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12. OPERATIONALISING WENGER'S COMMUNITIES OF PRACTICE THEORY FOR USE IN MULTILINGUAL MATHEMATICS TEACHER EDUCATION CONTEXTS

INTRODUCTION

In this chapter, we draw substantially on Wenger's (1998) Communities of Practice (CoP) theory to develop and then propose a methodological approach for analysing pre-service mathematics teacher education multilingual classrooms. The approach emerged in Essien's (2013) study that investigated how pre-service mathematics teachers were being prepared to teach mathematics in multilingual contexts. Like many others in mathematics education, the theoretical frame for the study drew from a disciplinary domain in the social sciences to investigate the teaching and learning of mathematics. But why Wenger, and his theory of learning through participation in a community of practice, particularly given that Wenger's CoP theory was developed from studying informal learning settings?

The theoretical journey that led us to Wenger began in a situated frame to enable us to bring to the fore the multilingual context in which pre-service mathematics teacher education in South Africa occurs, and in which prospective teachers will teach (e.g., Brill, 2001). We soon realised, however, that cognition was central to this work. Our concerns, however, were more with teaching and learning practices in teacher education, and not teacher educator thinking. Given our interest in foregrounding multilingualism, and our orientation to this as a resource and not a problem (Adler, 2001), we went on to explore the potential of sociolinguistic theory (Eggins, 2004) for this study. This more discursive approach brought with it a detailed focus on classroom discourse, backgrounding the classroom community as we came to view it. It was through this process of engagement with a range of theoretical resources with potential to illuminate language practices in mathematics teacher education in a context of multilingualism, (coupled with pilot empirical work in teacher education institutions), that we came to appreciate multilingual mathematics teacher education classrooms as complex communities. Such classrooms have diverse participants, roles and motives, and so we returned to our initial orientation to learning and teaching as situated. Hence we drew instead on Wenger and his more explicit and stronger social situative/practice theory, together with others who have argued its salience for studying teacher learning.

A. Halai & P. Clarkson (Eds.), Teaching and Learning Mathematics in Multilingual Classrooms, 173–193.

Clarke (2008, p. 30), for example, argues that since Communities of Practice (Wenger, 1998) theory is at once a theory of learning, of identity, of meaning, of community and a theory of practice, CoP "offers considerable potential for thinking about a community of students whose common enterprise is to learn the practices of teaching". It became productive to start with this view of learning teaching as a social practice, as the major structuring frame for our study of mathematics teacher education in multilingual settings, and then to seek additional resources to develop our methodology in full.

As a start, we needed to embrace Graven and Lerman's (2003) argument that in order to use Wenger's theory of learning in formal education settings, much work needs to be done to translate his theory from workplace/informal settings to learning in more formal education contexts (such as pre-service teacher education classrooms) where teachers play a central role in promoting successful learning. This "work", and the integration of additional theoretical resources with CoP theory forms the substance of this chapter. Through it, we propose a methodological approach for analysing the nature of pre-service mathematics teacher education (TE) classrooms in multilingual settings broadly based on Wenger's (1998) CoP theory, and elaborated by a set of additional and pertinent theoretical resources.

As noted above, the methodology and framework we offer in this chapter emerged in Essien's (2013) study of pre-service teacher education classrooms. The study involved four pre-service classrooms at two universities in one of South Africa's nine provinces. Two of the teachers were from University A and the other two were from University B.[1] University A is frequented by pre-service teachers (PSTs) and teacher educators (TEs) for who English, the Language of Learning and Teaching (LoLT), is an additional language. University B is frequented by PSTs of different linguistic backgrounds taught by a good number of teacher educators whose first language is the language of teaching and learning. The study focused on the nature of CoP of these different pre-service teacher education classrooms. The findings from this study indicated that within the multiple layers of teacher education, there was an overarching emphasis given to the acquisition of mathematical content. The findings also revealed that the communicative approaches and patterns of discourse used by the teacher educators opened up different possibilities as far as preparing pre-service teachers for teaching in multilingual classrooms is concerned.

As noted, our focus in this Chapter is not the study and its results, but the enabling methodology that evolved. We use selected data excerpts from the study as we describe the various aspects of the methodology.

WHY WENGER'S (1998) COP THEORY?

In developing a methodological approach for understanding the nature of the pre-service teacher education multilingual classrooms, we started with Wenger's (1998) notion of community of practice. We conceptualised the pre-service multilingual classrooms as a non-homogeneous community where different members play different roles, have varying levels of knowledge, confidence and commitment. Fundamentally, it was where every member is in a learning position as far as the dynamics of the community is concerned. We avoided explaining communities of practice using the apprenticeship model of learning in the workplace, which deals with interaction between the newcomers and the more knowledgeable other (the experts), and how newcomers create a professional identity. Wenger (1998) rather describes a community of practice as an entity bounded by three interrelated dimensions – mutual engagement, joint enterprise and a shared repertoire. For Wenger, communities of practice are, as Aguilar and Krasny (2011, p. 219) note, "a place of learning where practice is developed and pursued, meaning and enterprise are negotiated among members, and membership roles are developed through various forms of engagement and participation." For Wenger (1998), therefore, a community of practice has three interdependent components/dimensions: Joint enterprise (what it is about), mutual engagement (how it functions) and shared repertoire (what capability is produced).

Wenger (1998) argues that in a community of practice, mutual engagement, a carefully understood enterprise, and a well-honed repertoire are all investments that make sense with respect to each other. This means that the three dimensions of learning are "interdependent and interlocked into a tight system" (p. 96) (see Figure 1). For Wenger, it is essential that the three dimensions of a community of practice are present to a substantial and meaningful degree.[2]

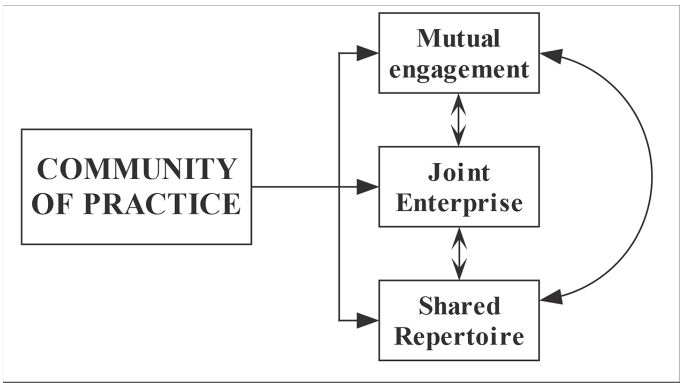


Figure 1. Dimensions of communities of practice

Practice, according to Wenger, does not exist in the abstract but resides in a community of people and the relations of mutual engagement by which they can do whatever they do. Hence, membership in a community of practice is a matter of mutual engagement (Wenger, 1998, p. 73). Mutual engagement can, thus, be defined as does Clarke (2008, p. 30) as "participation in an endeavour or practice whose meanings are negotiated among participants." A joint enterprise is the result of mutual engagement, and "refers to the focus of activity that links members of a community of practice" (Clarke, 2008, p. 31). Wenger explains that an enterprise is joint, not in the sense that everyone believes in the same thing or agrees with everything, but "in that it is communally negotiated." Wenger (1998, p. 83) defines a 'repertoire' as "a community's set of shared resources", thereby emphasising both the 'rehearsed character' and the 'availability for further engagement in practice' of a community's repertoire. Put differently, shared repertoire "refers to the common resources for creating meaning that result from engagement in joint enterprise" (Clarke, 2008, p. 31).

APPLYING AND EXTENDING WENGER'S COP THEORY TO PRE-SERVICE MULTILINGUAL TE MATHEMATICS CLASSROOMS

The process of recontextualising a 'non'-mathematics framework for analysing data in mathematics settings is not always a straightforward endeavour. So it was for us in using Wenger's (1998) Communities of Practice (CoP) theory. There were several challenges in developing a methodological approach for use in pre-service teacher education multilingual classrooms based on Wenger's theory. Firstly, Wenger is not a mathematician or a mathematics educationist and was not theorising specifically for the mathematics classroom. Wenger's theory, thus, has limitations in terms of providing tools for analysing the (nature of) mathematics pre-service teacher education communities of practice. Secondly, despite the importance accorded to shared repertoire and mutual engagement as dimensions of communities of practice, Wenger's CoP model lacks a coherent theory of language-in-use. Despite the emphasis on a jointly negotiated enterprise and on the negotiation of meaning, little insight is given into how meanings are made and interpreted (Creese, 2005). In the proposed methodological framework, this gap was addressed by using Mortimer and Scott's (2003) theoretical constructs of meaning making as a dialogic process (DP). For Mortimer and Scott (2003, emphasis in original), "meaning making can be seen to be a fundamental *dialogic* process, where different ideas are brought together and worked upon." They argue that the dialogic process makes a "shift in focus away from studies of students' alternative conceptions, and towards the ways meanings are developed through language in the … classroom" (p. 4). We contend that Mortimer and Scott's dialogic process is compatible with CoP theory by Wenger for two reasons: Firstly, just like CoP theory, DP acknowledges the centrality of purposeful discourse[3] between the teacher and the students in the classroom or learning environment as Mortimer and Scott (2003, p. 3, emphasis in original) argue that "talk is central to *meaning making* process and thus central to *learning*". Secondly (and related to the first), both theories are rooted in the premise that learning takes place in social situations where there is social exchange among members of a particular social configuration.

In general then, the challenge for us as researchers using Wenger's notion of CoP was to draw on CoP theory as a theoretical framework, and then using the teacher education community of practice classrooms that provided the empirical field for our study, to develop a methodological approach that would be relevant to (and provide tools for the analysis of) pre-service mathematics teacher education classroom contexts. In doing this, to deal with mathematical aspects of practices in the shared repertoire dimension of CoP, the works by several authors (McClain & Cobb, 2001; Sullivan, Zevenbergen, & Mousley, 2005; Tatsis & Koleza, 2008; Voigt, 1995; Yackel, 2000; Yackel & Cobb, 1996) were drawn upon. In drawing on these theoretical sources, we adapted and modified ideas to suit our purposes based on the data collected in pre-service teacher education classroom communities of practice. Limitations to Wenger's CoP were dealt with by introducing the work of Mortimer and Scott (Mortimer & Scott, 2003) into the mutual engagement process of CoP because of the ability of Mortimer and Scott's (2003) Dialogic Processes framework in charactering different kinds of discursive classroom interactions. In all of these, the three dimensions of communities of practice (as shown in Figure 1) and their associated processes as proposed by Wenger provided the backbone for the development of our methodological approach. Each dimension of CoP was subdivided into categories. The categories were then subdivided into sub-categories/ guiding questions with descriptors. While the dimensions and categories were developed *a priori* by using Wenger's CoP theory and other literature, much of the sub-categories and their descriptors were developed *a posteriori* from working with data obtained from the multilingual teacher education classrooms involved in Essien's (2013) study of pre-service teacher education classrooms.[4] In what follows, we elaborate on the characterisation of each of the dimensions of CoP.

CHARACTERISING THE SHARED REPERTOIRE

In characterising the shared repertoire of the different communities of practice in the study in which the present framework was developed, particular concepts/constructs within Wenger's notion of shared repertoire alongside categories emerging from data from pre-service teacher education classrooms were used. In so doing, three categories of analysis and their associated questions in each of the categories were identified: mathematical practices, norms of practice, and pool of shared language and shared representations that reflect and shape a joint understanding of the community's joint enterprise (see Figure 2). We also drew on the work that has been done in these three areas to characterise the shared repertoire of the different communities of practice. It is our contention that these three categories are representative of the common or shared resources (of a community such as the ones in our study) for the negotiation of meaning.

MATHEMATICAL PRACTICES

Our use of the term "mathematical practice" resonates with the way it is used by Godino, Batanero and Font (2007, p. 3) to refer to "any action or manifestation (linguistic or otherwise) carried out by somebody to solve mathematical problems, to communicate the solution to other people, so as to validate and generalize that solution to other contexts and problems." Given this definition of mathematical practices, practices for us is defined as taken-as-shared ways of doing and communicating mathematics which can be idiosyncratic of a person or shared within an institution (persons in the same problem situation). This definition of (mathematical) practices is consistent with Wenger's conception of practice and shared repertoire in that it acknowledges the fact that practices are shared (jointly owned by a community) and are common resources for the negotiation of meaning within communities.

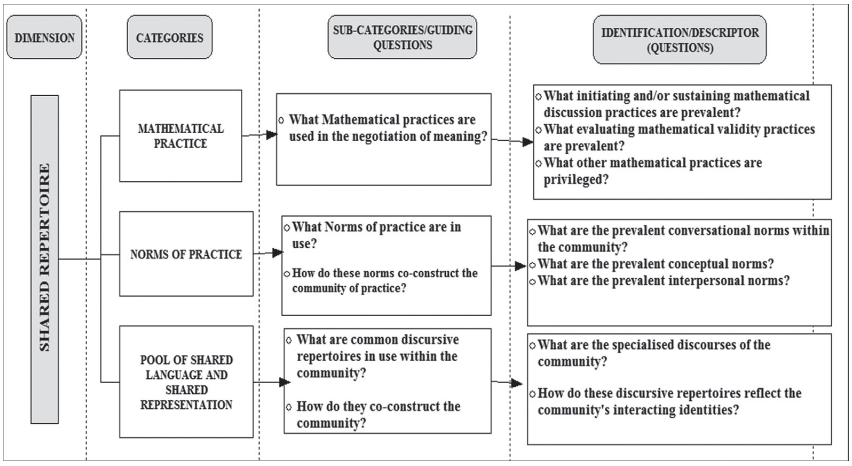
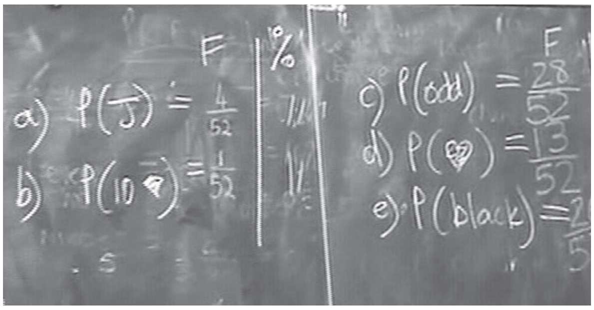


Figure 2. Categories for analysis of share repertoire and associated questions

In line with the above definition of mathematical practices, within the shared repertoire of the communities and under the category of 'mathematical practice', the analytical task as far as this category is concerned is to expound on the different practices that are in use in the negotiation of meaning in each community; and how these practices were made visible (or not) in the mathematics multilingual communities of pre-service teacher education classrooms. We use the excerpt below as a key record of classroom observation in which to illustrate some of the empirical features of the framework. In the excerpt below, the teacher educator called on a pre-service teacher to explain the reasoning in the solutions, which were proffered by other pre-service teachers (PSTs), after these PSTs had solved the questions on the board. The class was working on finding the probability of picking a jack, a diamond, and a club in a pack of 52 cards. The shared conversation developed as follows:

1	TE	Right. Right. Ready. [looks at her watch] I'm sorry I'm pushing you. Shh. There is one more little thing I want to do, …um…, but Simon has offered to just volunteer. Now what's going to happen is he's going to go through the thinking – how these people were thinking, see if he agrees with the way they were thinking about the desired outcomes and about the, all the possibilities, OK. And then he's going to look at the fraction, he's going to look, imagine he's a teacher now that's marking this work. So what he wants to do is look at what's going on in the thinking behind these answers, OK. If … let Simon, let him go through all of these 5 first. If there's anything you disagree with we will go back to it. OK? Because one thing you must be clear on, I don't care what phase you are, if ever you are teaching Maths or you're doing a little private lesson at home, or you're helping your little sister, it makes no difference, you've always got to think how they're thinking before you can say 'You are wrong', 'You are right'. And even if they're wrong you want to see what they're thinking about. OK. But let him go through, um, starting with number 1. And I'm going to step aside for a minute and I want you to imagine that you are now looking at their thinking and… carry on. [The solution provided on the board were:]



2	PST1	Ja, so for the first one here the thinking is…
3	TE	Well first of all go to the bracket, see what we want.
4	PST1	OK, [points to (a)] so in the bracket we have a Jack, so since we know that we have 52 cards all in all, so the Jacks that we have, we have 4 Jacks. So here this fraction tells us that we have 4 Js (Jacks) out of 52 cards. Right?
5	PSTs	[Some students] Mmm
6	PST1	OK, let's go to the second one [points to (b)] Since… Since each card is having a dice, a heart, a spade and a…
15	PST1	Clubs. So how many 10s? The 10s which… OK, how many 10s? We have which…[laughs] Class: [laughs]
16	TE	Simon, you're not teaching us. Just look at what's written there and how the person is thinking. Look at the answers.

17	PST1	OK. The person here was thinking that we have one Diamond 10, which is right because you have 4 10s – 1 is this, this, this and this. [points to ♠ ♣ ♦ ♥ which were drawn on one side of the board] So here the fraction is 1 over 52, and that is right.
18	PSTs	Yes
19	PST1	Let me go to the 3rd one after the 4th and the 5th.

A number of practices emerged. In the excerpt above, it can be argued that explanatory practices in the classroom community were intricately linked with providing justification and critiquing solution practices. Critiquing the solution was undertaken by both the teacher educator and the pre-service teacher. One of the ways in which the teacher educator encouraged the PSTs to critique solutions was to ask them to explain the thinking behind the solutions to classroom activities that have been produced by their fellow pre-service teachers as evident in turns 1 and 16.

In categorising the different practices that emerged, three major headings based on the nature of the practices and the purposes of the practices were used: 1) initiating and/or sustaining mathematical discussion practices; 2) evaluating mathematical validity practices; 3) General classroom practices. The first heading groups practices that enable what some authors have referred to as productive mathematical discussions in the class (e.g., Stein, Engle, Smith, & Hughes, 2008), and others as productive disciplinary engagement (e.g., Engle & Conant, 2002). The second heading clusters authorising practices, which deal with judgments about what is mathematically legitimate or not. Finally practices that neither belonged to the initiating mathematical discussion practices nor the evaluating mathematical validity practices were put into the third group. In coding the transcripts, where there were questions followed by an answer, the coding referred to both the question and the answer(s), provided that the answer(s) was/were direct response(s) to the question asked. For example, the question: "what do you mean by…" was coded as a call for an explanation (MP-EM). The response provided to this question formed part of the original MP-EM code. So, the question and the answer constituted one code rather than two codes of MP-EM each. Also, where a particular utterance which has already been coded (as writing mathematically (MP-WM) for example) was repeated[5] on the same task or sub-task, the utterance was not recoded as writing mathematically but as reiterating. But where there was a different emphasis on the same issue (for example, to a particular member of the community/group), then it was given the same code (in this case, MP-WM). In Appendix A, we present a selection of the practices that emerged from our study, the coding scheme and the code identification rule(s) (descriptors). The mathematical practices and descriptors presented in Appendix A are by no means exhaustive. They are intended to give indications as to how anyone who intends to use this methodological approach can categorise the emerging mathematical practices in his/her research study (See Essien, 2013 for full details). We now turn to the norms of practice category.

Norms of Practice

While mathematics practices deal with what discursive/pedagogic practices are made available in the community of practice and how this impacts on the community, the norms of practice are concerned with the rules of engagement that contribute to the stability of the mathematics discourse and the community of practice. Put differently, mathematical practices, it can be argued, are concerned with the dynamics of the learning process while the norms of interaction are concerned with the dynamics of the interaction process. Norms are regularities that guide social interactions. They are expectations/obligations (implicit or explicit) that community members have of one another (Yackel, Cobb, & Wood, 1991). Yackel et al. (1991) went on to argue that it is through the interlocking obligations in the mutual construction of classroom norms that make it possible for participants to act appropriately in specific situations giving rise to observable interaction patterns. Drawing from different works on norms in mathematics classrooms, two constructs pertaining to norms of practice in mathematical classrooms became pertinent for the present methodological framework: social norms, and sociomathematical norms (McClain & Cobb, 2001; Voigt, 1995; Yackel & Cobb, 1996). Each of these two norms were further sub-categorised into three norms:

- Conversational norms: Norms that guide interaction in the class and do not relate directly to the content of the mathematics at stake. Example: taking turns to speak norm; speak-out norm;
- Conceptual norms: Relates directly to the mathematical object under discussion: Example: Justification norm; mathematics justification norm; consensus norm; non-ambiguity norm;
- Interpersonal norms: This is related to conversational norms, but in this particular case, these are norms that guide the interpersonal relations in the class. Example: the avoidance of threat norm; one is expected not to ridicule the answer of another community member.

Appendix B provides a list of norms and their descriptors of what emerged. What was important in developing conjectures about the emergent norms of practice in the mathematics community was to look for instances, regularities and patterns in the way the pre-service teacher education classroom communities acted and interacted as they engaged with classroom mathematical activities. For example, prompts for rephrasing/reiteration would indicate the non-ambiguity norm, and words such as 'why' expressed through questions or the use of 'because' would indicate a justification norm.

For a norm to be considered to have occurred there needed to be some recurrence. Only one instance of, for example prompts for rephrasing, was not sufficient.

"Regularities" used in the definition of norms implies that there is some form of consistent reoccurrence of a particular 'instance of a norm'.

It is not the aim of this framework to delve into how norms are communally constituted. The main aim in delineating the norms of practice in this methodological approach is to make sense of how certain characteristics of the teacher education classroom CoPs and regularities in classroom activities are influenced by the social context of the community and how, in turn, they influence the dynamics of teaching and learning in multilingual pre-service teacher education classrooms.

Pool of Shared Language

The third category in shared repertoire is the pool of shared language and shared representation. A community's shared repertoire sometimes derives from the common knowledge base which is reminiscent of the common purpose of the existence of such a community and which are more often than not, unfamiliar to those outside of the community. The specialised discourse used in a community may indicate some form of reification or different mathematical practices. In analysing the pool of shared language and shared representations, the main questions that we bore in mind were: What are the common discursive repertoires or specialised discourses used in the community of practice? How do these common discursive repertoires co-construct the community and reflect the different mathematical practices of the community?

ANALYSING THE MUTUAL ENGAGEMENT OF COP

In analysing the mutual engagement dimension of the CoP, two categories were developed for use: pattern of discourse, and building of identities (see Figure 3).

Pattern of Discourse

As indicated earlier, the work of Mortimer and Scott (Mortimer & Scott, 2003; Scott, Mortimer, & Aguiar, 2006) was instrumental in developing the framework for analysing engagement in the community in general and of the pattern of discourse category in particular. Esmonde (2009) argues that in analysing mathematics classroom interactions, it is essential to focus not only on the content of mathematical talk, but also on the interactional context in which talk occurs. To this two, we would add that the nature of talk itself (that is, whether it is procedural, dialogic, authoritarian, etc.) is also crucial. To this end, while Wenger's theory provided the backbone for developing the mutual engagement dimension, the three aspects of classroom mathematics interaction provided the guiding principle. Hence, in the framework, while the content of talk is dealt with by asking the question *who makes substantive contribution*, the interactional context in which talk occurs is taken care of by analysing how participation is organised. Finally, the nature of talk was analysed through the communicative approach and patterns of discourse aspect of the framework.

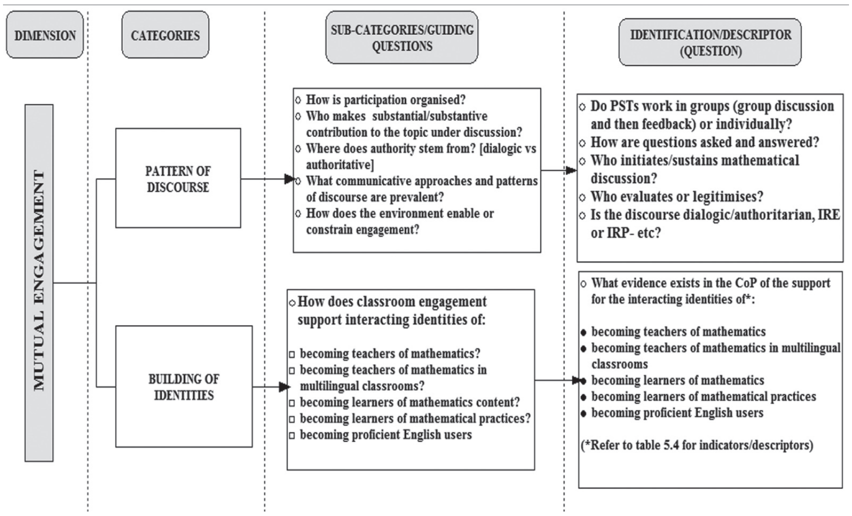


Figure 3: Categories of analysis for mutual engagement and associated questions

The term "pattern" in pattern of discourse is used in the broader sense that comprises how participation is organised, who makes substantive contributions, where authority stems from and what communicative approach is prevalent. By substantive contribution, we refer to subject-matter content talk/discourse that contributes to mathematical advancement in terms of knowledge and understanding of the mathematical content at hand, or in the teaching and learning of such content.

Building of Identities

Wenger (1998) notes that identity is in part a trajectory of where members of a community (as a collective and as individuals) have been, where they currently are, and where they are going. Examining this three-tiered trajectory of identity would entail following pre-service teachers as students, as student teachers and then as novice teachers. The methodological approach proposed in this chapter does not focus directly on this three-tiered trajectory since empirical data that informed its development was only collected during the time interval in which mathematics topics/concepts were addressed in class. The framework only focuses on the second part of Wenger's identity trajectory – where members are currently, while bearing in mind where they are going. As Hodges and Cady (2012) note, for Wenger, identity is in part how individuals come "to participate within a community in conjunction with how … individual[s] talk[ ] about and make[ ] sense of that participation." This means that access to where member are currently is possible through the observation of classroom practices in communities of practice. To this effect, under the mutual engagement dimension of CoP, the methodological approach made provision for the analysis of evidence present in the different CoPs in support of the interacting identities of: becoming a teacher of mathematics, becoming teachers of mathematics in multilingual classrooms, becoming learners of mathematics, becoming learners of mathematical practices and becoming proficient English users for the purpose of teaching/learning mathematics (see Essien, 2014 for full descriptors).

Examining the Joint Enterprise

The development of the joint enterprise dimension of CoP was informed by those dimensions of the community of practice that support the appropriation of mathematical knowledge and the associated processes of understanding and tuning the enterprise (Wenger, 1998). There is an overarching broad joint enterprise that brought members together in the first place. The way in which the pre-service teachers and the teacher educator (in the individual communities of practice) negotiated different aspects of the joint enterprise of teaching and learning to teach mathematics, and, therefore, how they tune this initial enterprise was analysed through: 1) the external conditions that constrain and/or enable a particular joint enterprise and how the community adapts or responds to these conditions; 2) how practices in use reflect what is valued by the community and can be perceived as the joint enterprise; 3) how responsibility is defined in the communities of practice. Figure 4 shows the categories and descriptors used in the analysis of the joint enterprise.

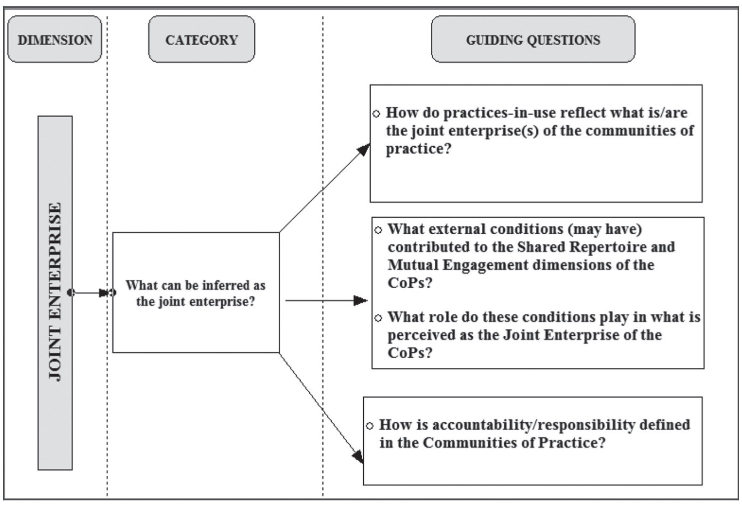


Figure 4. Categories of analysis for joint enterprise and associated questions

For Wenger (1998), mutual engagement is fundamentally defining of CoPs and such mutual engagement is directed towards a negotiated joint enterprise. In addition to this, the shared repertoire of a community as described by Wenger, "can be seen as the tangible expression of mutual engagement and the key means of carrying forth a joint enterprise" (Levinson & Brantmeier, 2006, p. 331). Hence, both mutual engagement and the shared repertoire dimensions serve as a window through which one gains entry into the communities' joint enterprise(s). Since the joint enterprise is anchored in mutual engagement and shared repertoire, what can be captured as a community's negotiated response to their specific conditions is captured through an encompassing gaze on the guiding questions related to mutual engagement and shared repertoire, and how together, all the categories and their descriptors provide a window with which to unlock the joint enterprise in mathematics pre-service teacher education multilingual classrooms. In analysing the joint enterprise of each of the pre-service teacher education community in our study, thus, the joint enterprise was taken as an outcome of the analysis of mutual engagement in the community's set of shared resources (shared repertoire) used in the negotiation of meaning.

In relation to the excerpt above, a number of features of this classroom are visible: first, in terms of the patterns of discourse, the class interaction was structured such that both pre-service teachers and teacher educators are able to explain. In turn 1, the pre-service teacher (PST1) was expected to gain an entry into how other PSTs reasoned when they solved the probability problem on the board. Hence substantive contributions were made by both the teacher educator and the pre-service teachers in this classroom. This was possible in this classroom community because of the interactive/authoritative communicative approach of the teacher educator. That said, it can be argued that the teacher educator positioned the PSTs as both becoming learners of mathematics content and becoming teachers of mathematics. This latter positioning comes out forcefully in turns 1 and 16 in excerpt 1 above where the TE exhorts the pre-service teachers and PST1 in particular to act like a teacher. The excerpt, thus, gives an indication that for this classroom community, not only was the acquisition of mathematical knowledge an important enterprise, but also, the development of the identity of the pre-service teachers as future teachers of mathematics was a valued enterprise.

POSSIBILITIES AND LIMITS IN THE ELABORATED FRAMEWORK

In using the methodological approach described above to analyse our data, an issue that arose was the fact that the shared repertoire dimension of CoP and the mutual engagement dimension were difficult to analyse separately. For example, in working with the methodological approach, we came to realise that we could not analyse the data beyond mere description of the practices (and norms) present in the class if we analysed the shared repertoire dimension as an independent entity. For a deeper analysis, we needed to combine the analysis of the different categories within shared repertoire and mutual engagement at the micro level, and between shared repertoire and mutual engagement at a macro level. For example, it was not in the naming of the different practices present in the CoPs that we saw differences between the TE classroom communities, but in examining how these practices shape and are shaped by the norms of practice and the mutual engagement dimension of CoP. In one community, for example, explaining mathematically as a practice dealt more with explaining a procedure while in another community, it was more on clarifying a concept. In both cases, the discourse around the concept shaped the nature of the content and provided an indication as to what the pre-service teachers were enculturated into and how their identities were shaped. Thus, shared repertoire and mutual engagement dimensions analysed together provided a richer description of the classroom communities involved in our study, and ipso facto, enabled us to make inferences as to what the joint enterprise(s) of these communities is/are. Of particular significance, our framework foregrounded the heavy reliance of the negotiation of the joint enterprise on the dialogic processes (communicative approach and patterns of discourse used by the teacher educator) that are privileged in the community, thus confirming the importance of strong analytic tools for discourse patterns.

Our analysis of the shared repertoire and the mutual engagement dimensions of CoP enabled us to gain entry into/deduce what is/are the joint enterprise(s) in particular teacher education classroom communities that has/have been jointly negotiated (or which can be considered as their negotiated response to their specific conditions), and by so doing, the implications thereof for pre-service mathematics teacher education especially in multilingual settings. We share this methodological framework in the hope that other researchers are able to use the framework in similarly productive ways.

But even though the methodological approach is useful in thinking about teacher education communities of practice in terms of mutual engagement, shared repertoire and joint enterprise, the approach however, presents a number of limitations. First, it does not capture the effect of boundary practices (Wenger, 1998) of other communities of practice that the pre-service teachers and the teacher educators belong to and how they (boundary practices) impact on the classroom CoPs. Clarke (2008, p. 94) argues rightly that "in conceptualizing the student teachers' community of practice within the wider set of communities of practice that comprise the enterprise of education, the issue of boundaries [in which the students learn to teach through participation in the university and the school communities] must inevitably arise". With regards to this point, one general limitation of this study is that the researchers did not follow the pre-service teachers (PSTs) to their practical teaching and so, cannot analyse PSTs' boundary-crossing practices. Moreover, the methodological approach was not developed to capture and explore the extent of PSTs' enculturation into the practices that are privileged in the CoP or the extent to which the PSTs have formed each of the interacting identities.

Suffice it to say in conclusion that research conducted in mathematics multilingual classrooms has always been accused of: 1) being skewed towards analysis of language use and language practices, and 2) of being devoid of the content itself which engenders the talk. Through analysis of mathematical practices in use and substantive contributions that are made in the class, attention is paid to the mathematical object of the classroom discourse; through the joint enterprise which provides for engagement with external condition that influence the interactional context; and in making provision for engaging with classroom discourse, the framework attends to the issue of discourse in the multilingual contexts. It is thus our contention that the proposed framework provides an approach that examines the mathematics content, the interactional context and the discourses in multilingual pre-service teacher education multilingual classrooms in an integrated manner.

NOTES

1 For ethical reasons, we do not expound on the empirical context of these two universities beyond their linguistic demographics.

2 Elsewhere (see Essien, forthcoming), Essien has engaged with the issue as to whether or not the appellation of Communities of Practice can be used to describe pre-service teacher education classroom social configuration.

3 Taken in our study as language and other forms of communication that are in use within a community and define members of such a community (Monaghan, 2009).

4 Due to space limitations, only the abridged version of the framework is presented in this Chapter. A complete argument of the theory and more details of data collection and analyses can be found in Essien (2013)

5 For example if the teacher educator repeatedly shows the PSTs the correct way to write/represent a mathematical concept.

6 There is obviously a blurred boundary between conceptual norm and mathematical practices because they are both mathematical in a sense. But if the consensus norm, non-ambiguity norm, justification norm, etc are more normative (that is, taken as regularities that guided the classroom discourse), they can be talked about as norms

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APPENDIX A

Mathematical practices in use and descriptors

Category: Mathematical practices	*Mathematical practices-in-use (sub-category)*	*Code*	*Code identification rule(s)*
Initiating and/or sustaining mathematical discussion practices	Explaining mathematically	MP-EM	When 'what' is used in a question by a community member. Or when the intonation used by the TE or any community member indicates a call for further explanation. Also, the use of the phrase/sentence: • 'anything else', e.g., anything else you want to add to that? • 'no? why not?' • 'this is what I mean…' • 'what does it mean?' • 'Do you understand what you have to do?' COMMENTS: MP-EM could also be a call for someone to shed more light on what has been said. Eg, 'what do you mean by …' MP-EM need not necessarily start in the form of a question. It could also be the explanation of a particular concept or an explanation of another PST's reasoning or solution to a mathematics problem.
	Defining Mathematically	MP-DM	When there is a formal or informal definition of a mathematical concept by either the teacher or the PSTs

(*Continued*)

Category: Mathematical practices	*Mathematical practices-in-use (sub-category)*	*Code*	*Code identification rule(s)*
	Exemplifying (Providing examples)	MP-PE	When the PST/TE provides an example to demonstrate a mathematics method (e.g., example of an application of a mathematics procedure) and in concept development to indicate a mathematics relations (e.g., examples of a concept like triangle, etc) (Bills et al., 2006). It could also be when a community member demonstrates how something is done in mathematics, e.g., how to draw a frequency table Close to MP-EM. An explanation can be made through the provision of an example. Use of words like: "like…", "example". It can also be a call by a community member for someone to give examples.
Evaluating mathematical validity practices	Providing Justification	MP-PJ	Close to MP-EM and MP-PE. The "how" question indicates MP-EM while the "why" question would indicate MP-PJ. Instances where a PST/TE is asked to explain the procedures or steps leading to the solution of a maths problem would indicate MP-EM while a call to justify the procedure would be MP-PJ. For example: "who can tell me why the positive sign becomes negative when taken to the other side of the equation?" would be providing justification. The sentence: 'what is your evidence', could indicate either MP-EM or MP-PE or MP-PJ depending on the context of use.

Category: Mathematical practices	*Mathematical practices-in-use (sub-category)*	*Code*	*Code identification rule(s)*
	Critiquing solution	MP-CS	Involves critiquing the solution of a problem proffered by a community member. Different from MP-PJ and MP-CC. Here, a community member critiques his/her or other peoples' solution to a mathematical problem. In MP-CC, postulates are critiqued while MP-PJ involves justification for a conjecture or for the solution to any of the processes involved in the solution of a question. It can also be a call by any community member for other members to critically consider his/her solution to a mathematical problem or the processes involved in finding such solution. E.g., "what did you do wrong", "think carefully why you would make that decision"
Other mathematical practices	Proceduralising	MP-Pc	When the TE or the PST deals with the procedure/steps for solving a particular problem. For instance, if the TE or PST talks about taking a variable to the other side of the equal sign and changing the sign, that would be categorised as MP-Pc. But if a member of the community states why this procedure works, then it was categorised MP-PJ. Could also be a call for a particular procedure or aspects of the procedure to be used in solving a mathematical task: example: "Where do we start?" (which calls for the first thing that needs to be done by way of procedures) "What do we do next?"

APPENDIX B

Norms of practice and descriptors

Category: Norms of practices	*NP in use (sub-category)*	*Code*	*Code identification rule(s)*
Conversational Norms	Participation by all norm	[NP-PA]	The expectation that all member of the community participate in the classroom activity. This is evident, when for example • the teacher calls to find out if some less active students are following the lesson • the TE calls out specifically for members who have not given input in the discussion
	Speak-Out norm	[NP-SO]	The expectation that members of the community should speak loud enough for everyone to hear. Phrases like 'louder', 'speak up', etc. would indicate the speak-out norm.
Conceptual Norms[6]	Mathematically Sensible norm	[NP-MS]	The expectation that a community members solution or solution strategy makes sense to others or that a community member's explanation of a maths concept makes sense to others. Words like, 'does that make sense to you', anyone wants to challenge that' and 'do you agree' may depict such expectation
	Consensus norm	[NP-CS]	Group members are expected to reach an agreement on the solution to a maths question or explanation of a maths concept.
	Non-ambiguity norm	[NP-NA]	Expectation that mathematical expressions are clear and unambiguous, expressed through prompts for rephrasing. Example: T: What is the formula we use to calculate the distance between 2 points? S: we use the same formula [laughter] T: what is that the same formula? What is that the same formula? Yes sir.

Category: Norms of practices	*NP in use (sub-category)*	*Code*	*Code identification rule(s)*
	Justification Norm	[NP-JN]	The expectation that a community member has to justify her/his opinion(s). Expressed through words such as "because", "that is why", "would you explain why…?"
Interpersonal Norms	No Ridicule norm	[NP-NR]	The expectation that no member of the community may be derided if he/she makes a mathematically or grammatically incorrect statement.
	Collaboration norm	[NP-CB]	Relates to group work. The expectation that all members of the group must work together to solve a mathematical problem