

"The effect of PLC on my assessment practices is normal," (#5, female).

"The understanding level of the learners affects assessment practices. There are not enough science resources to handle science topics so that learners can be assessed thoroughly," (#17, male).

The findings of this study are similar to other research findings. For example, Betts (2012) reported that Professional Learning Communities improved teachers' ability to use assessments to improve students' learning. During PLCs, the teachers discussed the development and use of common formative assessments. The teachers also used other information about student learning to determine instructional changes (Betts, 2012).

Correlation Between Science Teachers' Instructional and Assessment Practices

Table 4 presents the results of Pearson's correlation between science teachers' instructional and assessment practices. The results show a significantly high and positive correlation between science teachers' instructional and assessment practices (r = .851, p = 0.000).

Table 4. Pearson's correlation between instructional and assessment practices

Variable	Instructional practice	Assessment practice	*p*	*N*
Instructional practice	1		0.000	17
Assessment practice	.851*	1		

* *significant at* $\alpha = 0.05$

This finding implies that science teachers' use of appropriate instructional practices can influence their assessment practices. The findings of this study confirm that of other studies, for example, Samaie and Valizadeh (2023) found that the majority of teachers have a formative perspective toward assessment and consider assessment as closely connected to teaching and learning. The teachers stated that assessment, teaching, and learning have an interwoven relationship (Samaie & Valizadeh, 2023). Assessment is integrated with student learning and the actual process of teaching. Many teaching strategies are effective ways of assessing the progress of students (Panizzon, 2020). Amua-Sekyi (2016) reported that assessment influences how teachers teach and, consequently, how students learn.

According to Panizzon (2020), the teaching activities, tasks or strategies selected depend on the purpose of assessment, the level of the students, and the intended learning outcomes. The purpose of assessment activities used at the beginning of a lesson is to ascertain students' existing understandings and stimulate students to continue building and restructuring their existing scientific knowledge (Panizzon, 2020).

Science Teachers' Instructional and Assessment Practices

Table 5 shows the results of paired samples t-test between science teachers' instructional practice and assessment practices. The results show no statistically significant difference in science teachers' instructional practice (M = 3.71, SD = 0.92) and assessment practice (M = 3.74, SD = 0.71), t (16) = -.269, p = .791.

Table 5. Paired samples t-test between science teachers' instructional and assessment practices

Variable	*N*	*M*	*SD*	*df*	*t*	*p*
Instructional practice	17	3.71	0.92	16	-0.269	0.791
Assessment practice	17	3.74	0.71			

Conclusion

The study found that professional learning communities (PLCs) positively affected teachers' instructional practices. It was also revealed that PLCs positively affected their assessment practices. However, there is no statistically significant difference between science teachers' instructional practices and their assessment practices. Continuous professional learning through PLCs is crucial for teacher development and instructional improvement, which ultimately benefits student performance. There is a significantly high and positive correlation between science teachers' instructional and assessment practices. This agrees with the findings of Barton and Stepanek (2012), who assert that Professional Learning Communities (PLC) are powerful mechanisms that enable educators to join forces to promote ongoing growth and improvement for themselves and their students. PLCs are based on the premise that learning results from the varied perspectives and experiences that members share with one another as they work toward common goals.

Recommendation

The findings of this study have important implications for policy, practice, and future research. The Ghana Education Service and school heads should improve on the implementation of PLCs, which improves instructional and assessment practices. For PLCs to be successful, it is essential to provide sufficient meeting time for teacher groups to engage in a continuous process of discussing best practices on constructivist instructional approaches, teaching 21st century skills, gender equity and social inclusion issues, ICT integration, and social and emotional learning. School heads and management should create an enabling environment for teachers to engage in the ongoing inquiry into the standards-based curriculum, instruction, and student learning. Schools should be provided with adequate ICT infrastructure to support the integration of ICT into teaching and learning. Again, the Ghana Education Service should provide adequate teaching and learning resources for implementing the standards-based curriculum.

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