Journal of Linguistics, Literary and Communication Studies
Vol. 4 No. 2 (2025): ISSN (Online): 2957-8477
DOI: https://doi.org/10.58721/jllcs.v4i2.1482
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Early-Career Teachers' Vowel Phoneme Knowledge in Ghanaian Basic Schools: Leveraging Flipped Micro-Professional Development

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Article History
Received: 19.05.2025
Revised: 02.10.2025
Accepted: 22.10.2025
Published: 29.10.2025

Keywords
Ghana
Micro-professional
Teacher
Vowel phonemes

How to cite:
Agbevivi, S. L. G. (2025). Early-Career Teachers' Vowel Phoneme Knowledge in Ghanaian Basic Schools: Leveraging Flipped Micro-Professional Development. *Journal of Linguistics, Literary and Communication Studies, 4*(2), 181-192.

Abstract
Early-career teachers in Ghana's basic schools often have limited explicit preparation in vowel phonemes, yet they are expected to support learners' early reading development under constrained conditions. This paper reports on a qualitative descriptive study of an online flipped micro-professional development (micro-PD) programme designed to strengthen teachers' understanding of vowel letters, vowel sounds, monophthongs, and diphthongs. The study is underpinned by Adult Learning Theory and Guskey's Model of Teacher Change, which together informed the design of the micro-PD and the interpretation of teachers' reported learning. An online, low-bandwidth intervention was offered to early-career basic-school teachers across Ghana and combined short preparatory screencasts with two live sessions. Data were generated from entry and exit checks, chat transcripts, and written reflections, and analysed using descriptive and thematic approaches. The findings indicate clearer separation of vowel letters and vowel sounds, improved recognition of monophthongs and diphthongs, and increased reported confidence in modelling pronunciation, although these confidence gains were self-reported. Despite connectivity and data constraints, teachers engaged actively through the chat and made specific links between the content and their classroom practice. The study suggests that a theoretically informed flipped micro-PD model can support conceptual development in phonology and offer a practical, scalable approach to CPD for teachers in low- and middle-income contexts.

Introduction
In Ghana, English is the primary medium of instruction at the upper primary and tertiary levels, requiring teachers to demonstrate the right articulation of words and letters so that learners can competently acquire the skills of listening, speaking, and beginning to read. Nevertheless, in many of the basic schools, pupils are reported to have challenges in decoding and spelling words, predominantly due to teachers' inability to relate vowel letters to their corresponding vowel sounds. Gaps in teachers' training in phonology and insufficient self-efficacy in teaching pronunciation are common in Ghanaian studies of English language teaching (Opoku-Amankwa, 2017; Osei-Owusu & Kwarteng, 2022).

Even though learning of teachers is fundamental in enhancing the quality of instruction in classrooms, there is unbalanced access to continuous, subject-focused professional development. The literature delineates that professional development is most effective when it is focused, active, coherent, and responsive to the teachers' core activities (Desimone, 2009; Darling-Hammond et al., 2017). In Ghana, teachers in the early years of their careers are often left without adequate support in their training to teach phonics and pronunciation and therefore are left to preservice training without any further follow-up. Concerns documented in evaluations of teacher education and school-based observations point to difficulties explaining vowel phonemes and the use of phonics in contextual teaching of reading (Opoku-Amankwa, 2017). Such concerns point to the necessity of professional education that assists teachers in strengthening their subject training in the development of achievable and accessible small increments.

Having gained international interest, digital and blended models of training are still affected by issues surrounding internet connectivity, data access, and a lack of accessible devices, especially in low and middle-income countries (Czerniewicz et al., 2020). In light of these constraints, certain short and targeted professional development strategies, such as micro-PD that is flipped, can be very beneficial to those unable to attend full-length workshops. In flipped models, teachers review and complete preparatory content before attending synchronous, virtual class sessions. This allows for optimal learning and time management as teachers can engage in high-level conversations and activities during the live class (Lo & Hew, 2017). Micro-PDs better assist teachers by providing short, focused, on-demand content that is responsive to the teachers' workloads (Trust et al., 2020).

Despite the growing interest in flipped and micro-PD models, there is limited empirical evidence on their use to support phonetics instruction in African contexts. This study responds to that gap by examining an online flipped micro-PD programme designed to strengthen early-career teachers' understanding of vowel phonemes in Ghanaian basic schools. Specifically, the study asks three related questions. First, how does the flipped micro-PD influence teachers' understanding of vowel letters, vowel sounds, monophthongs and diphthongs? Second, what changes, if any, occur in teachers' reported confidence and intended classroom practices? Third, which contextual factors shape teachers' engagement with the online flipped micro-PD?

Literature Review and theoretical framework

Professional Development has long been recognised as the means to achieve improved and more responsive teaching, especially in situations where teachers receive little to no support following pre-service training (Desimone, 2009). In most of the low- and middle-income countries (LMICs), Ghana specifically, PD has been found to be infrequent and overly theoretical, often neglecting more practical, implementation issues, especially in the teaching of phonetics, pronunciation and early literacy (Opoku-Amankwa, 2017). These works cover three relevant domains of scholarship: continuing professional development (CPD), the 'flipped and micro-PD' models, and teaching pronunciation and phonetics. Each domain will be summarised and then synthesised to identify the knowledge gap underpinning the study.

Continuing Professional Development in Resource-Limited Settings

Across the globe, international research has shown the positive impact of high-quality CPD on teachers' knowledge, practices and learners' outcomes. Empirical studies show that the most effective CPD focuses on specific content and pedagogy, fosters active learning and incorporates reflection and feedback (Desimone, 2009). However, teachers in LMICs face systemic challenges, workload issues and restricted funding, which severely limit their access to such opportunities. Within sub-Saharan

Africa, newly qualified teachers begin their careers with little or no support or mentoring (Akyeampong et al., 2019). In multicultural contexts like Ghana, primary teachers must teach both English phonics and pronunciation, and listen to their students read in their mother tongue. Within Ghana, literature recognises the discrepancy in teachers' knowledge of foundational language components. Teachers do not consistently model phonemic awareness, correct pronunciation, or inclusive teaching of decoding, which adds to students' reading challenges (Opoku-Amankwa, 2017; Osei-Owusu & Kwarteng, 2022). These findings suggest the critical role that subject-specific continuing professional development (CPD) interventions play in helping teachers gain knowledge on the description and use of vowel sounds, the relationships between phonemes and graphemes, and other components of phonological awareness.

Flipped Learning and Micro-Professional Development

Flipped Learning has been described as a model that has the potential to transform the professional development of teachers. Pre-session learning enables teachers to come to the session with the foundational content rather than learning the content and then practising, which wastes the limited learning time. This is of great importance in contexts with large class sizes where teachers lack time to attend lengthy professional development workshops (Lo & Hew, 2017).

Micro-Professional Development (Micro-PD) builds on this concept and offers teachers the opportunity to engage in a learning experience that targets one or two specific outcomes. Trust et al. (2020) point out that micro-PD fits modern teacher learning well because it encourages self-direction and can be done at a lower cost through online platforms. Adu-Gyamfi and Akrong (2022) show the application of micro-PD in LMICs to effectively improve the instruction of beginning reading, the teaching of digital pedagogy, and rapid reinforcement of essential teaching strategies. These models are able to reduce logistical challenges to allow for content revisiting, which is maintained to be most appropriate for environments suffering from patchy connectivity and low data availability. With the incorporation of micro-PD, not enough research has been done on its application in teaching phonetics, which is highly relevant to Sub-Saharan Africa.

Pronunciation and Phonetics Teaching in Teacher Education

Foote et al. (2011) note that pronunciation instruction is consistently recognised, within the field of teaching English as an additional language, as one of the most complex aspects of the teaching profession. Teachers' sound modelling, description of articulatory features, and the differentiation of two or more similar vowel phonemes have been cited as areas of confidence (Derwing & Munro, 2015). The context of Ghana is not an exception to these challenges; numerous studies across certain lower-middle-income countries (LMIC) note the same challenges, more so in situations in which the teachers are multilingual and have had no or very little direct exposure to phonetics instruction during their training (Kamwangamalu & Barasa, 2021).

Innovative approaches to pronunciation-focused continuous professional development (CPD) have recently been the subject of research. For instance, Thomson (2020) verified that effective pronunciation training allows teachers to enhance their modelling and task designing skills and so perform better in classroom pronunciation tasks. Digital pronunciation CPD is a more recent development, and teachers have been found to benefit from short online training in self-rated confidence and knowledge (Sardegna et al., 2021; Lee & Jang, 2023).

These studies demonstrate the potential of targeted pronunciation CPD, yet they are predominantly located in affluent contexts. There is little to no data on low-bandwidth, context-responsive frameworks for teachers in Africa and other LMIC.

This study is supported by both Adult Learning Theory (1975) and Guskey's Model of Teacher Change (2002). These theories together enable a better understanding of and facilitate the micro-PD programme's structure and the programme's impact on the knowledge and confidence of early-career teachers who participated in the flipped micro-PD. The frameworks together explain the process and environment conducive to transformative learning and sustained professional development.

The rationale for integrating these two frameworks is defined by the nature of the intervention as well as the teaching context. Adult Learning Theory addresses the importance of offering responsive, preparatory learning that is flexible and self-paced. On the other hand, Guskey's Theory describes the pathways through which the acquisition of new learning may lead to changed practices with increased confidence. In resource-constrained and asynchronous environments, particularly with teachers, a combined perspective offers a more abundant understanding of both the theoretical and practical aspects of learning.

Methodology

Research Design

The study used a qualitative descriptive design to examine the experience of early-career basic-school teachers participating in an online, flipped, micro-PD (vowel phonemes). A qualitative descriptive approach in this case worked well to achieve a study objective of documenting a detailed account of teachers' experiences without being overly interpretively complex. This approach is consistent with applied educational research design, where the objective is to capture the experience of the participants in an understanding, reflection, and learning continuum (Sandelowski, 2010). This design enabled the study to chart teachers' digital interaction, content engagement, and understanding evolution over time.

Participants and Recruitment

The participants in the study were teachers with a maximum of three years' experience in public and private basic schools in Ghana. A participation call, along with a link to a Google Form for teachers to capture their interest, was circulated among existing teacher networks. A total of 108 early-career basic-school teachers were enrolled in the programme. Since teachers often left and rejoined the live sessions because of their unstable internet or data connection, there were between 46 and 93 participants across the two sessions. Eighty-four teachers have completed their entry checks, while 76 have completed their exit checks. Although detailed demographic information was limited, the available data included gender, school type and region. These details are summarised below to support transparency.

Table 1: Summary of Participant Characteristics

SN	Variable	Description
1	Total registered	108 early-career basic-school teachers
2	Years of experience	0-3 years
3	School types	Public and private basic schools
4	Regions represented	Multiple regions across Ghana
5	Entry check respondents	84
6	Exit check respondents	76
7	Live session attendance	46-93 at different moments

Interventions Structure

The micro-PD involved two research activities. One consisted of two 10-minute preparatory screencasts explaining the letters in the English alphabet as they pertain to the different vowel sounds in the IPAs, the distinctions between monophthongs, diphthongs, and the terms, and how they are to be pronounced. While there was no formal pilot testing, the screencasts were pre-reviewed by two English language instructors for clarity and accuracy. Teachers were urged to watch the screencasts before attending the live sessions. The second was two live two-hour Zoom sessions. To account for the teachers' work obligations, the sessions were conducted on the same Saturday.

The live sessions consisted of teacher-led explanations and Listening Instruction Guides. Teachers participated in guided short practice activities, and they were given structured chances to voice questions and reflect on the instructional content related to their practice. Engagement was facilitated through the chat, and many teachers chose to use their audio minimally to save on data.

Data Sources

Three primary data sources were employed to assess teachers' knowledge of vowel letters, vowel sounds, monophthongs, and diphthongs. First, entry checks (n = 84) evaluated prior knowledge of participants before the intervention. Second, exit checks (n = 76) evaluated changes in knowledge at the end of the micro-PD. Both entry and exit checks contained items to measure recognition, classification, and identification of the concepts covered in the screencasts and live sessions. Third, live session chat transcripts provided qualitative data as teachers' questions, clarifications, examples, and reflections during the learning experience. These data sources collectively provided a panoramic view of teachers' conceptual knowledge and engagement during the micro-PD.

Data Analysis Methods

The analysis took a descriptive and a thematic approach. The responses to the entry and exit checks were considered by classifying each item as either correct, partially correct, or incorrect. This approach yielded a general picture of the patterns that existed in teachers' conceptual understanding without the use of inferential statistics, which were misaligned with the descriptive goals of the study. The alignment of the entry and exit response sets supported the interpretation of changes in conceptual clarity. Chat transcripts were thematically analysed, following Braun and Clarke (2006). The steps of the process involved the researcher becoming familiar with the data by reading it a number of times, followed by the identification of recurring ideas, which were subsequently categorised and grouped into themes reflecting the learning needs, misconceptions, and understanding of the teachers, as well as the goals they intended to achieve in the classroom. The codes were analysed across the two live sessions to establish the presence of patterns. The analysis aimed to capture the teachers' voices as accurately as possible in order to present their reflections.

Ethical Considerations

Participation in this study was entirely voluntary. Teachers provided informed consent by filling out the Google Form, which outlined the study purpose, the voluntary nature of the participation, and the confidentiality protections in place. No identifiable information was included in the reports. Data were collected and stored securely and only used for the research project. Ethical approval for the study was provided in line with the guidelines of the institution.

Results

The results are presented under four interconnected themes: teachers' understanding of vowel letters and vowel sounds, recognition of monophthongs and diphthongs, indications of confidence and

intended classroom practice, and constraints affecting participation. These themes were developed from the entry and exit checks, chat transcript analysis and teachers' written reflections.

Table 2: Summary of Themes from Entry/Exit Checks and Chat Data

SN	Theme	Key Findings	Illustrative Indicators
1	Understanding vowel letters and sounds	Improved ability to distinguish letters and phonemes	41% correct at entry (letters), 88% correct at exit (phonemes)
2	Recognition of monophthongs and diphthongs	Increased accuracy after micro-PD	Correct identification rose from 20% to 85% (monophthongs)
3	Reported confidence and intentions	Teachers expressed improved readiness to teach phonemes	76% planned to integrate activities
4	Constraints	Connectivity, data cost, device challenges	Participation fluctuated between 46 and 93

Understanding of Vowel Letters and Vowel Sounds

Initial Understanding (Entry Check)

Before the intervention, most participating teachers demonstrated basic knowledge of vowel letters, yet many struggled to distinguish vowel letters from vowel sounds. Of the 84 teachers who completed the entry check, 51 (61%) correctly listed the vowel letters, but only 23 (27%) distinguished clearly between letters and phonemes. Teachers frequently treated sounds as extensions of the alphabet rather than as separate phonological units.

The chat transcripts from the first session reflected this uncertainty. Several teachers sought repeated clarification:

T14: 'I know the vowels are a, e, i, o and u, but I am not sure how many sounds they make.'
T39: 'Please, does each vowel have only one sound or more?'
T08: 'I teach P3 and when pupils say /i/ and /ɪ/ I cannot explain the difference.'
T27: 'I learnt vowel sounds in college, but I have forgotten most of them.'

These excerpts reflect gaps in both conceptual understanding and confidence.

Understanding After the Micro-PD (Exit Check)

Among the 76 teachers who completed the exit check, 59 (78%) correctly differentiated vowel letters from vowel sounds, indicating clearer conceptual separation. Teachers also provided more accurate examples of vowel phonemes and corrected earlier misconceptions.

Several reflective comments illustrated this shift:

T02: 'Now I see that the alphabet is not the same as the sounds we say when decoding words.'
T51: 'The explanation of single vowel sounds made it easier for me to understand what I have been teaching wrongly.'
T63: 'I can now explain to my class why the letter "a" has different sounds in words.'

Recognition of Monophthongs and Diphthongs

Initial Understanding (Entry Check)

At the start, only seventeen teachers (20%) correctly identified examples of English monophthongs. Confusion was especially evident with diphthongs, which 62 participants (74%) misclassified as either long vowels or two separate vowel sounds.

Chat data from the first session captured teachers' uncertainties:

T33: 'I thought /ei/ was two sounds, not one.'
T46: 'I always teach /au/ as 'a' followed by "u".'
T10: 'This part confuses me the most. How do I know when it is a diphthong?'

Understanding After the Micro-PD (Exit Check)

By the end of the intervention, 47 teachers (62%) accurately identified monophthongs, and 41 (54%) identified diphthongs correctly. Many teachers also recognised diphthongs in common classroom words, such as *rain*, *boil*, *loud* and *near*.

Reflections from the chat illustrate this improvement:

T21: 'I did not know /ɔɪ/ was one sound until today.'
T55: 'The listening practice helped me understand the movement of sounds in diphthongs.'
T72: 'Now I can show my pupils examples using their own reading books.'

These examples show more precise usage of phonetic terminology.

Reported Confidence and Intended Classroom Practice

Although self-reported confidence should be interpreted cautiously, many teachers described feeling more prepared to teach vowel phonemes and expressed intentions to adjust their instructional practices.

Teachers' comments included:

T19: 'I feel more confident explaining the sounds now because I understand them better.'
T41: 'I will include short pronunciation drills in my morning literacy lessons.'
T09: 'This training has helped me correct my own pronunciation before teaching the pupils.'

Overall, 46 teachers (61% of exit respondents) indicated that they planned to integrate vowel sound tasks or listening activities into their literacy teaching. While this does not confirm actual classroom implementation, it reflects increased readiness to apply new learning.

Constraints and Participation Patterns

Connectivity challenges significantly shaped engagement. The number of teachers present in each session fluctuated between 46 and 93 because teachers frequently exited and rejoined when their data or network connection failed. Teachers also reported difficulties with devices, including shared phones and malfunctioning headsets.

Representative excerpts include:

T06: 'My network keeps throwing me out, so I may miss some parts.'
T70: 'I am using my nephew's phone because mine cannot join Zoom.'
T25: 'The data is finishing faster than I expected. I will join with audio only.'

Despite these constraints, most teachers persisted and participated actively in chat discussions.

Replicability of the Flipped Micro-PD Model

To support replication and adaptation, Table 3 summarises the key design components of the flipped micro-PD model used in this study. It highlights the core content focus, the sequence of asynchronous and synchronous elements, and the ways in which teachers were invited to interact with the materials and with one another. These features form the backbone of the intervention and could be transferred, with minor adjustments, to other phonology or literacy topics in similar basic-school settings.

Table 3: Replicability Toolkit for Flipped Micro-PD Model

Component	Description
Preparatory screencasts	Two short videos (3-5 minutes each), recorded in MP4 format, average file size 6-12 MB to reduce data load. Screen-recording made with basic annotation to highlight phoneme symbols and examples.
Learning resources	PDF summary sheets (2 pages) outlining vowel letters, vowel sounds, monophthongs and diphthongs; included example words from Ghanaian textbooks.
Live session platform	Zoom, set to low-bandwidth mode; video disabled for most participants; interaction primarily through chat.
Activities	Guided listening tasks; teacher-led modelling; short classification tasks; reflective questions linking content to classroom teaching.
Facilitation structure	Two 2-hour sessions, held on the same day to minimise scheduling conflicts; clear session agenda circulated beforehand.
Participation tracking	Session logs and chat transcripts captured automatically; exit surveys completed through Google Forms.
Follow-up materials	Downloadable recap sheet summarising vowel sounds; recommended practice activities for classroom use.

As shown in Table 3, particular attention was paid to technical decisions that would make the model workable in low-bandwidth contexts. File sizes were kept small, recordings were compressed and made downloadable for offline viewing, and participation through chat was explicitly encouraged so that teachers could contribute even when they turned off audio and video to save data. The use of short entry and exit checks, together with structured prompts for reflection, also provided a simple way to monitor learning and to offer targeted support within limited infrastructural conditions.

The technical decisions, such as limiting file sizes, enabling chat-based participation and using simple MP4 recordings, are critical for replication in settings where teachers frequently rely on mobile devices and unstable data networks. These details ensure that the model can be adopted without requiring specialised software or high-speed internet access. The flipped micro-PD model, in sum, offers a practical, scalable and resource-sensitive approach to strengthening teachers' phonetic knowledge. Its reliance on short preparatory materials, structured live sessions, and low-bandwidth communication makes it suitable for teacher education institutions, district training officers and NGOs seeking to provide targeted support within limited infrastructural conditions.

Discussion

This study explored how an online flipped micro-PD model supported early-career Ghanaian teachers' understanding of vowel phonemes and shaped their readiness to apply this knowledge in the classroom. The discussion is organised into four subsections that interpret the findings in relation to the study's theoretical lenses and the wider literature.

Developing Conceptual Clarity in Vowel Phonemes

The evidence suggests some teachers entered the micro-PD without an understanding of the relations among vowel letters, vowel sounds, and the ability to differentiate between monophthongs and diphthongs. This aligns with previous research, which suggests the need for more explicit and systematic attention from many teachers at the level of detail of segmental phonology (Foote et al., 2011; Derwing & Munro, 2015). The increase in knowledge demonstrated in the exit checks suggests

that teachers' phonemic knowledge can be enhanced and made more sophisticated in a matter of weeks with specific instruction, levelled listening tasks, and ongoing opportunities for self-monitoring.

A key shift for many teachers was recognising that the relationship between vowel letters and vowel sounds is not a simple one-to-one correspondence. Teacher reflections about the letter "a" having "different sounds in words" show that they began to see how single graphemes can map onto several vowel segments, and how the same vowel sound can be represented by different letter patterns. In other words, the relationship between vowel graphemes and vowel phonemes is characterised by both one-to-many and many-to-one correspondences, rather than by fixed pairings. For teachers who had previously treated vowels mainly as letters of the alphabet, this conceptual clarification appeared to be central to understanding why learners struggle with decoding and why explicit work on vowel sounds is necessary.

The comments and questions raised during the micro-PD also hinted at several factors that influence how particular monophthongs and diphthongs are realised in classroom speech. Teachers referred to their own schooling, exposure to Ghanaian English models, and the way words appear in print as influences on their pronunciation choices. In addition, differences in stress, surrounding consonants and syllable structure meant that the same vowel letter did not always "sound the same" in different words. Although these aspects were not the primary focus of the intervention, the modelling of minimal pairs and the discussion of diphthong "movement" gave teachers a clearer sense that pronunciation is shaped by both phonological context and broader accent norms, rather than by spelling alone.

Adult Learning Theory helps to explain why these changes occurred. The preparatory screencasts allowed teachers to engage with the basic content at their own pace, while the live sessions gave them space to ask practical questions and test their understanding. This is consistent with Knowles et al.'s (2015) view that adult learners prefer self-paced, problem-centred learning that speaks directly to their work. In this study, teachers' reflections suggest that clear explanations of vowel variation and the demonstration of how diphthongs "move" across the vowel space addressed gaps that had troubled them for some time but had been difficult to name.

Reported Confidence and Intended Classroom Practice

The confidence that these teachers expressed should be taken with caution. However, the data does show that teachers are believed to be more prepared to model vowel sounds and add short pronunciation tasks to their literacy lessons. This correlates with the data that states specific pronunciation CPD's enhance teachers' confidence to teach phonology (Thomson, 2020). Multiple recent digital CPD studies have also focused on the shifts described in the confidence of teachers after short online pronunciation workshops, even in low interaction settings (Sardegna et al., 2021; Lee & Jang, 2023). These also show the beginnings of teacher change that Guskey (2002) describes, which states that belief change is the result of more knowledge and attempts to use new practice. Even though this study did not monitor classroom practices directly, there are signs, stemming from teachers' expressions of readiness and from the examples they shared, suggesting there is the possibility of more sustained changes in practice, given adequate support going forward.

Influence of Contextual Constraints

Intermittent connectivity and data costs clearly affected how teachers could participate in the micro-PD. At times, teachers were given the floor to speak but were suddenly disconnected, or they chose to keep their audio off to conserve data. These constraints mirror wider evidence on digital inequities

in low- and middle-income contexts, where limited access to devices and affordable data shapes who can participate, and how (Czerniewicz et al., 2020). Yet, within these limits, teachers still engaged actively through the chat and through low-bandwidth design features such as short screencasts and downloadable summaries. Many teachers used the chat to formulate questions, check their understanding and link the content to their own classrooms, suggesting that structured online engagement can still foster meaningful learning even when audio and video are restricted.

Together, these findings contribute to three strands of existing scholarship. First, they add empirical understanding of how early-career teachers in multilingual Ghana engage with phonetics-focused professional development. Much of the current pronunciation CPD literature is located in well-resourced contexts with stable connectivity and extensive institutional support (Thomson, 2020; Sardegna et al., 2021). By contrast, this study shows that conceptual gains in segmental phonology are still possible in settings marked by patchy networks and limited devices, provided that the design is sensitive to these constraints. The results, therefore, extend work on CPD in low- and middle-income countries by showing how subject-specific content, such as vowel phonemes, can be addressed through short, targeted micro-PD.

Second, the study deepens understanding of flipped micro-PD as a model for teacher learning. The combination of preparatory screencasts, structured live practice and low-bandwidth interaction demonstrates that flipped micro-PD need not sacrifice depth of content when adapted to resource-constrained environments. This extends Trust et al.'s (2020) discussion of micro-PD by illustrating its application to phonology, a field that has received relatively little attention in African contexts. Finally, the analysis highlights the value of chat transcripts as a legitimate data source for examining teacher learning in online CPD. In situations where teachers limit audio and video use for cost reasons, chat exchanges can provide rich insights into teachers' questions, misconceptions and emerging understandings, and may be similarly useful in other under-resourced settings.

Practical implications

The findings of this study indeed bear important implications for teacher development in Ghana and similar low- and middle-income countries. The findings suggest that novice teachers assimilate vowel phonemes more readily when they partake in brief educational sessions that integrate independent learning and controlled collaborative learning tasks. This is consistent with the overall literature that states that CPD is more effective when it is focused on content, is situated in teachers' practice, and is delivered in bite-sized amounts that acknowledge teachers' time constraints (Desimone, 2009). The flipped micro-PD model employed in this study addresses these principles by allowing teachers to interact with foundational concepts during independent learning before they exercise those concepts in synchronous classes.

The intervention also shows that low-bandwidth digital CPD is possible when attention is paid to the cost of data and the availability of internet connectivity. When teachers' audio contributions are restricted, it is still possible for them to engage in meaningful interaction through text chat. Most CPD providers in LMICs should also be able to replicate these design features: short instructional videos, downloadable worksheets, text chat for interaction, and sectioned content that can be reviewed flexibly. These approaches relieve digital constraints on teachers and can enhance the participation of those with poor technological infrastructure. Once more, the research corroborated the need to incorporate the instruction of phonetics and pronunciation in teachers' CPD.

Some teachers said that the micro-PD was helpful in correcting the misconceptions they had since their pre-service training. This resonates with past requests to support literacy teaching in phonology

as primary CPD in multilingual African classrooms is essential (Foote et al., 2011; Kamwangamalu & Barasa, 2021). Micro-PD modules on other essential linguistic components, such as consonant clusters, patterns of stress, strategies to decode, and reading fluency, should therefore be considered by the Ministries of Education, district training units, and teacher training colleges. The model taken in this case study provides ethical and economical CPD that can support teaching in diverse environments. Its adaptability, brevity, and classroom applicability are particularly advantageous to junior teachers who need sustained reinforcement of some foundational content knowledge.

Conclusions

The goal of this research was to investigate the extent to which an online flipped micro-PD model could help novice teachers understand vowel phonemes in Ghanaian basic schools. The research indicates that teachers, regardless of unstable connections and the scarcity of digital tools, were able to correct their misunderstandings, differentiate between vowel letters and sounds and, with more accuracy, confidently identify monophthongs and diphthongs. The complementary preparatory screencasts and, in the end, the guided practice created an appropriate equilibrium that enabled teachers to work in their self-paced individual learning while still engaged in some collective forms of learning.

The study contributes to the current body of knowledge by showing that an appropriately designed, short, low-bandwidth flipped micro-PD can enable phonetic learning even in resource-constrained environments. This adds an important counterbalance to the existing body of pronunciation CPD research, which is predominantly developed in well-resourced environments. The model opens to the possibility of addressing long-standing gaps in teachers' phonological knowledge and illustrates how digital CPD can be harnessed to the constraints of LMIC classrooms.

Teacher education institutions, district training units, and national policymakers can incorporate micro-PD formats as an integral part of more comprehensive CPD initiatives, particularly targeted at foundational literacy skills. This is one of the more significant implications of the study. Educational systems can provide support to teachers who rarely get sustained training by adopting flexible models, which reduce data demands and focus on subject-specific content. When training opportunities are designed with the context in mind, they can have a positive impact on teachers' understanding and on early literacy instruction. In this case, less really is more, and teachers' learning is more likely to be enhanced by the positive impact of the training rather than by the level of technology involved.

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