Theorizing Participation, Engagement and Community for Primary and Secondary Mathematics Classrooms

Bronwyn Ewing

Faculty of Education, Queensland University of Technology, Queensland, Australia
Email: Bf.ewing@qut.edu.au

Abstract

Student engagement and participation in mathematics learning is increasingly mentioned in Australian policy and curriculum documents that focus on ways to improve student achievement. However, such ways are not always made clear, nor is what constitutes participation, engagement and community in primary and secondary mathematics classrooms. These elements are theorised and discussed to identify their meaning and their influences on teacher and student engagement in mathematics learning.

Keywords

Mathematics Education, Student Participation, Student Engagement and Communities of Learning

1. Introduction

Schools and teachers play a critical role in providing a climate of learning and effective practices that encourage engagement and active student participation. The Australian Association for Mathematics Teachers (2016) and the Australian Institute for Teaching and School Leadership (2013) highlighted the need for communities to engage with schooling so as to provide a high quality education for students. Such engagement is central to Australia's future prosperity and social cohesion (Council of Australian Governments, 2009) and is reinforced by the early work of Lave and Wenger (1991) who argued that learning is a social activity that occurs in social communities (here, classrooms) whose members are active and engaged participants in its tasks and practices. In such contexts, learning (of some form or another) occurs as community members engage and interact together and in the tasks and practices they are expected to perform. In

the case of mathematics education, reforms in schools have included such strategies as schools engage and participate with the wider community to support the students they teach (Council of Australian Governments, 2009). This paper explores elements of Lave and Wenger's (1991) work to provide a lens through which powerful insights into the forms of student engagement, interaction and participation in mathematics classrooms can be gained.
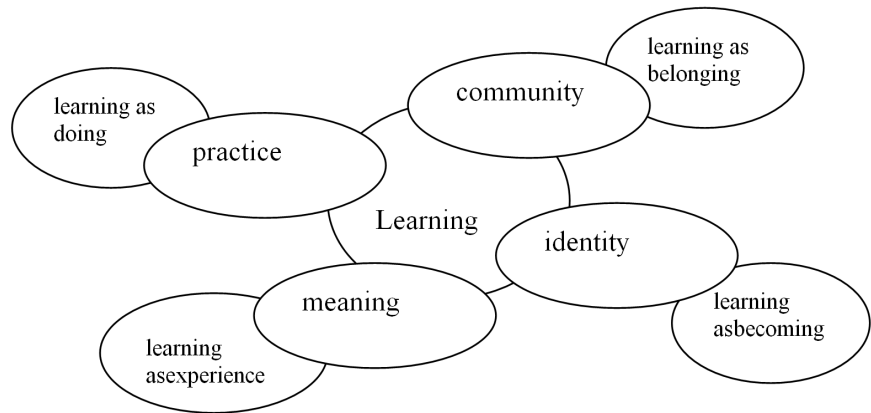
2. Learning as a Social Process

That learning is or can be a social process is acknowledged in such frameworks as Vygotskian socio-cultural theory (1930, 1934), social constructivism (Cobb & Yackel, 1998) the social construction of reality (Berger & Luckmann, 1966), Bandura's (1962) work on social learning theory and critical discourse theory (Chouliaraki & Fairclough, 1999; Fairclough, 1995, 2001). However, for this paper, where the aim is to develop a richer understanding of the complexity of forms of participation in mathematics classrooms and the discursive mechanisms that influence participation, a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) is fore grounded because of the centrality it places upon the experiences of social processes of participation for learning and knowing.

There are four components (see Figure 1) that are intrinsic to this process: meaning, practice, community and identity. The following definitions, which are applied in the discussion that follows, are appropriate to a social theory of learning:

1) *Meaning*: a way of talking about our (changing) ability—individually and collectively—to experience our life and the world as meaningful.

2) *Practice*: a way of talking about the shared historical and social resources, frameworks, and perspectives that can sustain mutual engagement in action.

3) *Community*: a way of talking about the social configurations in which our enterprises are defined as worth pursuing and our participation is recognisable as competence.

4) *Identity*: a way of talking about how learning changes who we are and creates personal histories of becoming in the context of our communities (Wenger, 1998: 5).

As Figure 1 indicates, these components need to be understood relationally and in terms of their contributions to the social process of learning. Practice involves learning through action in the social setting of the community. Identity is a process of learning through becoming a member of the community. Meaning is learned through experience in and with community. Community in turn involves learning to become a member, to assume an identity as a member, and to make meaning of that experience. Each presumes and requires the other, and learning is central to each. These processes of the social bring learners together so that they can identify themselves as mathematics learners. The construction of an identity in this sense becomes a social process that is influenced by the interactions of the classroom and what is valued and considered appropriate in it. In short, a social theory of learning provides the foundations for a richer under-

From "Communities of Practice: Learning, Meaning, and Identity" by E. Wenger, 1998, p. 5, Cambridge: Cambridge University Press.

Figure 1. Components of a social theory of learning.

standing of the social processes of mathematics classrooms, where learners are situated in ways that shape their identities, that is, who they are, what they do, and how they interpret what they do (Wenger, 1998). These four components of a social theory of learning are addressed in more detail in the sections that follow.

However, in contexts such as classrooms, not all identities have equal status; some have more recognition and value than others. While Lave and Wenger (1991) explicitly denied that learning communities were necessarily egalitarian, they did not elaborate further on this point. This study attends to this issue more expansively by focussing on the relations of power and issues of struggle and conflict in such communities, and the forms of identities constructed in that process.

2.1. Meaning: Learning as Experience

Learning is not a process conducted in isolation, it is related to a person's practices in a social context, their ability to negotiate meaning in that setting and to formulate an identity in the process (Wenger, 1998). Learning becomes a social matter in which experience and its social interpretation inform each other. Through this process negotiation of meaning becomes a necessary condition for mathematics learning (Voigt, 1994). When students' interpretations differ from the teacher's, negotiating meaning is crucial. As students negotiate and communicate in that context and articulate their thinking socially, their developing conceptual understandings are increasingly reified, that is, they take a reality of their own because they are made more explicit within the social context. Through this ongoing interplay of social participation and reification learners give shape to their experiences and meaning for their learning (P. Eckert, 2000; Goos, 2004).

Learners' ideas are given form through social interaction. It takes participation in a social learning context, the negotiation of meaning, knowing what to do and how to perform a task, for these ideas to become transparent. Coming to

know and understand is an effect of interaction between a speaker and a listener (Clark & Holquist, 1984) or, in this study, a learner and a teacher (Brown & Renshaw, 2004). Through such interactions students are assisted by their teachers to make sense of the mathematics that is presented. Thus, for teachers to understand a learner's ideas, they need to orient themselves with respect to those ideas and the context within which they arise.

In this dialogic framing, interaction, meaning and understanding are intrinsically relational (Clark & Holquist, 1984). These experiences and the knowledge formulated from them serve as a basis for further construction and negotiation of meaning, here, mathematical meaning. They provide a purpose for a learning community, allowing learners to participate in the activities of that community. In short, for this study, learning becomes a process of social participation, social interaction and membership in a social group or community, here the mathematics classroom.

2.2. Identities: Learning as Becoming

In this paper, identity is defined as who and what people think they are in particular social contexts or communities, what they do in consequence, and how they interpret what they do (Wenger, 1998). Identities are learned and acquired in and for social contexts; that is, they are social constructions (Pierce, 1995; Pietikäinen & Dufva, 2006). Since such social contexts are multiple and varied (family, school, work, play and so on), people develop a repertoire of identities appropriate for the variety of social contexts in which they operate (cf. Gee, 1996; Goffman, 1972; Hogg, Martin, & Weeden, 2004). The relevance of any particular identity is thus in some degree a function of the social context in which a person finds themselves (McNamara, 1997; Pietikäinen & Dufva, 2006). None of this is to simplistically infer that identities exist in a one-for-one correspondence to particular social contexts. They do not. Indeed, as Gee (1996) suggests, social actors have multiple and conflicting identities. The boy who is a local legend with his mates does not necessarily leave that identity at the classroom door, nor does the teacher who has won a medal at the Games. Developing more positive identities as successful learners of mathematics is not as simple as discarding the school uniform, along with that the various identities they bring from past contexts and experiences.

The construction of an identity is a work in progress. That is, they develop through and over time as people participate in and learn the practices and processes of particular contexts or communities (Fairclough, 2001). As they internalise the language, the gestures, interactions, and routines of their social setting, identities are constructed, maintained, modified, and or reshaped (Berger & Luckmann, 1966). For example, changing schools, moving from primary to secondary school, even the commencement of a new school year, with an altered social context—a new teacher, new rules and so on—may require change or transformation of social identities for the changed or different social context (McNamara, 1997).

Thus, to understand learning requires an understanding of the identities and relationships of the learners. This in turn requires an examination of the social contexts in which learning takes place and the historical background from previous learning experiences that students bring to these contexts (Henriques, 1998). Since learning occurs through participation in social interactions, changes in these contexts and relationships may affect students' identities as learners (Dudley-Marling, 2004).

These identities, as they develop and are expressed in the social relationships of the classroom, may be crucial to what counts as success and what is regarded as failure in classrooms (Sfard & Prusak, 2005). As before, this is not to deny that learners bring other identities to these contexts, rather the focus of this study is necessarily on the development of an identity of some form or degree of participation in the Youth Reconnected Program or traditional instruction-based mathematics classrooms.

Here success or failure in learning may be contingent on several related factors such as the differences in relations of power, the practices of the classroom context, teacher evaluations and expectations of students' potential for learning (see for example, Berry, 2005; Lubienski, 2002; Zevenbergen, Mousley, & Sullivan, 2004), and their social positioning (Fairclough, 2001; Klein & Saunders, 2004; Nasir & Saxe, 2002). Therefore, questions about who is learning what, and how much is learned (or how little), are in some degree questions about the relations of power implicated in the learning context.

In the conceptual framework elaborated thus far, active engagement in classroom interactions is presumed necessary for students to learn effectively and construct an identity as a successful learner. This process requires teachers to employ practices that encourage identity construction and collaboration (McDermott, 1996; Rogoff, Bartlett, Turkanis Goodman, 2002). However, such contexts not only run counter to teacher and student interactions in traditional classrooms (Schoenfeld, 2002, 2006), they may also present difficulties for students who are less engaged in the social interactions of the classroom (Berry, 2006: 492).

Students as learners of mathematics are defined by the forms of competence that classroom membership necessitates (Cobb & Hodge, 2002: 1). For example, a study of learning, identity and statistics (Cobb & Hodge, 2002) found that through taking part in the learning of statistics, students developed a strong sense of personal agency with respect to the investigative tasks involved. That is, their identities were compatible with who they wanted to become. The students' focus was more on their own activities in relation to the investigation than those of the teacher. They perceived themselves and other students as "substantial contributors" (p. 6) to class discussions. Their identity in and membership of the classroom was strengthened by active engagement and their consequent developing competence in mathematics. Thus, how students construct their identity as competent mathematics learners is linked with the manner in which they engage and participate in the subject (Nasir, 2002). In this process, the opportuni-

ties provided for them to take part in decision-making, the pace of learning, method, and working through tasks to completion, are critical (Gresalfi & Cobb, 2006). Where agency is distributed broadly between students and teachers who together determine "the legitimacy of one another's contributions by relying on mathematical justifications" (p. 51), active participation is linked with increasing motivation to learn mathematics (Cobb & Hodge, 2002), which in turn leads to students engaging in mathematical investigations of increasing complexity (Gresalfi & Cobb, 2006). However, where authority is distributed solely to the teacher, who then determines both the legitimacy of responses and whether student contributions are acceptable, student agency is restricted to "applying an established method" in solving tasks (p. 52).

In short, the centrality of identity to the work on learning and participation in social contexts such as classroom communities underlines the significance of the social dimension of mathematics learning. As works in progress, identities are shaped by a sense of belonging and participation in a social community. It is crucial to explore then, how forms and degrees of participation and non- participation affect the learning opportunities of students in classrooms.

2.3. Participation: A Tripartite Model for Understanding

The overlap between participation, participation of peripherality and non- participation of marginality has been recognized by Wenger (1998) and Lave and Wenger (1991) leading to the point that all the aspects of participation are "indispensable in defining the others and cannot be considered in isolation. Its constituents contribute inseparable aspects whose combinations create a landscape … of community membership" (Lave & Wenger, 1991: 35). Put succinctly, participation implies social inclusion (Hill, Davis, Trout, &Tisdall, 2004). It is described more broadly as "the social experience of living in the world in terms of membership in social communities and active involvement in social enterprises" (Wenger, 1998: 55). It requires the necessary skills of communication, negotiation, and decision-making. It is the means by which students construct and shape their identities as members of a community (Wenger, 1998).

Here a useful distinction may be made between forms of participation. Active participation infers that students have reason to believe that their involvement can make a difference. Passive participation relates to being listened to or being consulted (Sinclair, 2004: 108). Both forms afford students a wide range of opportunities to engage in the language of their context and become active members of classrooms. Processes such as collaboration, the importance of learners contributing to the agenda, and "a common and clear but flexible ethical basis" (p. 91) are important for contributing to this inclusion. This point is emphasised in Lardner's (2001) model of participation, with six dimensions of participation, each laid out on a continuum "according to who holds power":

Initiation of the method – who's [sic] idea was it?

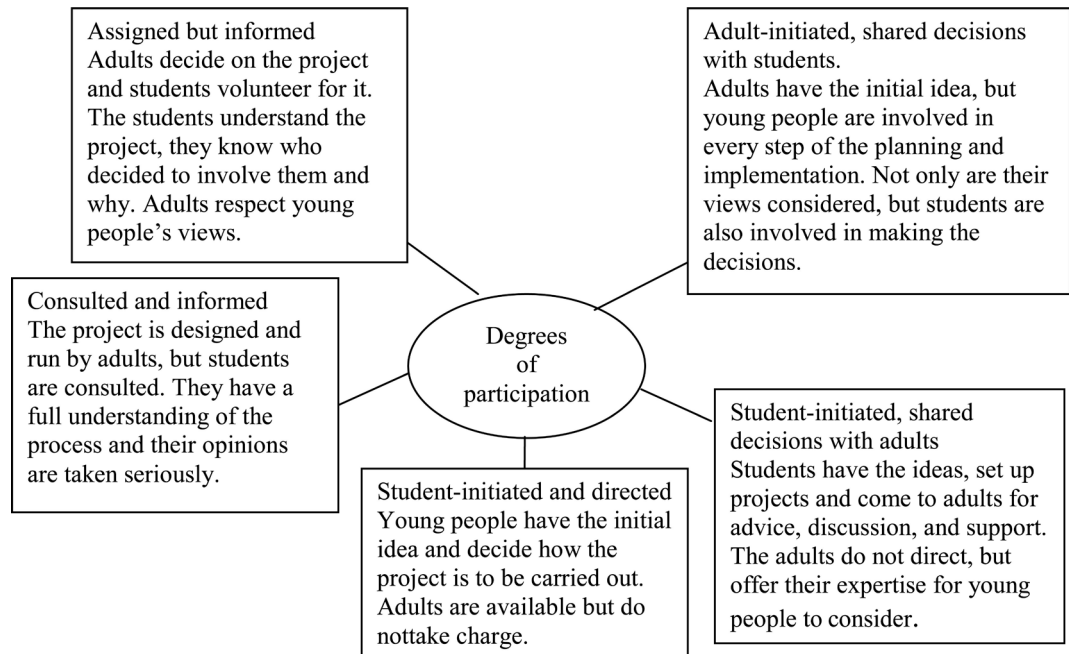The agenda – who decides what's discussed?

Decision-making – who makes decisions about how to proceed?

Information – who holds the information necessary for decision-making?

Implementation – who takes action on the decisions?

Structure of participation – how formal or informal is it, does it replicate adult ways of doing things. (p. 1)

A number of models seeking to explicate the effectiveness of participation have been developed (see for example, Arnstein, 1969; Lardner, 2001; Shier, 2001). However, Treseder's (1997) model of participation, presented in **Figure 2**, best articulates with Lave and Wenger's (1991) and Wenger's (1998) views of the range of different forms of participation in a situation involving students and adults.

Five dimensions to participation are presented in this model: assigned but informed, consulted and informed, adult-initiated but shared decisions with students, student-initiated but shared decisions with adults, and student-initiated and directed (Treseder, 1997). Within each of these dimensions, students' attitudes and views are regarded as important components of their participation and learning. As a minimum, students should see that they are valued, listened to, and respected. However, as with the previously cited work of Lardner (2001) on dimensions of participation, this model also raises the question of the extent of power sharing between those in classrooms.

The different forms of participation possible in learning communities proposed by Lave and Wenger (1991) and Wenger (1998) provides a useful adjunct to Treseder's model. As already mentioned, there are overlaps with the forms of participation (Wenger, 1998; Lave & Wenger, 1991). It has been argued previously (cf. Lave & Wenger, 1991) that the relationship between participation, par-

Assigned but informed
Adults decide on the project and students volunteer for it. The students understand the project, they know who decided to involve them and why. Adults respect young people's views.

Adult-initiated, shared decisions with students.
Adults have the initial idea, but young people are involved in every step of the planning and implementation. Not only are their views considered, but students are also involved in making the decisions.

Consulted and informed
The project is designed and run by adults, but students are consulted. They have a full understanding of the process and their opinions are taken seriously.

Degrees of participation

Student-initiated, shared decisions with adults
Students have the ideas, set up projects and come to adults for advice, discussion, and support. The adults do not direct, but offer their expertise for young people to consider.

Student-initiated and directed
Young people have the initial idea and decide how the project is to be carried out. Adults are available but do nottake charge.

Adapted from Research and resources about participation by the Commission for children and young people (NSW) (2004), p. 6 Commission for children and young people.

Figure 2. Treseder's model of participation (1997).

ticipation of peripherality and non-participation of marginality can be best understood when each is considered to have its own unique set of relatively specific characteristics, in addition to a core set of characteristics shared by each group.

For example, the shaping of identities involves a combination of forms of participation, peripheral participation, and non-participation. Partial participation of students does not mean they are "disconnected" from the learning of the classroom (Lave & Wenger, 1991: 37). Peripherality when it is enabled, provides an opening or a way of gaining access to the practices and resources for learning through developing involvement in a classroom community (Lave & Wenger, 1991). The initial experience of participation therefore does not necessarily lead to an identity of non-participation. As Lave and Wenger (1991) further explain, "peripherality suggests that there are multiple, varied, more-or- less-engaged and -inclusive ways of being located in the fields of participation defined by a community" (p. 36). "Peripheral participation is about being located in the social world" (p. 36). Changing locations are part of developing learning trajectories, identities and forms of membership (Lave & Wenger, 1991).

Peripheral participation can be a source of power or of powerlessness (Lave & Wenger, 1991). It is implicated in social structures such as classrooms and involves relations of power. For example, from the periphery of a classroom the newcomer is exposed to the practices of that community and the manner of its articulation, and hence over time, engages with it, ultimately participating more fully (Lave & Wenger, 1991). Lave and Wenger (1991) have described this as "legitimate peripherality" (p. 36). As a student moves towards becoming more intensive participatory member of a community, peripherality can be empowering. Here, newcomers are "granted enough legitimacy to be treated as potential members" (Wenger, 1998: 101). They are provided with access to the community's members, their negotiated enterprise and their repertoire of resources:

> Granting the newcomers legitimacy is important because they are likely to come short of what the community regards as competent engagement. Only with enough legitimacy can all their inevitable stumblings and violations become opportunities for learning rather than cause for dismissal, neglect or exclusion (Wenger, 1998: 101).

For example, on entry into an existing mathematics classroom or with the introduction of a new process—Algebra for example—some students may find much that is different and poorly understood. At this point, there is a degree of participation of peripherality as they are new to that classroom or that process. However, as they engage in their learning and interact with their teacher, their peers and the learning resources, they move inwards from the periphery to greater participation and success with their tasks. Knowledge and success increase with continued exposure to and participation in the learning of that community. As they develop an "identity of participation" (Wenger, 1998: 67), the mathematics classroom becomes an inclusive community for them.

This initial degree of participation could end in exclusion, however. If over time, a student is kept from participating more fully in a community, it becomes disempowering. When a student is unable to make sense of the mathematics to which they are exposed they are less likely to develop or obtain effective explanations of what is going on. If they cannot negotiate meanings or receive adequate support for their learning—and this will be particularly the case as mathematics becomes more complex and abstract—their lack of understanding and their ineffective participation becomes a "relation of marginality" (Wenger, 1998:. 166-167). Consequently, and because of the practices of that classroom, they may remain in marginal positions. This experience becomes so dominant that "conceiving of a different trajectory within the same community" (p. 167) becomes difficult or impossible. When such an identity of "non-participation of marginality" (p. 167) is constructed, students are either ultimately excluded or exclude themselves from participation in the mathematics classrooms. They are excluded from the social world of the mathematics classroom.

In short, the initial relations of participation can be either enabling or problematic (Wenger, 1998). **Figure 3**, a tripartite model for understanding participation, represents this issue more fully. In doing so, it indicates the level of participation across the three aspects addressed above— identity of participation, identity of participation of peripherality, and identity of non-participation of marginality. These forms of participation are combined with Treseder's model to provide a framework for understanding participation in mathematics classrooms. When students have opportunities to initiate and direct their learning they are more likely to participate and construct their identity as a member of that community. When new to the community, they are more likely to experience participation of peripherality while they learn how to become a member of the group. Learning is more likely to be organised by the teachers, with students consulted. Decisions are shared between the teacher and students. However, when teachers assign the required learning and the students are not informed or consulted, they are more likely to experience marginalisation and are less likely to participate in their learning.

An examination of the different forms of participation in **Figure 3** indicates potential barriers to student participation in classrooms, each having serious implications for student learning (see for example, Commission for Children and Young People NSW, 2004; Rajani, 2000). When students are told what to do without really knowing or understanding why, a barrier exists between the teachers and the students, with some students withdrawing into passive indifference (Rajani, 2000). Their opportunities are closed by the practices used in some mathematics classrooms.

Ideally, however, a classroom should support learning in such ways that it becomes a transformative experience rather than an alienating one. In such contexts, learners are more likely to develop an identity of non-participation of periphery, from which they move to full participation in the classroom. They learn that they can contribute to, and engage with others in the enterprise of that
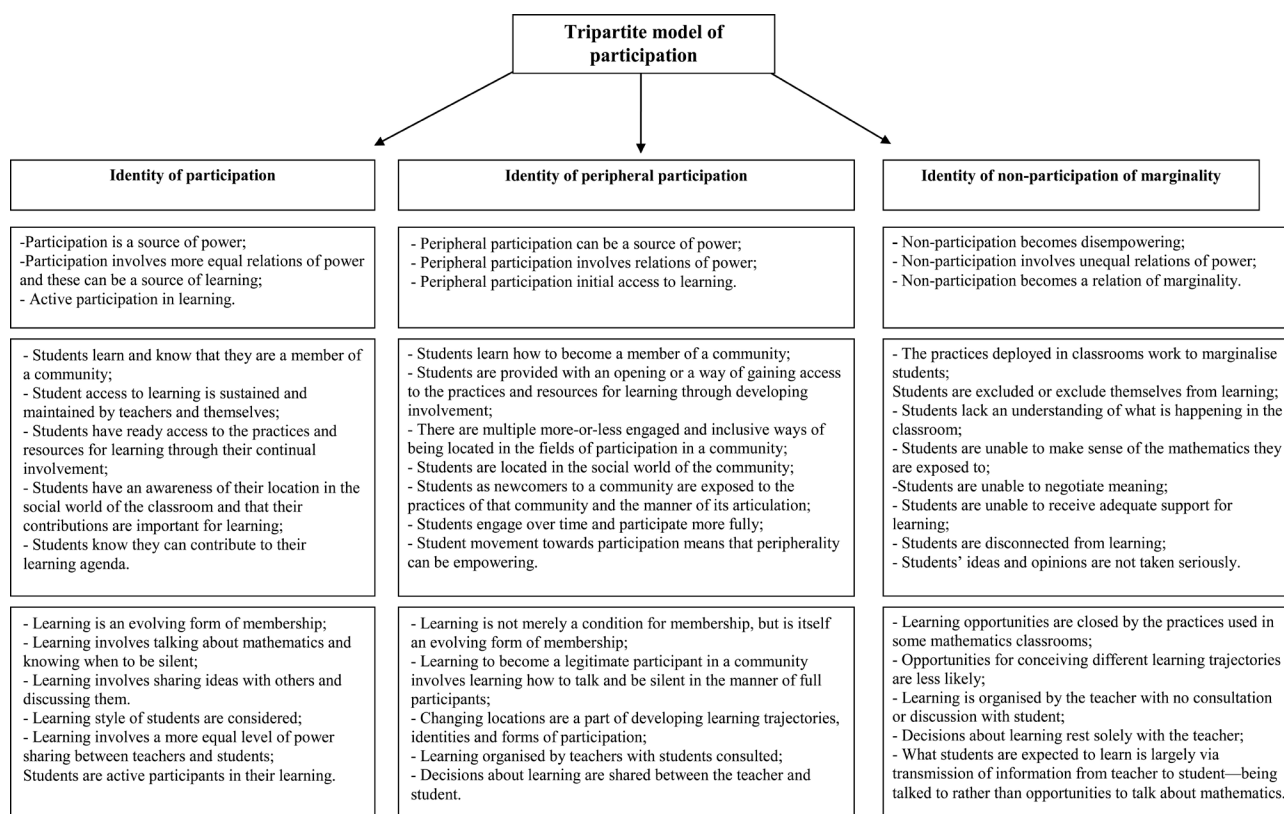
Figure 3. Tripartite model for understanding.

classroom (Rogoff, Bartlett & Turkanis Goodman, 2002). In this instance, the practices of **Figure 3** become an enabling feature of mathematics classrooms in such a way that engagement and participation are encouraged. The next section provides an explanation of how practice is understood in this paper.

2.4. Practice: Learning as Doing

In the literature on mathematics education, practice has been subsumed under the heading of pedagogy, focusing on epistemological understandings of teaching (see for example, Lerman & Zevenbergen, 2004; Schoenfeld, 1994; Sierpinska, 1998). In the sociological literature, it has been defined in different theoretical perspectives, such as the cultural anthropology of Bourdieu (1990) and Lave and Wenger (1991), de Certeau(1984) cultural studies, Turner's (1994) social theory of practice, Fairclough's (2001; 2003) critical discourse theory and Bernstein's (1990) theory of pedagogy and practice. To understand and apply practice in this study, a toolbox approach—taking what is useful for the job at hand (Foucault, 1974)—has been adopted, that is, ideas or aspects of relevant conceptual frameworks have been drawn on where necessary to develop a more useful and effective understanding in practice of practice.

Practice has been described as learning by doing and participating in social involvement with people who already embody the practices (Spinoza, Flores & Dreyfus, 1997), as part of the belief in institutions that are a driving force behind social order—the way a game produces its own reality (Bourdieu, 1977). Bourdieu

proposes that the ritualisation of practices, in classifying and assigning them a time, that is a moment, a tempo or duration, confers an "arbitrary necessity which specifically defines cultural arbitrariness" (p. 163).

> The reason why submission to the collective rhythms is so rigorously demanded is that the temporal forms or the spatial structures structure not only the group's representation of the world but the group itself, which orders itself in accordance with this representation (Bourdieu, 1977: 163).

These arbitrary cultural classifications order practices that are seen as natural and taken-for-granted by groups who join a sense of reality and its limits to how they negotiate their world. However, those who challenge more powerful systems and their practices can do so by controlling its consumption or the way it is used (de Certeau, 1984). For example, members of creative popular culture who seek out new or different ways of operating serve their own interests, but at the same time acknowledge the interests of the more powerful group. Much of this can be subversive, with members "making over" (de Certeau, 1984, p. xx) the offerings to their own ends. Subversion can operate through practices such as the misuse of the mathematics textbooks and student exercise books whose function is to serve as a sign of student immersion in mathematics. However, they also operate as a battleground with students testing and challenging authority by creative modifications to their books. Whilst institutional structures are organised strategically to control the meanings they produce, they can also be used to produce subversion.

The term practice could then be described as the relationship that an individual has with the "world, activity, meaning, cognition, learning, and knowing" (Lave & Wenger, 1991: 50), and the social negotiation of meaning (Lave & Wenger, 1991). It emphasises the "socially negotiated character of meaning and the interested, concerned character of the thought and actions of persons-in- activity" (p. 50).

Participating in practice requires "transparency" of the artefacts engaged in practice (Lave & Wenger, 1991: 91). Transparency implies that artefacts are available for a learner to explore, but greater understanding of their use is significant. Transparency also implies access to practice, that is, it refers to "the way in which using artefacts and understanding their significance interacts to become one learning process" (p. 103). This transparency of access to practice requires access to a range of ongoing activities, teachers, students, information, resources and opportunities for participation. It includes the explicit and the tacit, what is said and unsaid and what is represented and what is assumed (Wenger, 1998). This description of practice emphasises the social and negotiated character of knowledge and involves the learner in acting, knowing, theorising and understanding meaning in a classroom (Wenger, 1998). These processes are not static, but continually changing as a consequence of participation, learning by doing, and social energy. The next section elaborates the concept of community with emphasis upon its participative aspects. In particular, it focuses

on three understandings of community.

2.5. Community: Learning as Belonging—a Tripartite Model

The intention of this section is to discuss what is understood by the term, community, and its relation to a community of practice, a community of inquiry, and a community of learners. In doing so, this discussion will elaborate the key ideas of each form of community. The intention is to see what these communities have in common and how each might further develop teaching and learning in mathematics classrooms. Once again a tripartite model is used to elaborate the different understandings of community.

Community, as the term is understood here, describes a social group with common interests located in a common context and whose members develop an identity as members of that group as they participate in its activities (cf. Dewey, 1916; Wenger, 1998; Williams, 1976). Its use is widespread in education (see for example, Pardales & Girod, 2006). Community of practice (Wenger, 1998), community of inquiry (Pardales & Girod, 2006; Seixas, 1993), and community of learners (Matusov, 1999; Rogoff, Matusov & White, 1998), all play a central role in such educational discussions. Their use indicates the current thinking about how and why a classroom might become a community.

2.5.1. A Community of Practice

A community of practice has been described as "a kind of community created over time by the sustained pursuit of a shared enterprise" (Wenger, 1998: 45), "an ongoing collective negotiation of a regime of competence, which is neither static nor fully explicit" (Eckert & Wenger, 2005: 583). Ethnographic studies of apprenticeships provided the basis for its initial description by Lave and Wenger (1991). Their intention was to establish what these studies might contribute to understanding how learning takes place. Primarily, their interest was with the ways in which meanings, beliefs and understanding were negotiated and enacted in practices, such as those of tailors, butchers and midwives. Subsequent work by Wenger (1998) built on this early work to include the key concepts of identity of participation and non-participation and the term, communities of practice. Through participation in communities of practice people build a sense of their place, their identity, and their possibilities in society (Eckert, 2000). The link between an individual's experience and their place in the social order is the structure of participation in communities of practice. Since learning is central to a community of practice, studying such communities affords insights into the socially embedded nature of learning—insights that, in turn, can be systematically utilised to enhance learning in various social contexts.

Three key characteristics—mutual engagement, joint enterprise and shared repertoire (Wenger, 1998: 73)—define a community of practice. The first, mutual engagement of all participants is an essential component of practice. Inclusion in what matters is a necessary prerequisite for engagement in a community's practice, and "what it takes for a community of practice to cohere enough

to function can be very subtle and delicate" (Wenger, 1998: 74). This form of coherence requires continuing work or community maintenance (p. 74). For example, Wenger identified the activities of claims processors such as arriving, talking and interacting while they work as important features of a community. Similarly, in the context, talking by phone, email or radio are all constitutive of mutual engagement. Hence a community of practice is not simply a social category defined by a network of associations or geographical proximity. It requires interaction, diversity and sustained interactions centred on participants' involvement in what they do. It presumes their possession of the language of the community with its shared systems of meaning and understanding. In short, a community of practice "can become a very tight node of interpersonal relationships" (Wenger, 1998: 76) that exist through engagement in practice.

The second component that keeps a community of practice coherent is joint enterprise. It is the result of a collective process of negotiation that reflects the full complexity of mutual engagement.

> It is defined by the participants in the very process of pursuing it. It is their negotiated response to their situation and thus belongs to them in a profound sense, in spite of all the forces and influences that are beyond their control.
> It is not just a stated goal, but creates among participants relations of mutual accountability that become an integral part of the practice. (Wenger, 1998: 77-78)

Here joint enterprise does not necessarily mean that all participants agree, because it is a process and not static. Indeed, disagreement can be a productive aspect of the enterprise. The participants are not expected to believe and agree on the same things, but rather, such things are communally negotiated. When participants negotiate in a joint enterprise, relations of mutual accountability follow. Such relations include what matters for that enterprise and what does not (Wenger, 1998).

Wenger's (1998) third characteristic is shared repertoire. As participants engage in joint enterprise, drawing on their language and the language of their community to participate and communicate with one another, resources for negotiating meaning and understanding are created. Such elements of a repertoire include,

> routines, words, tools, ways of doing things, stories, gestures, symbols, genres, actions or concepts, that the community has produced or adopted in the course of its existence, and which have become part of its practice. The repertoire combines both reificative and participative aspects. It includes the discourse by which members create meaningful statements about the world, as well as the styles by which they express their forms of membership and their identities as members. (p. 83)

These elements gain their coherence through belonging to the practices of a community engaged in joint enterprise. They are developed and shared through

interaction and sustained engagement in a community.

The understandings of community are moving beyond research into application. For example, an ethnographic study of situated learning in the funeral industry (Carden, 2005) in which the researcher became a mortuary assistant, evidenced the transition from legitimate peripheral participation to full membership of that community of practice. Another study (Willis, 2005) examined a group of postgraduate educational researchers to determine to what degree it demonstrated the features of a community of practice. An insightful study of implementing radical change in a tertiary curriculum development team (King, 2005) in which its members became "novice practitioners" again, demonstrated the need for "understanding the role that emotions play in the reconstruction of learning, meaning and identity" (p. 101). In a major South Australian project for transformational school leadership, principals and designated change leaders from groups of schools met in learning circles twice a term with university staff and departmental curriculum officers (Peters & Le Cornu, 2005). A "degree of congruence" (p. 107) was found between these learning circles and communities of practice, in particular the key concepts of "community, meaning, practice and identity" (p. 107). Finally, a study of designing and facilitating learning communities in formal courses identified seven key components of a community—shared goals, safe and supportive conditions, collective identity, collaboration, respectful inclusion, progressive discourse towards knowledge building, and mutual appropriation (Wilson, Ludwig-Hardman, Thornam, & Dunlap, 2004). These characteristics were seen as essential qualities "which should be considered when attempting to establish or support such communities in courses or programs" (p. 6).

However, the complexity of creating such communities, or incorporating such a perspective into existing research and practice activities, must be taken into account:

Bringing together a diverse group of people to establish a new community can be a daunting undertaking, particularly if the learning needs and the task are not perceived as legitimate by all participants. Viewed through an anthropological lens, a community of practice is not actually created, but rather emerges based on mutual interests, shared goals, understandings, and common practice (Lave & Wenger, 1991). The challenge lies in recognizing the opportunities to move existing groups closer to a community of practice perspective. Once these opportunities have been identified, the key to transforming groups into practice communities is not merely to enlarge the group or extend the tasks, but to give members a legitimate role in society by linking their ideas with those of the broader educational community. (Buysse, Sparkman & Wesley, 2003: 274)

A further concern was raised in a review of Wenger's (1998) work which indicated that it offered insufficient information about pedagogy and education and how it might be applied for empirical work (Ernest, 2002). Two possible ex-

planations could be suggested here. First, as noted earlier, Wenger's (1998) work was not conducted in classrooms but in organisations of work and training such as claims processing. In these contexts, a concrete process exists and gives a focus for joint enterprise, one that the community and its members move towards. The concern of the community is about the links between members and how such links work towards and or away from a group identity. Membership is determined by the endeavours that bring people together (Eckert & McConnell-Ginet, 1995). Secondly, the people work to establish an "identity of relation" (Fairclough, 2003: 166)—the claims processors define themselves in relation to their employer as well as to claims processing (Davies, 2005). Thus, it is easy to identify the general enterprise that drives the people towards the need for mutual engagement. Further, Wenger (1998) does not explore the specifics of the claims processors' roles. However, a shared enterprise should "be reasonably specific and not very general or abstract" (Meyerhoff, 2001: 528). Questions have been raised as to whether, given Wenger's, position as an outsider to the claims processing group, he could identify with the group and their specific shared enterprise and so decide whether the group of people met the criterion for shared enterprise (Davies, 2005).

These concerns about Wenger's (1998) ideas are compounded by the types of groupings and the size of groupings to which the three characteristics of a community of practice can be applied. Davies (2005) argues that there is a question of "grain size" (p. 564), that is, "does the requirement of joint enterprise and mutual engagement mean by definition that communities of practice is a tool for micro-level analysis, or can the concept be articulated at more macro-levels of society?" (p. 564). While this issue cannot be resolved here, this study seeks to examine the three characteristics, joint enterprise, mutual engagement and shared repertoire to identify if they can be articulated at the micro-level of analysis.

A further limitation of the work of Lave and Wenger (1991) and Wenger (1998) relates to the question of who has access to participate and who in a community of practice endorses an individual's access. Lave and Wenger (1991) note, but do not discuss extensively, the unequal relations of power in communities of practice, observing that

> learning and alienation from full participation are inherent in the shaping of the legitimacy and peripherality of participation in its historical realizations. (p. 42)

They highlight how these relations potentially create "interstitial communities of practice" (Lave & Wenger, 1991: 42), that is, communities that are alienated from full participation, and reduce the possibilities for "identities of mastery" (p. 42).

Despite these caveats, the work on communities of practice has resulted in substantial further elaboration, modification and debate (see for example, Stehlik & Carden, 2005). The two models of community, community of inquiry and

community of learning, which are addressed below, build on and adapt the central features of communities of practice.

2.5.2. A Community of Inquiry

The previous section described a community of practice as it relates to people and work. In this section, a community of inquiry is discussed as it relates to classrooms. A community of inquiry has been described as a community that produces knowledge that leads from doubt to belief and to what is real (Pardales & Girod, 2006). Reality in this sense results from inquiry and is defined by rationality rather than by a person's beliefs (Pardales & Girod, 2006). This kind of reasoning is inductive, that is, a person's doubts move from uncertainty to action to producing knowledge that is believed. Here, as with Peirce (1878), doubt and belief begin with a question and its resolution.

Belief has three properties, it is "something we are aware of; second, it appeases the irritation of doubt; and third, it involves the establishment in our nature of a rule of action" (Peirce, 1878: 4). Doubt, the motive for thinking, is appeased when belief is reached (Peirce, 1878). Through this process, thinking is subjected to the community's standards that allow doubts and beliefs to be corrected and revised (Pardales & Girod, 2006). A community of inquiry serves as an arbiter of standards for producing reliable knowledge. It frames the establishment of relationships between individuals and the social interactions that occur as a consequence of such relationships. The exchange of opinions, beliefs, and experiences guides to more reasonable beliefs and a more rich experience in the future (Planas, 2003-2004).

In mathematics education, a community of inquiry views mathematics as an evolving human construction (Lafortune, Daniel, Pallascio & Sykes, 1995-1996). The role of the teacher is significant in transforming a classroom to a community (Lafortune, Daniel, Pallascio & Sykes, 2003-2004). Through inquiry, teachers are viewed "less as the infallible experts" (p. 82) and more as people who talk and think about mathematics through interaction with their students. They encourage and engage in discussions with students, scaffolding their interactions and participation in the inquiry. In doing so, the students are expected to listen to one another, build on ideas, challenge these ideas, provide reasons for unsupported opinions, and identify one another's assumptions (M. Lipman, 1991). There are three preconditions for these processes to occur in a community of inquiry:

1) Readiness to reason;
2) Mutual respect (of children towards one another, and of children and teachers towards one another);
3) An absence of indoctrination (Lipman, Sharp & Oscanyan, 1980: 45).

Here readiness to reason is cultivated and transformed through the teaching of formal and informal logic (Pardales & Girod, 2006). Through this process, the teacher, who is considered to have more background knowledge and techniques of inquiry, assists students in following their own paths of thinking. The teacher must stop however "at the point of legitimising or delegitimising particular

points of view" (p. 304). The reason is that for the creation of a community of inquiry and the mutual respect by which it continues, the teacher must not expect that beliefs and opinions must always meet. Here indoctrination is challenged through a pluralistic stance (Pardales & Girod, 2006). The mechanisms by which the three preconditions of a community of inquiry can be sustained include:

1) Group solidarity through dialogical inquiry;
2) The primacy of activity and reflection;
3) The articulation of disagreements and the quest for understanding;
4) Fostering cognitive skills (e.g., assumption finding, generalization, exemplification) through dialogical practice;
5) Learning to employ cognitive tools (e.g., reasons, criteria, concepts, algorithms, rules, principles);
6) Joining together in cooperative reasoning (e.g., building on each other's ideas, offering counterexamples or alternative hypotheses, etc);
7) Internalization of the overt cognitive behavior of the community (e.g. introjecting the ways in which classmates correct one another until each becomes systematically self-corrective)—'intrapsychical reproduction of the interpsychical' (Vygotsky);
8) Becoming increasingly sensitive to meaningful nuance of contextual differences;
9) Group collectively groping its way along, following the argument where it leads (Lipman, 1991: 242).

These mechanisms provide a way for understanding how teachers and students become a community of inquiry. While there are similarities to the characteristics of a community of practice—group cooperation, mutually engaging in building on ideas, and sharing in the enterprise of the community—a community of inquiry provides more detail about the specific processes of inquiry in a community. That is, the community forms by being inquisitive, reflective, articulate, cognitively adept, and sensitive to context and investigative (Pardales & Girod, 2006). There is a commitment to action by all members of the community (Planas, 2003-2004). When students and teachers engage over topics of interest, internalising the language of the community in the construction of knowledge, they become the arbiters of legitimate and illegitimate forms of inquiry. The classroom becomes a place where teachers and students inquire into topics of mutual interest and where such interest would become the curriculum, rather than teachers alone dictating what and how things are learned (Pardales & Girod, 2006). It is not a place where information is given and exchanged, but rather a community where information is analysed, contrasted and evaluated (Planas, 2003-2004).

This section has built on the earlier discussion of a community of practice, with its focus on employment contexts and the collaborative engagement of employees in the enterprise of such a community, to provide more specific detail about the characteristics of a community that is inquiry focused, with particular

emphasis on classrooms where teachers and students collaboratively engage in inquiry. The next section describes a third type of community, a community of learners, and how it relates to classrooms and the process of collaboration.

2.5.3. A Community of Learners

The previous section described the conditions required for inquiry to take place. In this section, a community of learners is described, with particular emphasis on an ideal situation (Matusov, 1999; Rogoff, Matusov & White, 1998). Here learning is situated in collaboration and collaboration is situated in learning in contexts such as classrooms (Matusov, 1999). Within such an ideal community, all participants play an active role, with no one having all the responsibility, while the integration of students' contributions affords opportunities for negotiating meaning with other learners and teachers (Matusov, 1999; Renshaw & Brown, 1997; Rogoff, Matusov, & White, 1998). Through these experiences, students and teachers develop relations that are supportive of learning, much like that of a community of inquiry and practice (Matusov, 1999). The identity of a learner is constructed through the practices utilised by teachers in classrooms as discussed earlier. These practices include the teacher providing the support necessary to encourage engagement (Renshaw & Brown, 1997) and the shaping of an identity of participation in that community. Where there is effective interaction between students and teachers, the students are more likely to identify themselves as mathematics learners, participating and negotiating mathematical meaning with other students and their teachers.

In a community of learners the "tasks and teaching responsibilities are divided between students, ... by social scaffolds such as collective argumentation" (Renshaw & Brown, 1997: 210). The teachers' role in classrooms is to link students' actions and representations with the "knowledge community of mathematicians" (p. 210). In an ideal community of learning,

> building the classroom community and learning the curriculum are the same thing; members of the classroom learn through building a community and at the same time build a community through their learning. (Matusov, 1999: 163)

Here, students and teachers are active participants, and learning involves the transformation of participation through collaborative endeavour in their community (Matusov, 1999). The role of teachers, in such a situation according to Renshaw and Brown (2004) is to provide opportunities for student voice, where they draw on their interpretative procedures to generate understandings of their experiences. Through this process teachers can provide the types of conditions whereby students are supported in sustaining a collaborative community of learners (Renshaw, 2002). The teachers assume some responsibility for guiding the process, while students learn how to participate and manage their learning (Rogoff, Matusov, & White, 1998).

This kind of community is different from a traditional mathematics classroom as described by Ewing (2011), where students attempt to learn in isolation

mathematics tasks demonstrated by the teacher to the whole class. Such a classroom is more likely to be a site for contestation and struggle because students are unable to access the mathematics taught because of its disconnectedness from other parts of their learning and experiences outside the classroom. Practices, such as those that do not maintain a strong focus on active engagement, participation, identity and membership in classrooms, sustain this struggle with the classroom likely to become a battleground where students subvert authority by modifying their participation in learning.

The work of Dewey (1916) on community-relevant and democratic schooling and that of Beane and Apple (1999) on democratic schooling exemplifies desirable forms of classroom communities of learners. They emphasise that knowledge emerges for students and teachers when connected with their social experiences. When this occurs, students use their knowledge to understand real life problems and issues, which in turn are connected to "communities and the biographies of people's lives" (p. 119). When such explicit connections are made between teachers, students and their communities, social learning and the construction of knowledge are based on the questions the students and teachers ask (Brodhagen, 1999). Success with learning follows from working together on common goals and issues.

The next section provides a summary of the previous discussions— communities are reviewed to identify particular characteristics that will assist with understanding the teaching and learning experiences of mathematics classrooms.

2.6. Understanding Teaching and Learning in Mathematics Classrooms

To this point, a social theory of learning has been elaborated, with particular attention to the significance of learning as a social activity, along with issues relating to identity, forms of participation and non-participation, and community. The critical importance of identity for success or failure in learning of mathematics has been shown to be contingent on the quality of relationships in the social context—here the primary and secondary mathematics classroom—in which learning takes place, along with the background that students bring to learning in that context. A learning community is now presented as the natural concomitant of a social theory of learning.

Adopting a tripartite model has enabled the investigation of three related types of communities, a community of practice, a community of inquiry, and a community of learners. Similar features in all three include the significance of participation and active engagement in the tasks, activities, and language of the communities. All three emphasised the importance of sustained interactions focused on those involved in the community. A community of practice and its three defining characteristics, mutual engagement, joint enterprise and shared repertoire, provide useful explanations of how learning occurs in social contexts. A community of inquiry underlines the role of the teacher as leader and participant in the collegial adventure of learning, the need for openness and dialogue in

investigation, and the importance of learning activities that are relevant to learners' interests and concerns. A community of learners with its focus on effective teaching practice that develops supportive relations, engagement to learn through collaboration, and the negotiation of meaning between students and teachers, provides a useful basis for an examination of the students' accounts of their learning experiences. Its combined focus on the individual and the social context is needed to make adequate interpretations of learners' experiences in such communities.

However, access is a necessary prerequisite for students to engage and participate in learning in communities (Davies, 2005; Lave & Wenger, 1991). Prospective members do not have open access to membership based on their wanting to be a part of a community and its practices (Davies, 2005). As described earlier in this paper transparency is critical. That is, to have such access they need to know the prerequisites for membership, which they should either possess, be able to acquire and be assisted with acquiring. If transparency is to be comprehensive, they need also to know who possesses the authority to make such judgements and what guarantees they offer to ensure effective access and sustained participation in the community (Davies, 2005). Potentially, then, an individual's choice to mutually engage in joint enterprise and share their repertoire is constrained or enabled by those who have the power to allow access to occur (Davies, 2005; Lave & Wenger, 1991).

As Schoenfeld (2006) and Boaler (2002) explain, access to and increasing participation in a specific grouping is a necessary prerequisite for students to engage and participate in mathematics learning in classrooms. That is, in classrooms where access is provided and authority is distributed between the teacher and students, students can exercise a high degree of agency. Agency in this sense refers to students taking part in mathematical discussions, decision-making, and learning to choose methods to work on tasks until completion.

Applying the elements of participation, participation of peripherality and non-participation of marginality, foregrounds the significance of students' experiences. These elements in turn imply the need to address issues of access and inclusion and exclusion in mathematics classrooms. When applied to teaching and learning contexts, they enable to further understand identity, the individual and the social context. However, as stressed earlier, what can be further illuminated are the issues of power relations and struggle as they relate to identity, forms of participation and non-participation and the social context.

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