Science and Mathematics Teachers Participation in Professional Learning Community for Effective Teaching: The case of Chang'ombe Demonstration School

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Abstract

This study explored science and mathematics teachers' participation in professional learning communities (PLC) for effective teaching in Tanzania. It sought to determine teachers' understanding and participation in PLCs. The study took a qualitative approach and used a case study design. Semi-structured interviews and documentary reviews were used to collect data. A total of 20 participants were involved in the study; 9 Science and Mathematics teachers, 4 heads of departments and 1 head of school, and 6 teachers from a University College were interviewed. The findings revealed that teachers have a partial understanding of PLCs although they have been engaging in several activities intended to improve their classroom practices. Likewise, the findings showed

that teachers' engagement in PLCs is constrained by factors such as limited time, insufficiency of resources, inadequate collaborative culture, and content provided in the PLC training. The study concludes that emphasis should be placed to ensure all teachers engage in professional learning while school managers should provide support and a conducive environment for PLC. The study recommends that teachers should be encouraged to take individual initiatives for their professional development.

Keywords: *Mathematics, Professional learning communities, Science, Tanzania, Teachers*

Introduction

A teacher's capability to teach effectively depends on both pre-service training and access to professional development programmes (Darling-Hammond & Lieberman, 2017; Nawab, 2021). Professional development [PD] refers to all activities done by teachers to improve students' learning across all levels of education. It encompasses formal and informal programmes such as seminars, workshops, self-directed learning, a community of practices, and lesson study (Akiba & Liang, 2016; Darling-Hammond *et al.*, 2017). All these forms of teachers' PD programmes are aimed at improving students' learning. Trends show that PD is relevant because students' needs change with the rapid changes in technology, economic issues, societal needs, and the labour market, which necessitate changes in education (Schleicher, 2016). Today's students learning needs are changing due to rapid changes aligned with the 21st Century skills; problem-solving, creative skills, information communication technology, and collaborative skills are intended to enable students to fit in the labour market. For students to acquire those skills, they require teachers that are updated with the competencies that suit their current needs. As such, continuous PD for teachers is paramount to ensure teachers are updated to keep up with the changing needs of students. According to (Darling-Hammond *et al.*, (2017) and DuFour *et al.* (2016), among the approaches which ensure effective continuous PD are those which are teacher-led, ongoing, sustained over time, and embedded in classroom practices.

Trends show that the common existing PD for science-related subjects (physics, chemistry, and biology) and mathematics teachers is standardized training, which comprises workshops, seminars, or short-term courses (Anney, 2013; Koda, 2014; Komba & Mwakabenga, 2019). A standardized PD is often planned and limits teachers' active engagement in learning. Such training is considered ineffective since it

has little impact on teachers' classroom practices because it is fragmented, irregularly provided, and mismatched with teachers' classroom needs (Komba & Mwakabenga, 2019). Since it has detached from the actual context of teachers' work, the significance of these programmes has not been recognized in helping teachers improve classroom instructions. Due to these weaknesses of standardized PD, the teacher's driven professional development has necessitude. Hence, today's focus is on school-based professional development, which is collaborative and encourages teachers to engage together in practices that develop the professional knowledge needed in their context (Darling-Hammond *et al.,* 2017; Çetin & Bayrakcı, 2019). Such professional learning takes the form of lesson study, coaching, a community of practice, the professional learning community (PLC), action research, teamwork, and inquiry learning. This study focuses on PLC because it is considered effective in enhancing teachers' classroom instruction through collaboration, supportive leadership, active participation, and shared mission and vision (Stewart, 2014; DuFour *et al.,* 2016). Also, it is considered effective since what teachers learn is linked to classroom practices.

PLC refers to the group of teachers within a school or department who work together by sharing their experiences to improve their classroom practices to enhance student's learning (DuFour *et al.*, 2016; Antinluoma *et al.,* 2021). PLC is an ongoing process in which teachers work collaboratively in cycles of collective inquiry to achieve better results for the students they serve (DuFour *et al.,* 2016). PLCs provide opportunities for teachers to share and critically examine their instructional practices in an ongoing, reflective, and growth-promoting manner (Chen, 2020). Since it is collaborative in nature, context-based PLC is considered effective in enabling Science and Mathematics teachers to improve their teaching and it sets a platform for teachers to plan collaboratively, teach together and reflect on their teaching and students' learning.

Several studies done in Tanzania confirms that, teachers at all levels of education need to be engaged in professional development led by themselves to overcome the challenges of teaching science and mathematics (Kafyulilo, 2013; Koda, 2014; Hardman, 2017; Swai,2018). Among others, the challenges include overcrowded classrooms and limited curriculum materials (Mabula, 2012; Kafyulilo, 2013), a shortage of science and mathematics teachers as well a lack of effective PD (Koda, 2014; MoEST, 2018). Research shows that, when teachers engage in

successful PLCs, they improve their instruction and lead to improved learning among students. This is because learning by sharing is long-lasting and removes the isolation culture among teachers. Turner *et al.,* (2018) asserts that, peer learning through PLC is very essential since teachers tend to value the contributions of their colleagues with whom they share their daily experiences.

However, PLCs in Tanzania lack a formal structure to guide their effective implementation, given the relevance of PLC to teachers, exploring teachers' understanding of PLC and how they engage in it is relevant. Hence, the present study addresses the following questions: what is teachers' perception of PLCs? Do secondary school teachers engage in PLCs in Tanzania? What factors hinder teachers' participation in PLCs and how can they be addressed? Thus, the study is very useful since it is aimed at providing insights to teachers on how they can engage in school-based professional development through PLC and ensure that the school becomes a learning organization. Also, the study findings will inform researchers, policymakers, and other educational stakeholders about PLC.

The existing efforts by the government to ensure effective teaching are several, including the Education and Training Policy (United Republic of Tanzania [URT] 1995,2014) which specifies that continuous professional development should be compulsory for all teachers. This is despite the claim that in-service training reaches few teachers and leaves many others unattended (Koda, 2014; Komba & Mwakabenga, 2019). Also, the government established the Teachers Development Management Strategy [TDMS 2008 – 2013] to revise the organization of in-service training for teachers at all levels. Hence, school-based professional development was recommended to be used for teachers of all levels, due to its effectiveness in changing teachers' classroom practices (Hardman, 2017). Likewise, there is a National Framework for in-service training which emphasises that school-based professional development should be core for all teachers (MoEST, 2017). Although school-based professional development has not yet scaled up, teachers are encouraged to engage in PD within their schools to enhance effective teaching and learning of science and mathematics.

Teaching and learning science and mathematics in Tanzania

Studies show that teaching and learning Science and Mathematics in secondary schools has been a challenge for years due to overcrowded

classes, inadequate curriculum materials, the chalk-and-talk approaches, and inadequate impactful PD (Kafyulilo, 2013; Koda, 2014; Timothy *et al.,* 2021). As a result, students' performance has been declining yearly. Table 1 reflects the trends in students' performance in science and mathematics over the past five years.

Table 1: National Form Four examinations pass rates % of science and mathematics subjects 2016-2020

Subject	2016	2017	2018	2019	2020
Biology	55.7	61.5	60.5	55.3	55.2
Chemistry	59.2	53.4	61.8	76.8	87.1
Physics	44.8	42.2	45.2	48.4	48.9
Mathematics	18.1	19.2	19.9	20.0	20.1

Source Basic Education Statistics in Tanzania (BEST), (2017, 2019, 2020, 2021)

Table 1 shows the pass rate of students in science and mathematics subjects for the past five years. As the table indicates, a large percentage of students have been failing. Only Chemistry is an exception as its performance has been increasing, although data from BEST shows that the number of students who take the subject has been decreasing. For example, from 2018-2020 candidates who sat for the Chemistry examination were 165,776, 162,777, and 154,143 respectively.

Besides, in the struggle to improve science and mathematics teaching and learning in secondary schools, several projects were introduced like the Science Teachers Improvement Project (STIP) funded by the governments of Tanzania and Germany, Science Education in Secondary Schools (SESS) also funded by the German government, and the Teacher Education Assistance in Mathematics and Science (TEAMS) funded by Dutch and Tanzania governments. All these projects focus on PD among science and mathematics teachers to ensure improved learning. Such projects have proved to be useful for science and mathematics teachers but since they were donor-funded projects they did not last longer: they ended when the support from the donors finishes. As a result, emphasis is now on PD, which is ongoing and sustainable over time, involving learning in collaboration with peers within the school. The ultimate goal is to turn schools into learning organizations where teachers will share their expertise and experiences in their community of learning (DuFour, *et al* 2016).

Professional development through PLCs is reported to be effective in developing teachers' competencies since it is aligned with the constructivist learning theory, which is grounded in classroom practice.

The constructivist learning theory emphasises that learning is a process of making sense of information and experiences. Learning is socially constructed, requires an environment where learners work collaboratively, and is situated in realistic activities and contexts (Chuang, 2021). Since teachers have prior experiences and every teacher is unique, therefore, new knowledge should be built on experiences through collaborative learning. This is necessary given the fact that teachers are adult learners who have learning experiences upon which new knowledge can be built (Darling-Hammond *et al.*, 2017). Likewise, the teaching context matters as effective PD should be situated in the working place since learning cannot be separated from the context (Darling-Hammond *et al.*, 2017; Chuang, 2021).

Professional learning Communities, Meaning, and Characteristics

PLC refers to the group of teachers within a school or department, who work together by sharing their best practices to improve their classroom practices and hence resulting in students' improved learning (DuFour *et al.,* 2016; Antinluoma *et al.,* 2021). In a PLC, since learning is contextualized teachers learn from each other on how students learn and later apply what they have acquired. In the field of education, the PLC model has been at the forefront as one of the most effective professional learning frameworks for improving students' achievement and overall school success. The main focus of PLC is on teachers' collaboration outside their classrooms meant to improve their pedagogical practices, students' learning, and school performance.

PLC entails the formation of teams by subjects, departments, or the whole school. The role of the team begins by identifying the learning needs of the students. The needs can be related to teaching strategies, teaching theory, assessment, etc. The team must be committed to working together for a semester or longer than that for professional development. Adequate time is needed for collaborative learning, but the time should be well-planned and utilized. The figure below summarises the steps of PLC. Figure 1 summarizes the cycle of continuous professional improvement. The cycle represents the steps for effective teacher-led professional development.
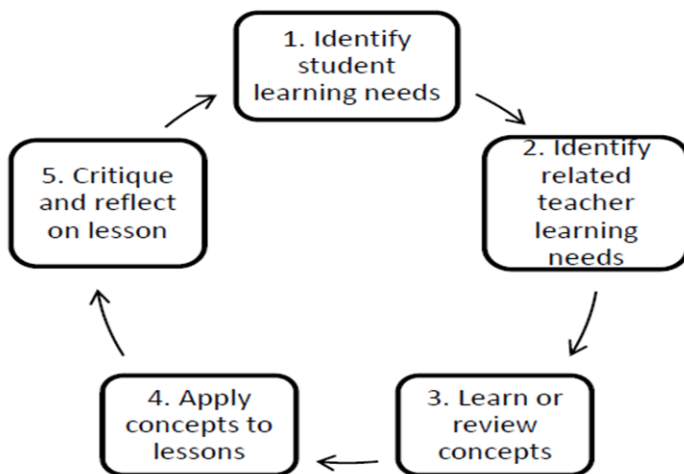
Figure 1. Professional Development cycle for continuous professional development Adopted from Stewart, (2014) Transforming Professional Development to Professional Learning 29 pg.

A team of teachers should critically assess students' work to identify student needs, they should note the gaps in student learning. After the needs of the students are known, then the needs of teachers are identified, and the chosen content is learned and applied. The lesson is observed, critiqued, reflected on, and improved. The PLC proceeds in a continuous manner thus the cycle begins again by reviewing student learning from the previous cycle.

Characteristics of PLCs

Understanding the features of PLCs provides insights into how they should be implemented at school. Several scholars categorise the characteristics of PLC into a shared mission, vision and values, collaborative learning, focus on student learning, reflective dialogue, and participatory leadership. Each is further discussed in the following sub-sections.

Shared mission, vision, and values

The mission identifies the school's purpose while the vision expresses the future of the school, and the values articulate the shared beliefs of a school (Antinluoma *et al.,* 2021). These all together help teachers to share their expertise and experiences to improve learning and school effectiveness. Again, clear statements of the mission and vision of the school help teachers to work collaboratively to improve their professional competency and students' achievement. School leaders are supposed to make these clear to all teachers and to build a school culture under which everyone works towards achieving the mission and vision of the school.

Collaborative learning

Collaboration entails a practice in which teachers share their expertise to advance and create new knowledge to improve students' achievement (Turner, *et al.,* 2018). It is something beyond a collegial relationship. According to Horn *et al.*, (2017), collaboration steers reflective dialogue among teachers, making them free to give constructive criticism to one another. Thus, through collaboration, teachers-built trustworthiness in each other hence become possible to work together. DuFour *et al.* (2016) argue that working collaboratively in PLCs is not an option, rather it is something teachers must do since it is an organizational requirement that helps to sustain members' commitment.

A focus on student learning

The main purpose of school is to ensure all students learn. This should be the major motive of the whole school community (DuFour *et al.,* 2016). Teachers investigate how their instruction promotes students' intellectual growth or affects the opportunities for students to learn (Turner *et al.,* 2018). The purpose of all actions involved in PLC should be to promote the learning and development of all students. It is the responsibility of each teacher to make sure students learn and this is achieved through collective commitment (DuFour *et al.,* 2016).

Reflective dialogue

Reflective dialogue refers to an organized conversation among a team of teachers participating in PLC that focuses on improving their teaching practices and students' learning. The conversation is possible if the teachers have a collaborative culture in their school. Each teacher feels free to provide constructive opinions to his/her colleagues to improve classroom instruction (Stewart, 2014; Turner *et al.,* 2018). When teachers reflect on practice, they gain a deeper understanding of how instruction can improve or inhibit students' learning and engagement. Also, in reflective dialogue, teachers assess the effectiveness of their practices meant to help students to learn.

Participatory leadership

Participatory leadership plays an important role in ensuring teachers develop collaborative learning behaviour by modelling effective practices and working with colleagues (Turner *et al.*, 2018; Çetin & Bayrakcı, 2019). This can be seen through teachers' engagement in participatory decision-making at the school level. For teachers to be effective, they need leaders who are good and experienced instructors, trusted and respected by others (Turner *et al.*, 2018). These leaders are expected to develop and demonstrate collegiality by involving teachers in making decisions that are necessary for professional development and student achievement. Again, PD leaders must be in a position to encourage teachers' engagement and commitment to change and must be able to respond to the group needs (Wilson, 2016; Turner *et al.*, 2018;).

Studies on the effectiveness of PLC

International studies on the effectiveness of PLC in enhancing teaching and learning show that teachers can change their teaching practices and lead to the high performance of students when they engage in PLC (Darling-Hammond *et al.,* 2017; Hauge, 2019; Chen, 2020). PLC has been considered to be an effective PD approach due to its nature of teachers learning in a community of practice. For example, Stewart (2014) did a study on transforming professional development into professional learning and found that professional development through PLCs is more effective than standardized PD since learning occurs within their context and the learned content is initiated by teachers. Another study by Hairon

& Tan, (2016) concluded that, through collaborative learning, teachers gain new knowledge and learn ways to resolve instructional issues. In the process, they develop a shared vision and strengthen their ability to achieve the vision that they want for their schools. Since it is a shared activity, the solution developed out of it will be better than that which is developed by individual teachers.

In Tanzania, micro studies reveal that school-based professional development is effective although, unlike in other countries, there is no established structure for these programmes (Kinyota *et al.,* 2019; Mwakabenga *et al.,* 2022). For example, a study by Hardman *et al.* (2015) on the implementation of school-based professional development in Tanzania found that teachers who participate in the programme demonstrate significant differences in their instructional practices. Hence, it was recommended that school-based professional development has to be scaled up to all levels. A study by Anney (2013), Kafyulilo (2013), and Koda (2014) argue that science and mathematics teachers could improve their instructional practices by participating in collaborative learning in their working contexts. Those studies explain the effectiveness of school-based professional development in general. Since there are several approaches to school-based development, this study sought to fill in the gap by exploring PLCs as an approach to school-based PD

Methodology

This study employed a qualitative case study research design to explore Science and Mathematics teachers' participation in the professional learning community and the factors which constrain their participation and how they could be resolved. The qualitative approach allowed the researcher to collect data in a natural setting without manipulating the context. It enables researchers to talk directly to participants and watch them behave and act within their context (Creswell, 2014). The case study design was chosen because of its suitability in describing a unit in detail, in context, and holistically. In the present study, the design enables researchers to deeply explore science and mathematics teachers' understanding and participation in PLCs. The population of the study comprised Science and Mathematics teachers of secondary school, heads of departments, the head of a demonstration secondary school, and university teachers. The sample comprised 9 science and mathematics teachers, 4 heads of the department, 1 head of the school, and 6 teachers

from the university making a total of 20 participants. The heads of the departments and the head of the school were purposively selected by their positions since one of their responsibilities is to coordinate all issues related to teaching and learning. The university teachers were also purposively selected because of their teaching roles during pre-service training for science and mathematics teachers and their expertise in PD. Thus, they were considered to be well-informed in the area of teachers' professional development and the school could hire them to facilitate PLCs. Takahashi & Mcdougal (2016) assert that, external experts are very important in job-embedded PDs since they guide how to run these programmes. The sample of teachers involved in the study comprised different categories; in terms of gender, as well as specialization. Where twenty-five percent (25%) of them were female while seventy-five percent (75%) were male. In terms of specialization, 30.7% were Biology teachers, whereas physics, chemistry, and mathematics occupied 23% each.

The study area was purposively selected since it is a demonstration school owned by a university college. Being a demonstration school, it was expected to be exemplary of its neighbouring schools in terms of effective teaching and student performance. Since it is owned by a University College, it was expected to have the advantage of using available expertise from the college in running the programmes for teachers' professional learning. The researcher explored the way the school organizes and runs PLCs as a strategy for developing teachers professionally to ensure effective teaching of science and mathematics. Semi-structured interviews and documentary reviews were used to collect data. The semi-structured interviews enabled the researcher to probe and ask follow-up questions in an attempt to get in-depth information (Creswell, 2014). Meanwhile, the documentary review was used to supplement the information obtained from interviews to ensure data authenticity. School documents, policies, journal articles, textbooks, and published government documents were reviewed to obtain data. The collected data were subjected to thematic analysis, where similar and related issues were clustered together to form themes and sub-themes according to the research questions. Then, they were interpreted and a conclusion was drawn.

Findings

This section presents the findings on the participation of science and mathematics teachers in PLC. The findings are presented based on the questions of the study.

Teachers' understanding of PLC

The study found that most of the interviewed teachers did not have a broader conceptualization of PLC. Their understanding was restricted to the standardized PD. They proved to be missing an in-depth understanding of PLCs. For example, one teacher said the following:

> According to my understanding, PLC refers to all activities which in-service teachers engage in to improve students' learning, like attending seminars and workshops. Again, it is like what we are doing here in our school, every Monday we conduct a meeting to discuss various issues concerning teaching and learning, like how to prepare a lesson, and how to construct good test/exam items (April 2022).

Another teacher commented, in *my understanding PLC is all that teachers do to improve their classroom instruction, like attending the seminar, engaging in self-reading, or asking for assistance from colleagues.*
    The above quotes imply that teachers lack an in-depth understanding of PLCs since their descriptions were narrowed to standardized PD programmes like seminars and workshops.

Another teacher said,

> On my side, I am not aware of PLCs since I am a new employee in this field, so I have never come across the term PLCs (April 2022).

This quote entails that the concept of PLC is not clear to teachers. It implies that pre-service training by itself is not enough for the teacher to acquire all the required competencies. Likewise, the quote from the teacher is contrary to the argument made in an interview by a lecturer from the university heard said that:

> Teachers must be aware of different types of PD even before they are introduced to the work since they learn them in some courses during their pre-service and a teacher may know what to do when she/he wishes to engage in PD.

Thus, by having awareness of the types of PD teachers will be able to run and engage in it effectively depending on their needs. Likewise, another lecturer said, *our commonly used PD are those standardized ones, which are centrally organized, by the government, NGOs, or other stakeholders.* This implies that teachers have a perception that it is the government's role to initiate professional learning for them. Hence, efforts are needed to help teachers to change their attitudes and stop considering PD as a government responsibility rather than a personally initiated learning.

Teachers' participation in PLCs

The findings revealed that teachers participate in professional learning both at school and outside their schools. However, the findings indicate that out-of-school professional learning is irregularly done due to budgetary constraints. In-house professional learning programmes are conducted once every week. During an interview, one teacher said;

> We do engage in PLCs every Monday when our students are in religious session, in which we learn various topics concerning teaching depending on the chosen topic, through participation to PLC I have seen some improvement in the quality of classroom instruction (April 2022).

Again, a head of the school said:

In my school, we have about 80 minutes of professional learning every Monday. Within this time, teachers discuss various issues concerning teaching and we are lucky that we have one teacher who has served as a national facilitator of in-service training for teachers. We usually use him as a facilitator of these PLCs (April 2022).

An interview with one head of the department said that:

> Apart from participating in school PLCs, in my department, we do have sessions for assessing our teaching and students' learning and identifying difficult topics for students after every three months. Then after identifying the problem we plan a lesson together and teach it to see how we can improve students learning.

These excerpts imply that teachers do participate in PLCs and the school has specified time for teachers' professional learning. However, others

use the extra time for learning within their departments, because the allotted time is limited. One lecturer said,

> …teachers' participation in PLCs has to be given support from the school administration and environment, whereby a supportive environment should be created by the school administration.

Implementing PLC with regard to characteristics

Implementation of PLC requires an understanding of its characteristics. An effective PLC should be guided by its characteristics. The findings revealed that teachers and the head of school were implementing PLCs, although they missed a broader understanding of some characteristics which are supposed to guide implementation. For example, one teacher commented, *after learning in the meeting, we do not have further time for discussion as a group, rather everyone struggles to ensure what has been learned is implemented in the classroom.* This implies that the reflective dialog was not well featured in the implementation of PLC at school. Thus, teachers and school leaders must be familiar with the characteristics of PLC. Teachers' learning should go beyond the classroom. That is, after collaborative planning, teachers should go to teach together and have a post-discussion, later on, to ensure that the weaknesses and strengths of the lesson are shared.

On the other hand, the findings revealed that teachers are aware that the focus of PLC is on student learning. Almost all the interviewed teachers and the head of the school showed to be aware that whatever they do is aimed to improve students' learning. For example, one teacher said the following:

> …in my department was trying to make sure that students who take this subject can get support from any teacher among us without being scared since we teach together and sometimes, we do divide the topics of the subject for a certain class among all of us. This makes students free to face any among us in case of learning problems.

A collaborative culture is the major element of PLC. As such, this study sought to find out how teachers collaborate. The findings revealed that teachers collaborate with one another, but time constraint tends to hinder them from learning and working collaboratively. According to the nature of PLCs, time is essential in building a collaborative culture at

school. It was observed that some do it well within their departments but not across departments. One teacher said,

> In the beginning, it was so difficult to work together because of being worried about criticism or having not prepared materials to share especially for the junior staff. However, as time goes on, I am comfortable with these collaborative activities since I learn from seniors as well as share my little experience.

Through collaboration, teachers can work towards the shared mission and vision of the school. This collaborative culture should be built and exercised to ensure sharing of expertise and experience among teachers. According to DuFour *et al.* (2016), to have a successful PLC, teachers must work collaboratively and take collective responsibility for the achievement of every student. Therefore, working collaboratively should not be an option but an obligation.

Again, among the characteristics of PLC, participatory leadership was observed. The findings from interviews revealed some elements of participatory leadership; for instance, some teachers reported that they were voluntarily taking charge of the PLC in case they had certain expertise and wished to share it. The Head of the School said:

> Since financial resources are limited, facilitators for PLC are teachers among us, who volunteer to share certain skills and, in our school, we have a teacher who has been a facilitator of national in-service training. So, we usually use him to facilitate and lead the PLC programmes. Likewise, any teacher who wishes to share their experiences is allowed to do so.

Challenges for conducting and participating in PLCs

Time for professional learning

Data from interviews revealed that time for conducting and participation in PLCs has been a constraint since teachers tend to be inundated with a lot of activities that they have to accomplish. Unfortunately, their responsibilities related to teaching such as completion of syllabi on time and preparation of examinations make them too busy. This affects their participation in PLCs since they normally prioritize teaching responsibilities over professional learning. One interviewed teacher said:

I usually have other responsibilities to accomplish apart from teaching, so sometimes I miss the chance to engage in PLC due to limited time.

Likewise, the lack of specified time to be spent on professional learning activities per semester or year was found to be another factor that impedes teachers' participation in professional learning. Data from the Tanzania Education Policy (1995, 2014) revealed that the policy does not specify how exactly the ongoing and compulsory in-service teacher education should be attained. As a result, teachers' professional development remains a sporadic process.

Insufficiency Resources for PLC

As per the findings, another factor is the insufficiency of resources to facilitate PLC activities. The study findings revealed that the school had no budget for PD since the available financial resources are doomed for other school activities. One teacher said,

I do appreciate the support that the administration provides to PLCs, but financial support is also important since it could be used to pay facilitators who are usually volunteering to lead these programmes.

Likewise, the head said;

Due to limited financial resources as a school, we cannot afford to hire facilitators from outside, instead, we emphasise the staff members who are competent in a chosen topic and lead the programme for a particular session.

The above comment is inconsistent with the argument by Takahashi & Mcdougal (2016) that external experts are important for the effective implementation of school-based professional development.

Collaborative culture

Another factor that was found to affect teachers' participation in PLC is the limited collaborative culture among teachers. A collaborative culture is the main principle of the PLCs. The findings revealed that collaboration is very minimal among teachers since only a few of them perform collaborative activities like team teaching, assessing students together as a department, planning lessons as a team, etc. One head of the department said the following;

> The way we do it in my department is better. I wish other departments could learn from us since we participate in PLCs and at the department level, we conduct meetings in which we plan lessons together. We also teach collaboratively by dividing the topics among ourselves and we usually have time to visit each other's classes. Through our collaborative teaching practices, we have seen improvement in our students' learning (April 2022).

According to the quote above, it seems the collaborative culture within the school is limited. When collaboration is low among teachers, even trust among themselves and the culture of learning together becomes less possible. As a result, teachers miss the opportunity to develop their careers by working together and learning from one another. When teachers trust each other, a strong collaborative culture develops among themselves, hence reflective dialogues become possible since everyone will be willing to receive or give criticism for the sake of professional improvement.

The content of the PLC

Another factor that was disclosed during interviews with science and mathematics teachers was the lack of motivation to engage in PLCs due to irrelevant content. The findings revealed that there are still elements of standardized PD in the sense that what teachers learn during PLC is planned by the administration. This affects the actual purpose of the PLC which emphasises teachers' autonomy in the planning of the PLC. The findings revealed that the content learned was sometimes not the teachers' priority.

One teacher was heard saying:

> The administration tends to dictate what to learn in the PLCs, thus sometimes what we learn is not consistent with our needs, and my advice is that the needs assessment should be done before planning the content to be learned in PLCs (April 2022).

This implies that the school still considers teachers as recipients of knowledge like in standardized professional learning. The use of standardized content contradicts the argument by Çetin & Bayrakcı, (2019) that teachers learn better when they are self-directed and if what they learn is relevant and significant to their classroom practices. PLCs

usually insist on teacher autonomy in the choice of what to learn as per the needs. According to Hauge (2019), since teachers have autonomy, they can decide on their learning and they can support and help each other to improve instructions through collaboration. Thus, through sharing of the good practices, teachers can learn from each other unlike when they are subjected to learning content that they were not involved in planning.

Accountability for participation in PLCs

The study findings revealed that teachers' participation in PLCs in this school is optional since there is no mechanism to ensure every teacher participates in PLCs. This suggests that there should be a mechanism to ensure teachers are willing to participate in PLCs. Holding teachers accountable for their professional development would help to ensure teachers participate in PLCs since they will have to demonstrate or justify their participation. Taking the example of China, teachers' participation in PLCs to improve students' learning has implications on performance appraisal and the results of appraisal affect teachers' incentives, ranks, and promotion (Kinyota *et al.,* 2019). Thus, teachers engage in PLCs knowing that the process has implications for their professional life and students' achievement. One lecturer commented, *for teachers to participate effectively they should be motivated in various ways to recognize their efforts.* According to Hairon and Tan (2016), teachers' participation in PLCs should be appraised since everything which gets valued also gets recognized and rewarded.

Discussion

Understanding and participating in PLC

The study found that teachers had a limited understanding of PLC, which could hinder their engagement in professional learning. This finding is in line with Mwakambenga and Komba (2019) who examined the status of teachers' professional development and found that many of them lacked knowledge of professional learning, hence they failed to engage in it. For teachers to be able to engage well in any professional learning activity, they need to be well-informed (Hairon & Tan, 2016). Teachers' limited knowledge of PLCs hinders them from seeing the available opportunities for professional development in schools like

coaching, discussion, peer learning, classroom observation, and lesson study. As well, even if they participate in PLC, they are likely not to implement properly what they gain from the PLC. As a result, the significance of participating in PLC may not be seen. Having a clear understanding of PLCs helps teachers to plan, organize and implement effective PLCs and make it a routine practice (DuFour *et al.,* 2016). So, a lack of clear understanding of PLCs has implications for teachers' participation in PLCs. The teachers may not be motivated to engage effectively in professional learning once they are not aware of it. The findings corroborate those of Abdou (2017) who examined the discourse and practices of school-based professional development in Egyptian public schools. Abdou's findings revealed that teachers cannot engage in effective PD unless they are well informed about the nature and purpose of professional learning. Again, the findings are aligned with the findings of qualitative studies by Mwakabenga *et al.* (2020) and Sinyangwe *et al.* (2016) who established that teachers need adequate knowledge of the concepts, implementation procedures, and their roles to be able to engage in professional learning effectively. Likewise, Stewart (2014) argues that, for effective engagement in PLC, teachers should undergo a series of training to gain awareness about it so that they collaborate in learning. This means that, when teachers have a common understanding of PLCs, it is possible for them as a community of learners to engage in professional learning to improve students' achievement. On the contrary, if teachers are not aware of the PLCs, it becomes difficult for them to find the available opportunities, hence professional learning is unlikely to take place. Thus, more information is needed so that all teachers and administrators may have a common understanding of how to organize and implement effective PLCs.

Again, the findings showed that teachers in this school participate in PLCs regardless of the few obstacles which have been seen. A good thing about this school is that there is time allotted for professional learning. Although the time is limited, at least teachers have an opportunity to engage in professional learning, which allows them to share with colleagues the best practices and challenges they met in the classroom for the sake of finding solutions. Also, it was revealed that sometimes teachers use their own time for PLC. One teacher said that they use their extra time for departmental learning. This finding is consistent with the argument by Mwakabenga *et al.* (2022) that once teachers realize the importance of engaging in professional learning, they become willing to devote their time to professional learning. However,

due to the nature of PLC and the teaching job itself, sometimes teachers fear to commit time for PLC that extends beyond the regular school day (Çetin & Bayrakcı, 2019). So there should be a means to ensure teachers value their professional growth regardless of any obstacle. Scholars assert that, for effective PLCs, time is required for teachers to meet and share, plan, and implement the learned practices in a collaborative manner (Wilson, 2016; Antinluoma *et al.,* 2021; Chuang & Ting, 2021). Since time is among the major constraints for teachers' participation in PLC, teachers should be motivated to use the available time wisely.

Guiding characteristics of implementing PLC

A core characteristic of PLC is a focus on students' learning (DuFour *et al.,* 2016). The study found that PLC characteristics were known, for example, all the interviewed participants reported being aware of the focus of PLC. According to Chuang & Ting, (2021), DuFour *et al.,* (2016), and Wilson (2016), PLCs must focus on students' learning. As such, what teachers plan to do should be aimed at ensuring all students learn. According to Turner *et al.,* (2018), a focus on students' learning motivates collective responsibility among members of the community as it makes all of them struggle to ensure all students learn. Since it needs teachers' collaboration to attain the goal, thus collaboration should be more than a collegial relationship; it should involve creating new knowledge or programmes that improve teachers' expertise and have tangible products. Since it is a major element of PLCs, it needs school leaders to promote and make it part of the school culture. Teachers cannot be able to share, plan or visit other teachers' classrooms if they do not have a well-established collaborative culture.

Although the reflective dialogue was not found, it was among the barriers to the effective implementation of the PLC in the school, but this was a result of limited time. In reflective dialogue, teachers have conversations that enable each of them to have a deeper understanding of how instruction could be changed to ensure students learning is improved (Turner *et al.*, 2018).

On top of that, there is a shared vision and mission. Teachers' understanding of the school's mission and vision enables them to work interdependently to attain the school's mission and vision. Wilson, (2016) asserts that teachers are not only involved in developing a shared vision and mission of their school, rather all the decisions they make about teaching and learning should be guided by the mission and vision of the

school. Teachers' ability to pursue the school's vision and mission depends on participative leadership. A good school leader should establish a sharing culture by engaging teachers in making managerial decisions in which they will contribute to developing strategies for attaining the school goals. Therefore, the characteristics of PLC should be observed if teachers desire to be successful.

Challenges for PLCs

The study found that, although teachers engage in PLCs, several factors hinder them from participating effectively as has been mentioned in the previous section. According to Chuang & Ting (2021), the availability of enough time is vital for the sustainability of PLCs Since teachers have several duties to accomplish, it becomes difficult for them to devote their time to PLCs. Thus, enough time is required for teachers to learn and practice what they have learned through the community of learning and the time should be featured in the school timetable (Hauge, 2019). However, teachers should be helped to use the allocated time wisely. For example, in countries like China (Shanghai), each teacher is likely to engage in 240 hours of professional development within five years of employment (Kinyota *et al.,* 2019). Similarly, in Singapore teachers are given 100 hours to be spent on professional learning per year, together with government support for additional training and compensation (Darling-Hammond & Lieberman, 2017). Thus, in such a situation, teachers can willingly engage in professional learning since they have time for such an activity and it is well known. When the time for PD is fixed within the working timetable, the learning activities can be ongoing, sustained, and dedicated to solving contextual issues. Likewise, time is needed for the development of a community-learning culture within the school since it cannot be built within a short time (Hairon & Tan, 2016). A community learning culture in the school is built after an extended time of practice.

Also, inadequate resources like financial resources and space have been challenges for teachers' participation in PLC. Darling-Hammond *et al.* (2017) argue that the insufficiency of resources constrains teachers' participation in professional learning. Financial assistance is important in facilitating professional learning programmes in schools, although it is not the only factor (Kinyota *et al.,* 2019). Financial resources are needed for paying incentives to teachers who engage in PLCs as a motivation, purchasing the resources needed for professional learning, and paying the

facilitators of the programmes. Chen, (2020) argues that PLC is a cost-effective approach for teachers' PD and can be conducted even with limited resources because most of the things can be supported within school structures, there is no need to hire a room for the meeting or teachers' transport, etc. According to Darling-Hammond *et al.* (2017), intensive investment of resources is required for the effective professional development of teachers. Hence, a successful PLC requires a heavy investment of resources and time since the community of learning cannot be built overnight as it requires a long-term investment.

Likewise, the findings revealed that there is limited collaboration among teachers. Collaboration is the major element of a successful PLC. Since teachers become members of the community, they must be dedicated to resolving common instructional challenges together, sharing the best practices and experiences, and building relationships that allow them to learn from one another. Teachers can learn best when they interact as they teach together, collaborate in planning, and discuss how students learn and the teaching methods to be used (Hauge, 2019). According to Gray & Summers (2015) and Wilson, (2016), school leaders should help teachers to develop collaborative skills by engaging them in activities like decision-making, problem-solving and conflict resolution to develop a collaborative culture. Thus, in a PLC working collaboratively is a must because the success of it depends on teachers' interdependence. Since collaboration is a major factor for teachers to work together, it can be practiced by sharing instructional strategies, making decisions about teaching and learning, and coming up with ideas that enhance teaching and learning for all members of the learning community (Stewart, 2014). As a result, the isolation culture disappears automatically as teachers keep learning together inside and outside of their classrooms.

Besides, the content of PLC is another factor that was found to be constraining the programmes for professional development. Since PLC emphasises teachers' autonomy and focuses on outcomes, the choice of content should consider teachers' needs (Stewart, 2014). If the content chosen for PD is not aligned with teachers' needs, it will end up making the programme boring and what is learned from it will not be applicable in the class. Since learning in PLCs is supposed to be teacher-led, context-based, and characterised by peer learning, what teachers learn must be consistent with their prior knowledge and needs. The learning content should be focused, specific, and grounded in adult learning theory and informed by policy (Darling-Hammond *et al.,* 2017). School leaders should have a clear understanding of how to run PLCs in their

schools such that the usefulness of PLCs becomes evident in the school's success (Wilson, 2016). If a bottom-up style of leadership is used, teachers can have autonomy over what to learn and the sustainability of the programme will be assured (Chuang & Ting, 2021).

Again, it was found that it is difficult to overcome the challenges that hinder teachers' participation in PLC in secondary schools without a well-established framework to guide these programmes (Hardman *et al.*, 2015; Komba & Mwakabenga, 2019; Kinyota *et al.*, 2019). A framework should be established to guide the implementation of PLCs at the school level. It will help to guide school leaders in managing the activities related to the professional development of teachers. As a country, we can learn how other countries like Singapore, Shanghai, and Southern Korea where these programmes are run (Lee *et al.,* 2015). For example, Singapore has a nationwide PLC model that clearly describes the process (Chuang & Ting, 2021). Secondly, regarding the issues of timetable, there should be an agreement among education leaders and policymakers on how teachers should engage in PLC while at the same fulfilling their daily responsibilities. Unlike in countries where time for professional learning is specified in the school calendar like Finland, Singapore, and Japan, it is quite different in Tanzania since there is no specific time set for professional learning. As a result, professional learning remains an option for teachers rather than a compulsory endeavour as defined by the education policy. According to Chuang & Ting (2021), teachers are already stressed psychologically and physically due to the pressure of handling their daily routines such that they do not find time for PLC collaboration. Consequently, teachers complain about being overloaded when it comes to the issue of participating in PLC since they fear that their participation in PLC (Çetin & Bayrakcı, 2019) will affect their teaching schedule and make them fail to finish their syllabuses. According to Çetin & Bayrakcı (2019) school, administrators and policymakers should work collaboratively to address obstacles that hinder teachers' efforts for professional development at the school level. Issues like the rigid timetable of teachers' work days, which denies them time for individual or peer collaborative working, need to be addressed. Our country has to learn from other countries to ensure there is time allotted for professional learning within teachers' working days. According to Antinluoma *et al.* (2021), for PLC to be effective, there should be good networking of educational stakeholders at the national level, district, and school levels to be destined towards a common goal.

Recommendations

The researcher recommends that the Education and Training Policy should specify in detail how continuous professional learning is to be attained by teachers at the school level. This will enable school administrators to develop school policies to guide the implementation of PLCs at the school level as elucidated in the national education policy. Again, teachers should be motivated to take individual initiatives for their professional growth. They have to know that engaging in professional learning is their responsibility. Likewise, school leaders and managers should support teachers' participation in PLCs by setting conducive environments for PLCs; for instance, by allotting time for professional learning and ensuring the resources for the PLC programmes are available. Moreover, policymakers, school managers, and teachers should promote PLC practices to ensure continuous professional learning. Thus, to have effective PLCs, the educational leaders from the school level to the national level must be well interconnected.

Conclusion

Since the study findings show that PLC programmes help teachers to change their classroom practices and improve students' performance, emphasis should be placed on making sure that all science and mathematics teachers participate in PLCs. School leaders should develop mechanisms for providing skills to teachers and facilitators on how to implement effective PLCs and make it a continuous practice. Likewise, since every best practice is rewarded, teachers' participation in PLCs should be recognized in different ways like the provision of certificates and/or incentives to those who participate in professional learning. This is necessary to motivate teachers to engage in these programmes. Regardless of time insufficiency, teachers should be guided to wisely use the time available for professional learning.

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