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# Student perspectives on group work in support of the learning of mathematics at high school and at a university of technology

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## Abstract

Debates on improving performance in science and engineering at higher education institutions have stressed the need for institutions to adopt pedagogic practices appropriate for the setting. In this paper we contribute to this debate by presenting the results of empirical research conducted in a first-year foundation mathematics course for Civil Engineering students at a University of Technology in South Africa. Using the perspective of learning as participation in a community as a theoretical framework, the paper focuses on a particular type of student learning community, that is, small group work for the learning of mathematics. We use individual interviews to investigate students' perspectives on small group work in support of their learning of mathematics at high school and in the foundation mathematics course. The results suggest that students have considerable experience of working in groups inside and outside the classroom at school, and they identify conditions conducive for group work, including having a sense of belonging in a group. They value group work for providing support that may not be provided by the lecturer, for example, by obtaining alternative explanations (often in their home language), sharing ideas on problem solving, and getting immediate feedback. We argue that higher education institutions should draw on students' experience of group work and create the space for this type of student learning community both inside and outside the mathematics classroom. We also use the empirical results to develop the notion of "community" as described in the theoretical perspective of learning.

**Keywords:** foundation programmes; learning as participation in a community; mathematics learning, small group work

## Introduction

Participation in South African higher education has increased and become more representative racially in the past two decades (Organisation for Economic Cooperation and Development, OECD, 2008). Yet this increased representativeness is not in all disciplines with Black students being underrepresented in the sciences and engineering (OECD, 2008). In this paper we use the term "Black" to mean Black African, which is the commonly used racial classification in published data on South African education, along with "Coloured", "Indian", and "White". Further, the throughput rates (number of students graduating over time) indicate that access to a higher education institution does not necessarily translate into success. Cele and Menon (2006) argue that the widening of access to students previously disadvantaged by apartheid inequities

has resulted in students taking longer to graduate. The most recent cohort study, for example, shows that only 6% of students in engineering programmes at Universities of Technology (UTs) in South Africa graduate with a three year diploma in the minimum time, with the proportion of Black students at only 4% (Scott, Yeld & Hendry, 2007). One of the key factors affecting student performance in higher education is the quality of the schooling sector (Scott et al., 2007). Since the first democratic elections in 1994, the new government has instituted measures to reform education. However, 80% of schools in South Africa are considered to be poorly performing and interventions to improve these schools have proved to be inefficient (Taylor, 2007). In addition to identifying the quality of the schooling sector as a factor affecting student performance in higher education, Scott et al. (2007) argue that performance is also influenced by factors such as material conditions (for example, socio-economic conditions and student finance), affective factors and the institutional climate, and the effectiveness of the educational processes in higher education. This view is supported by empirical work, conducted in South Africa and elsewhere, that identifies the social integration of students as playing a role in success in higher education (for example, Case, 2008; Pearce, 2006; Wilcox, Wynn & Fyvie-Gauld, 2005).

Higher education institutions in South Africa have a history of responding to the articulation gap between school and higher education, normally in the form of specially designed programmes for students identified as being disadvantaged by the inequitable schooling system (Pinto, 2001). Various models of foundation provision have been attempted at university level, from add-on tutorials for selected students in the mainstream, to non-credit-bearing “bridging” courses in preparation for entry into mainstream, to extended curricula providing additional contact and learning time in credit-bearing courses, as part of a students’ degree programme (Pinto, 2001; Rollnick, 2010a). Research into the effects of foundation programmes is encouraging, for example, both Rollnick (2010b) and Mabila et al. (2006) report on foundation programmes that provided access to and success in university science for students who would otherwise not have participated in higher education. Wood and Lithauer’s (2005) study of the perceptions of students in a foundation programme, also at a South African university, suggests that students viewed the academic, social and emotional skills they acquired as beneficial in preparing them for mainstream studies.

Responding to the problems of access and throughput in higher education, the Department of Education in South Africa has, since 2004, provided universities and UTs with additional funding to start or expand foundation programmes (Department of Education, 2006). Referring specifically to the challenge of educating engineers, Allie et al. (2009) argue that institutional responses need to be based on a sound understanding of the context and what pedagogies may be appropriate for the context. The research reviewed in this introduction indicates that such responses cannot only take into account the gap between school and higher education, but must also consider social factors and how the institution responds to the changing needs of students. This paper responds to the call to “develop a deeper understanding of the systems we work in” (Allie et al., 2009, p.360) by investigating student perspectives on the use of small group work in high school mathematics and in their first-year foundation mathematics course for Civil Engineering at a UT. In particular, the paper sets out to answer the following research questions:

1. What type of small group work do students say they have experienced when learning mathematics at school and at the UT? In what settings does this group work occur?
2. What type of activity do students describe as happening when they do mathematics in these groups?
3. Do students perceive small group work as beneficial to their learning of mathematics? If so, in what way is their learning enabled? If not, what are the constraints?

We use the answers to these questions to develop a description of a particular type of student learning community, that is, small group work both inside and outside of the mathematics classroom. We argue that this empirical description makes a contribution to the theoretical perspective of learning as participation in a community proposed by Allie et al. (2009).

## Theoretical framework

Sfard (1998, p.6) has identified a trend in education towards theories of learning that view learning as a process of becoming a member of a particular community, what she terms the “participant metaphor” of learning. Learning is regarded as situated in the sense that it cannot be considered separately from the context in which it takes place. Participation involves acting according to the valued ways of the community; these valued ways include certain activities, ways of using language and other forms of semiosis, ways of using tools and sign systems, ways of interacting, particular perspectives etc. These valued ways can be termed the “discourse” of the community (Gee, 2005, p.7) or the “practice” of the community (Wenger, 1998, p.5). For example, a foundation mathematics course will be characterised by attention to particular mathematical objects, a focus on solving particular types mathematics problems (with tools such as calculators or computers) and particular ways of writing the solutions to these problems, and the presence of particular relationships between the students, lecturer, and tutors. Wenger (1998) argues that a theory of learning as participation does not only entail active participation in the practices of social communities, but also the construction of identities in relation to these communities. This notion that participation in a community is related to the notion of “who we are” (Wenger, 1998, p.5) also features in the work of Gee (2001) who suggests that, “discourses are ways of being certain kinds of people” (p.110). Brown, Reveles and Kelly (2002, p.783) use the term “discursive identity” to capture this notion that discourse is used to communicate identity. Allie et al. (2009) draw on the theoretical work presented here and propose that a view of learning as an ongoing process of participation in the discourse of a community is productive for conceptualising the learning of engineering in higher education. Since the position taken by Allie et al. (2009) has been developed in the same context in which this paper is located, we have found it useful as an overall framework for this paper.

The focus of this paper is on the concept of “community” in the theory of learning as social participation. Wenger (1998, p.45, 72) argues that ongoing interaction of people around a common enterprise comes to define certain practices related to this enterprise and the associated social relations. In time these practices become the property of a certain “community”, a community that is created around and recognised by these practices and hence the term “community of practice”. Allie et al. (2009, p.360-361) refer to various communities in the context of higher education, for example, the “workplace community” and the “classroom community”. The classroom community is described as a “safe space” (p.361) where students can experiment with new identities. They also argue that, since students can be members of multiple communities, there is a need for staff at higher education institutions “to develop an understanding of the communities from which students come” (p.362).

We argue that the theoretical perspective of “community” presented by Allie et al. (2009) is weak in two respects. Firstly, although particular communities in the higher education space

are named, the concept of “community” is not clearly defined. It is stated that “Through our use of the characteristics of a discourse, we can recognise ourselves and others as belonging to a community” (Allie et al., 2009, p.361), thus suggesting that a community is given meaning by the use of recognisable ways of using language, of acting, of using tools etc. In this paper we use the term “student learning community” to refer to a grouping of students engaged in shared activity in support of their learning. Here “activity” is used broadly to refer to physical action, use of language and other forms of semiosis, social interaction etc., and “learning” refers to the learning of mathematics, either at school or in the first-year foundation mathematics course at the UT. In this paper we focus on a particular type of student learning community, that is, small group work amongst students in support of their mathematics learning.

Secondly, we argue that the notion of “community” as described by Allie et al. (2009) is weak in the sense that it attends only to communities in the formal learning environment (the classroom) and in the workplace (the workplace of engineers). In this paper the focus is on mathematics and we describe the use of group work in the learning of high school mathematics (what Allie et al. (2009, p.362) would refer to in the higher education context as students’ “backgrounds”) and in a foundation mathematics course at a UT. This description includes the use of group work that occurs outside of the classroom, for example, student study groups after school. We argue that knowledge of such student learning communities and the resources that students develop in such communities is important if higher education institutions are to support student learning in mathematics.

In the next section we describe the research which investigated student experiences of group work in support of their mathematical learning at high school and at a UT. We then present the results, with a focus on describing the small group work both within and outside of the classroom, as reported by the students.

## **The research study**

### ***The location of the study***

The students who participated in this research were enrolled in a first-year foundation mathematics course for Civil Engineers at a UT in South Africa. This course forms part of an extended curriculum programme in Engineering. In the year in which the research was conducted, the course catered for a total of thirty-five students, all of whom did not meet the institution’s minimum entry requirements for Civil Engineering. Of the thirty-five students twenty-two were Black, eleven Coloured and two White. These students studied mathematics in a full year credit-bearing course. In addition to the normal mainstream first-semester mathematics syllabus, the extended course covers sections of school mathematics required for this syllabus. Since the syllabus is algorithmic in nature, most of the activity in the classroom involves working on exercises from a prescribed textbook and from other sources. The lecturer’s use of group work in the classroom is based on the cooperative-base group method (Smith, Sheppard, Johnson & Johnson, 2005), the main purpose of which is for students to work together on a long term basis to support each other’s learning of mathematics. Students self select groups of three to six students and are seated around hexagonal tables during all mathematics classes (except during assessments). A mathematics class is characterised by both direct whole class instruction by the lecturer (usually for less than half the time) and students working with their peers on mathematics problems.

## ***Selection of students for the study***

Selection of research participants from the group of thirty-five students in the course was based on information collected in a questionnaire completed by all the students. This questionnaire was designed to gather information on the students' educational background. On the basis of the responses from students, eight students from the class were selected for the individual interviews. The first selection criterion was to select only Black students for participation in the study. This, since the Black student population makes up the largest percentage of students at the UT at which the research was conducted (as well as at UTs in South Africa in general), and the highest failure rates occur in this segment of the population (Scott et al., 2007). The second criterion was to select students who attended disadvantaged former Black schools. These schools are also the poorest schools (OECD, 2008). So the selection of students was purposive in the sense that it focused on those students in the course who could be regarded as most "disadvantaged" in terms of their schooling and who statistically could be considered at risk in terms of performance at the UT. Gender was not a selection criteria in the study. Seven of the eight students (Andile, Bongsi, Simphiwe, Siphso, Thando, Vusi, and Xolani) are male. The eighth student, Thembi, is female. It was discovered during the interview process that the student Siphso had completed his high school education at a former White school. Nonetheless, it was decided to include the data from his interview as it provides some interesting contrasts with the wider group of participants. All students identified their home language as isiXhosa. The names of the eight students have been changed for the purposes of reporting in this paper.

## ***Data collection***

Each of the eight students took part in one individual interview during July 2007. The interviews (consisting of semi-structured questions) were conducted by the lecturer of the course. The questions addressed whether group work was used at school, which form of group work was used and of what benefit it was to their learning. The students were asked to describe their experiences of group work in broad detail at the UT, and these responses were followed up with questions on the benefits of group work at the UT, language use in their groups, etc. The lecturer was also the researcher, interviewer and transcriber of the interviews. It was thus necessary from an ethics point of view for the researcher to, in all these situations, be aware of his multiple roles, and to address his dual roles as researcher and lecturer with the participating students.

## ***Analysis of the data***

In a "systematic search for meaning" (Hatch, 2002, p.148) three themes were identified from the transcriptions of the interviews. These relate to (a) students' views on what group work means, (b) descriptions of the type of group work practised at school, and (c) students' descriptions of their positive and negative experiences of group work. Each of these themes was then subcategorised into codes. For example, the theme "descriptions of the type of group work practised at school" was subcategorised into three codes "teacher-initiated group work (formal)", "teacher-initiated group work (informal)", and "student-initiated group work". In some cases it was necessary to further subcategorise these codes so that each code or subcategorised code represented an assertion which could in turn be supported by evidence from the transcriptions.

## Results

We begin this section by presenting the students' perceptions of small group work when studying high school mathematics. We then turn to the student perspective of small group work at the UT, with a focus on the students' descriptions of what happens in these groups and the value students place on the use of group work for mathematics learning. We use student quotes from the interviews as evidence of the students' perceptions. The students are identified by their pseudonyms in these quotes and "I" is used for the interviewer. The number in the square bracket at the end of each quote indicates the line number in the interview transcript.

The data in this paper consists of students' reports (as given in an interview setting) on their use of and views on small group work. This paper does not make use of observations of actual group work in practice. Yet the students' reports are rich in the sense that they are based on the students' experiences of participating in small group work in different settings. They provide insight into what happens in the groups and the conditions under which students feel that group work may or may not be productive for their mathematics learning.

### *Group work for learning mathematics at high school*

Seven of the eight students reported engaging in some form of group work at high school. Only Siphso, who attended a former White school, said that at grade twelve level "you were working on your own" [Siphso, 16].

For the seven students who experienced group work in the mathematics classroom at high school, the nature of this group work varied. In some cases small group work was of a formal type in the sense that it was implemented by the teacher and supported by the physical arrangement of the desks so that students faced one other. In other cases the small group work was informal, with students choosing to work with classmates seated next to them, without encouragement from the teacher to work together. Thando indicated that groups formed spontaneously when he said, "... groups formed without us even knowing we were forming, but it was just the natural thing to do" [Thando, 40].

Thando also indicated that he worked with the same students throughout high school. He described the relationship amongst these fellow students as friends as follows:

...because in grade twelve, the guys that I studied with, I knew from grade six...so it was most like sitting with friends...so it's natural to help to try to help other friends...yeah we also sit as friends...it's more or less the same [Thando, 62].

These descriptions of the students' self-initiated group work in the mathematics classroom suggest that they found value in working on their mathematics with their classmates. Andile's description below of working with his peers at home and of going back to school after hours to get extra help suggests that he found the interaction useful:

At high school we're living in the same village...the guys. And then we do problems when we are at home and go back to school if we got stuck with some problems [Andile, 124].

Andile's comment also suggests what he valued about the group work, that is, getting help from fellow students when he got "stuck with some problems". He argued that this type of support enabled him to "improve my math" [Andile, 70].

Like Andile, Thembi identified small group work outside of the mathematics classroom. Thembi's views emerged when she contrasted her experiences of group work at high school and at the UT. She stayed in the high school hostel where she worked with friends, from her own class as well as from other classes (thus supporting Thando's claim that working with friends enables productive group work):

That one [at school] was better because there was students that always wanted to go and practice Maths [Thembi, 208].

The results in this section provide insight into the students' participation in small groups for learning mathematics in their "background" (Allie et al., 2009, p.362) and what resources they bring to the study of mathematics in higher education. The statements suggest that the students view working together in small groups in the classroom as an integral part of doing school mathematics; it happened irrespective of the physical arrangement of desks in the classroom and whether it was formally initiated by the teacher. The fact that group work happened "naturally" suggests that the students value its role in their learning of mathematics, for example, as an opportunity to get help when having difficulty. The students also identified student learning communities outside of the mathematics classroom, that is, at home or in the school hostel. They pointed to conditions that enable productive group work; small groups formed easily amongst friends or when students stayed in proximity to one another.

### *Group work for learning mathematics at the UT*

In this section we use the students' descriptions to identify small group work that occurs in both formal and informal settings at the UT. Next, we describe the activity that students identify as taking place in these groups. The section ends with students' perspectives on the value of group work for the learning of mathematics at the UT.

### *Group work in different settings at the UT*

As noted earlier, small group work is an official part of the classroom activity in the students' foundation mathematics course and is supported by the physical arrangement of the desks in the classroom. Such formal group work in the mathematics classroom would have been new for some of the students, as suggested by their descriptions of the group work in their high school mathematics classrooms. Sipho described his experience of working in a group in the mathematics classroom at the UT as "better" than sitting individually at a desk at school and provided a reason why, "Even if you don't understand there is another person that can help you out" [Sipho, 42].

Students also identified small group work that happened outside of formal class time at the UT. For example, Andile indicated that he understood group work as a process in which students worked together in class as well as outside of the mathematics classroom. He said that because his group members lived far from him, he went to the residence at the UT to work with other students from his class:

Then the other guy stays in Delft and the other guy stays in Phillipi and they are too far from here [the UT] ...then I am not too far ...I'm staying here in Kuils River. So, I used to come here [the UT] with Bongsi and Siya and Xolani [Andile, 120].

Andile identified himself as a participant in other academic communities at the UT, and not just as a mathematics student at the UT. He noted that he worked with different groups of students in the mathematics classroom and in his engineering drawing course. His argument below suggests that he regarded other students who had done drawing at school as experts who could assist him:

It's different because I've never done...drawings in high school. Sarah and Robert did drawings in high school. So, I wanted to [work with people that know] [Andile, 138].

### *Descriptions of the type of activity in the small groups*

The students' descriptions suggest that participating in a small group involves helping one another to solve problems. This could involve helping another student who is having difficulty:

Yea, because some of us in our group...Lunga...he was struggling with Maths, then we were trying to help him, and then we help him [Andile, 94].

Yet this activity may involve a pooling of resources to the benefit of all involved. Andile described the small group as a place where they "collect minds":

...there are problems that I don't even know how to solve them. So then we collect minds then we can [Andile, 100].

Andile's description indicates that students share ideas for problem solving when working in a small group. Students also talked about explaining to one another. These explanations were sometimes different to the lecturer's explanation and were often more detailed, as suggested by Simphiwe who explained, "Because sometimes a learner...a student like you explains more than a teacher [lecturer]" [Simphiwe, 40].

It is possible that Simphiwe was referring to the lecturer's explanations that were restricted to what was necessary to do a particular problem in the mathematics course at the UT, but which did not extend to students' difficulties with mathematical concepts from high school.

Similar to the sharing of ideas for problem solving is the sharing of shorter methods for solving problems, which Thembi referred to in the following quotation:

Maybe I don't know the easy way to when I am making some calculations but I don't know the easy way I just know the long way... then they can show me the shorter one [Thembi, 100].

Working in small groups on mathematics problems also involves evaluating one another's work. A student pointed out that the students in his group identified one another's mistakes, mistakes that are difficult to pick up when working alone:

For now...yeah...I get help quickly and I passed because of that. Because when there's wrong ... something that I don't understand. When you're working alone you can't even see you're making

a mistake, but when you're working in groups then someone will tell you ...no, you made some mistake here [Simphiwe, 84].

In this quotation Simphiwe also argues that his performance in mathematics improved as a consequence of the support he received in his group. This is discussed further below. Simphiwe suggested that participation in a group is efficient as one can get immediate help in solving problems. He thus did not waste time continuing to work on a problem that was incorrect and also did not have to wait for the lecturer to solve the problem.

We end this section on the description of the activity in the small groups at the UT by describing the language practices within the groups. Seven of the eight students reported that they spoke their home language, isiXhosa, in the groups in the mathematics classroom at the UT, despite the fact that the language of instruction at the institution is English. Siphon, who attended a former White school, indicated that switching between speaking isiXhosa and speaking English in his group at the UT helped him to "understand" mathematics:

I usually ask the teacher, but with the group thing it's also good...because if you don't understand that...maybe you did not grasp it...because it was maybe English, the peers that you're sitting with can also tell you in your own language and you ...understand better [Siphon, 60].

In summary, the students describe the small groups for mathematics learning as exhibiting certain characteristics. Much of the talk is conducted in the students' home language. The activity involves helping one another with mathematics problems. This takes the form of explanations which are usually more detailed or may be different to those provided by the lecturer, sharing problem solving ideas and shorter methods of problem solving, evaluating one another's work, and giving immediate feedback.

### *Perspectives on the value of working in small groups*

All the interviewed students, except for one, expressed positive views of group work at the UT. The description of the activity that takes place in the small groups, presented in the previous section, suggests that these students value group work for providing a particular type of support. The group activity fills the gaps in the support provided by the lecturer. For example, the lecturer cannot provide immediate assistance and feedback to all students as he attempts to cater for the needs of a class of thirty-five students, many of whom need help with high school mathematics. He also does not share the students' home language. In addition the students reported that the valued activity that takes place in the small group is something that they do not experience when working alone:

Yeah, if I had sat alone I don't think my marks would be better ...I think that they would be low because there are some things which I don't understand [Bongi, 54].

Bongi suggested that his marks would be lower if he only worked on his own. Other students also claimed that the support they received by working in groups resulted in improved performances in mathematics, for example, in the previous section we noted Simphiwe's claim that he passed mathematics as a result of the immediate feedback he received from his peers in the group.

Although the students' statements suggest the value they place on small group work for learning of mathematics, some students were concerned that group work made them dependent on others for their performance in mathematics:

Yes, it's been good but sometimes it's like I take an advantage of...I do have people to help me. Sometimes like I don't give myself much time to...to work on my studies alone. It's like depending on other people [Bongi, 62].

However, Bongi also indicated in the above quote that he benefited from group work, and certainly did not dismiss the use of group work. Rather, he argued that dependence could be overcome by working in a group as well as alone:

I will say...it won't be okay to work alone. It's okay to combine them...to work alone and to work with a group [Bongi, 160].

Thembi on the other hand was finding working in a group in mathematics at the UT difficult, and this experience differed from her experience at school:

It's a bit different because you feel that other students don't want to work with you [Thembi, 160].

In her description of group work in her high school hostel Thembi mentioned that she worked with friends and expressed a sense of belonging in a number of different small groups. In contrast, she was new to the area in which the UT is situated and indicated that she travelled a long distance to the UT each day, often experiencing difficulties with public transport. This could account for her difficulty making friends at the UT.

Sipho's description below suggests that simply having the right physical arrangement in the classroom is not enough for enabling group work, but that certain relationships need to be built between participants. He indicated that it took some time at the UT before the group members got along with each other:

At first we weren't that social with each other and we just discuss because we were close ...the desks were close, but as we got to know one other we got to trust each other then we...easy to speak to one another [Sipho, 34].

The students' descriptions of the activity that takes place in the groups points to why they value small group work when learning mathematics; this group work provides support that they do not get from the lecturer or when working alone. Nonetheless, students are realistic about the limitations; they are aware that they also need to be able to perform alone, and that small groups will only function if students feel they belong in the group.

## **Discussion**

In presenting the theoretical framework for this study, we have signalled our intention to engage with the concept of "community" in the theoretical perspective of learning proposed by Allie et al. (2009). This paper has focused on a particular type of student learning community, that is, small

group work in support of mathematics learning. In this discussion we use the empirical results to engage with this perspective in three respects; understanding the communities from which our students come, developing a conception of what the mathematics classroom community at a UT might look like, and describing possible student communities outside the classroom.

Allie et al. (2009, p.362) argue that lecturers need an understanding of the communities from which students come to study at higher education institutions. The results of this study suggest that students are accustomed to working in small groups in the high school mathematics classroom. In some cases the group work in the school mathematics classroom was organised by the teacher, but students also reported taking the initiative themselves to work with other students seated around them, often their friends. The fact the students chose to work with one another in the school mathematics classroom suggests that they found the interaction useful. Most students in this study were also accustomed to doing school mathematics with their peers outside of school hours. Having friends who were also doing school mathematics and feeling comfortable with the group members seemed to enable this type of group work, as did staying in proximity to one another (such as in a school hostel).

In the UT setting, students reflected positively on their experience of group work in the mathematics classroom and identified the group activities that they found useful, for example, getting detailed explanations to aid their understanding (often in their home language), sharing ideas on problem solving, and getting immediate feedback. These findings point to the range of support that group work can provide in the mathematics classroom, and that this is support that they do not get from the lecturer or when working alone. This research confirms the results of studies conducted at universities that argue that students are positively inclined towards group work (for example, van Rheede van Oudtshoorn & Hay, 2004). The findings of this study, this time conducted at a UT, add to Setati's (2002) view that switching between the home language and the language of instruction is quite common in school mathematics classrooms in which these languages are not the same, and that students' home-language can be a resource for learning teaching mathematics.

Some students claimed that the assistance they received when working in groups actually resulted in improved performance in Mathematics. Although this study only set out to investigate students' perceptions of group work, it should be noted that all eight participants in the study passed the Mathematics course at the end of the year, and the pass rate for the course was higher when small group work was a formal part of the course than when this was not used. This improvement could, of course, be explained by a number of factors, for example, the new extended curriculum model implemented in the year in which the research was conducted meant that all courses were credit bearing, providing an incentive for students. However, the results from this study suggest that the group work may well have been a contributing factor. Other studies have claimed that the benefits of group work include gains in academic success (for example, Potgieter & Webb, 2004; Smith, Sheppard, Johnson & Johnson, 2005; Springer, Stanne & Donovan, 1999).

The results of this study provide support for our argument that the concept of "community" used by Allie et al. (2009) needs to take into account the wider student communities outside the classroom. Students referred to working with other students, usually their friends, outside of the mathematics classroom both at high school and at the UT. Students appear to value these groups for mathematics learning.

Participation in a small group outside the mathematics classroom may be of benefit to students in a number of respects, yet some of the students in this study indicated that becoming a participant

in such a group could be difficult. Students who lived with relatives at often a considerable distance from campus argued that participation was difficult. Some students felt that their participation in groups in mathematics at the UT was hampered by not having friends in the class. This sense of loneliness and feeling of not belonging seems to constrain the opportunity to participate in the type of academic activities described by the students as taking place in the groups. These findings support the claims that social factors, for example residence, transport and a sense of belonging, are problems that affect many students, in particular first-year students (for example, Pearce, 2006; Read, Archer & Leathwood, 2003; Solomon, 2007; Tinto, 1997; Wilcox, Winn & Fyvie-Gauld, 2005).

## **Conclusion**

Only eight students were interviewed for this paper and the claims are based on students' perceptions of group work. We acknowledge that actual observations of the use of group work at school and in higher education will not necessarily mirror the students' descriptions. For example, the work of Rogan (2004) suggests that although group work may be used in schools, this tends to be superficial. In the context of a first-year foundation course in mathematics, Le Roux (2009) argues that simply seating students in groups does not imply that the interaction will be productive mathematically. Yet we believe that the empirical data presented in this paper adds to our understandings of a particular type of student learning community, that is, small group work in support of mathematics learning, in both high school and UT settings. Firstly, the perceptions reported are those of Black students whose schooling is considered to be disadvantaged and have been identified as being at risk in the UT setting. Secondly, these perceptions are based on what emerges to be the students' considerable experience of working in groups.

We argue that the results of this study have implications for teaching and learning practice in higher education. Lecturers can draw on the students' experience of working in groups for the study of high school mathematics. These results suggest that the physical arrangement of furniture in a classroom need not be an impediment to using small group, but that lecturers should take into account students' need to develop productive social relationships and a sense of belonging within a group. Given the reported difficulties non-residence students have participating in student learning communities, higher education institutions should consider providing physical space where students can work together at the institution outside of formal class time. These institutions should also take seriously the need to provide residence accommodation to students in foundation programmes.

This study uses empirical evidence to make a contribution to the theoretical perspective of learning as participation in a community proposed by Allie et al. (2009). While the work of Allie et al. (2009) attends quite broadly to communities in the learning of engineering, this study focuses on the learning of mathematics, a key discipline in both science and engineering communities. This paper conceptualises small group work as a student learning community and provides an empirical description of the reported activity in this community, both inside and outside the mathematics classroom at high school and at a UT.

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