Lesotho's Students' Achievement in Mathematics and their Teachers' Background and Professional Development

David Mogari [1]
Jeanne Kriek [2]
Gerrit Stols [3]
Ogbonnaya Ugorji Iheanachor [4]

[1, 2, 4] Institute for Science and Technology Education, University of South Africa
mogarld@unisa.ac.za; kriekj@unisa.ac.za; ogbonui@unisa.ac.za

[3] Dept. of Science Mathematics and Technology Education, University of Pretoria
gerrit.stols@up.ac.za

The study sought to obtain information on the relationship, if any, between students' achievement and teacher background as well as between students' achievement and professional development. The respective correlation coefficient showed that there was a significant relationship between students' achievement and teacher background and an insignificant relationship between students' achievement and the extent of professional development. Of the three components of teacher background (viz., qualification, subject major and teaching experience), teacher qualification showed the strongest significant relationship with students' achievement, followed by level of subject major. But teaching experience displayed a curvilinear significant relationship with students' achievement. It was concluded that quality qualifications and deep subject content knowledge tend to make teachers more effective while teachers improve and develop when they are exposed to quality professional development programmes.

The study primarily seeks to obtain information about the relationship, if any, between students' achievement in mathematics and their teachers' background (refers to qualifications, mathematics major and teaching experience) and professional development, respectively. The study is necessitated by, seemingly, continual poor results produced in mathematics in Lesotho. The examinations report compiled by the Examination Council of Lesotho (ECoL) indicates that, in the past five years, less than 12% of the candidates were able to score up to 50% in the mathematics examination of the Cambridge Oversees School Certificate (ECoL, 2005). The report also shows that in the Junior Certificate (JC) 2004 mathematics examination the average students' performance was F+. For 2005, 4% of the students scored grades A and B while 13% scored grades C and D (ECoL, 2006). For the situation to improve the focus has to be on teachers. They are the ones who daily interact with learners in the class. They also have to prepare and plan lessons they are to teach by knowing, arrange and organise the subject matter knowledge, prepare and organise the necessary teaching-learning resources, and select and identify appropriate teaching strategies for their lessons. In addition teachers have to be 'confident in their ability and skills to guide and facilitate meaningful learning' (Onwu & Mogari, 2004, p. 162), to be able to communicate knowledge and develop complex thinking and problem-solving skills to students (Loucks-Horsley, Hewson, Love, & Stiles, 1998) as well as being able to inspire students to learn.

Teachers, therefore, need relevant education and training to adequately prepare them to aptly handle and manage the teaching-learning tasks they are expected to carry out in class. The education and training provided to teachers should not only focus on familiarising them with various instructional models. But it should also put emphasis on deepening their understanding of the mathematical content, their interpretations of the mathematical content in the context of facilitating meaningful learning, their knowledge of learners' conceptions and learning difficulties (Shulman, 1986). In South Africa, for example, a teacher development programme is essentially required to make a teacher be a learning mediator; interpreter and designer of learning programmes and materials; leader, administrator and manager; scholar, researcher and life-long learner; role model and moral being; assessor; and subject specialist (Department of Education, 2000, p. 13-14). It is hoped that if teachers can display all the seven competencies, they will be in a position to teach effectively and thus facilitate meaningful learning. It can, thus, be argued that the success of students with their studies is at the core of the goals of any education system. Possibly, it is for this reason that teachers are expected to continually upgrade and update both their content and classroom practice knowledge. Hence, the current study, among others, seeks to establish whether there is any relationship between students' achievement and the amount of professional development available to teachers.

From the point of view of ensuring students' success in their studies, the common practice has been to look for teachers with appropriate qualifications. The assumption being that, such qualifications can provide teachers with relevant mathematical content knowledge and classroom practice knowledge and skills. The main focus should not only be on what the qualifications can provide, but should also be on the quality of education. Hence, mechanisms, processes and procedures have been put in place, in countries such as South Africa, to assure and promote the quality of education and training offered in higher education institutions. Each institution is expected to formulate a quality management system to promote and assure quality in its core activities of teaching and learning, research and community engagement. Institutions would then have their quality management systems audited with a view to identifying their strengths and weaknesses (Higher Education Quality Committee, 2007a). In addition, programmes by the higher education institutions offered are reviewed to establish whether their provision complies with the set standards (Higher Education Quality Committee, 2007b). As part of the quality management system, institutions are required to determine the appropriateness and relevance of the qualifications they offer by, among others, at reasonable intervals, conduct tracer studies and employer surveys. Therefore, it is argued that the mathematics teachers with a qualification offered within the purview of such an institutional quality management system have the necessary expertise to do well in their profession. That is, such teachers have been afforded, during pre-service or in-service training, a mathematical content knowledge sufficient enough to enable them manage accordingly the cognitive demands and challenges posed by the content they teach. In terms of classroom practice training, teachers have been exposed to the requisite instructional strategies and techniques to make learning meaningful and fun to students. It is for this reason some information is sought about the relationship, if any, between students' achievement and teacher's background.

Rationale for the study

The students' poor achievement in mathematics has become an issue of global concern. For many years, teachers, researchers and other interested parties have raised debates about which school variables have any association with students' achievement (Darling-Hammond, 2000; Reynoid & Farrell, 1996). To this end a number of research studies have focused on a wide array of factors presumed to be associated with students' achievements in mathematics. For instance, some of the studies focused on teacher qualifications (e.g., Darling-Hammond, 2000; Rice, 2003; Wenglinsky, 2000), some others on teacher subject major (e.g., Wilson & Floden, 2003), some others on teacher teaching experience (e.g., Betts, Zau, & Rice, 2003), and some others on teacher professional development (e.g., Franke, 2002; Kennedy, 1998; Varella, 2000).

Teachers' background

The need to improve students' achievement in mathematics in Lesotho is extremely critical. However, the factors that actually are related to students' achievement in mathematics in the said country, seemingly,

have not been identified by any empirical study and so are not well understood. It is for this reason the present study is conducted in Lesotho with a view to providing some knowledge about the relationships between students' achievement in mathematics and factors such as teachers' qualifications, subject major, years of experience and teacher professional development. Teacher qualification, subject major and years of experience can be considered to constitute teacher background hence they are treated as its composite variables in the present study. But the significant role these factors tend to play in the teaching and learning of mathematics has led to the possible relationships between students' achievement and each of them also being considered.

Teachers' qualifications

There is strong evidence supporting the need for teachers to have rich mathematical content knowledge and deep understanding (Brown & Borko, 1992, p. 209). It is thought that these teacher traits can be related to students' achievement (Collias, Pajak, & Rigden, 2000; Sanders & Rivers, 1996). Therefore, it is argued that students with less exposure to qualified teachers seem far less likely of achieving academic success than those with more. A number of studies have examined the ways in which teachers' highest qualifications are related to students' achievement and many of these studies found that teachers' highest qualifications correspond positively with students' achievement. For instance, Betts, Zau and Rice (2003) found that teachers' highest degree correlates positively with students' achievement. Rice (2003) found that when teachers have an advanced degree in their teaching subjects it will have a positive impact on the students' achievements.

Greenwald, Hedges and Laine (1996) conducted a meta-analysis of studies that examined the relationship between school resources and student achievement; and found a significant positive relationship between teachers' qualification (measured as having a master's degree or not having a master's degree) and students' achievement. Goldhaber and Brewer (1996) indicated that an advanced degree that was specific in the subject taught was associated with higher students' achievement. On the contrary, there are studies that present opposing results. For example, Greenberg, Rhodes, Ye and Stancavage (2004) and Wenglinsky (2000) found that postgraduate qualifications at Masters or higher level were not significantly related to students' achievement. Further study is therefore necessary to shed more information on the relationship, if any, between teachers' qualifications and students' achievement in mathematics.

Teachers' subject majors

The importance of the relationship between teacher subject major and student achievement have repeatedly been acknowledged by leading education groups such as the Education Trust, the Education Leaders Council, and the National Commission on Teaching and America's Future despite being characterised by their diversity and commitment (Thomas & Raechelle, 2000). Several other studies have shown a positive connection between teachers' subject majors and higher students' achievement in mathematics. For example, Wilson and Floden (2003) established that students of mathematics teachers with mathematics degrees as majors tend to demonstrate higher academic achievement in mathematics. But, Wilson and Folden assert that there is a limit at which further mathematics knowledge no longer helps the teacher. Goldhaber and Brewer (1996) found that teachers having a major in their subject area are the most reliable predictor of students' achievement in mathematics and science. Similarly, Darling-Hammond (2000) reported in a review of a study of high school students' performance in mathematics and science that a teacher having a major in his/her teaching subject was the most reliable predictor of students' achievement scores in mathematics and science. Also, Wenglinsky (2002) and Greenberg et al. (2004) indicated that teachers with mathematics major correlated with higher students' achievement in mathematics. Hill, Rowan and Ball (2005) found that teachers' specialised mathematical knowledge was significantly related to student achievement. However, a few other researchers reported inconsistent results about the relationship between teachers' subject majors and students' achievement. For example, Ingvarson, Beavis, Bishop, Peck and Elsworth (2004) found that a number of studies on the relationship between teachers' subject majors and student's achievement in mathematics suggest complex and inconsistent results. Martin, Mullis, Gregory, Hoyle and Shen (2000) and Wenglinsky (2000) also

discovered that mathematics major could not be associated with teacher effectiveness that is linked to meaningful learning which in turn leads students' success. Perhaps, there is a need to explore more the issue of relationship, if any, between students' success and teachers' subject major.

Teachers' experience

A number of studies found that teachers' years of experience positively correlate with students' achievement. For example Betts, Zau and Rice (2003) reported that teachers' experience significantly correlates with students' achievement in mathematics. A report by the Centre for Public Education (2005) showed that there was a positive correlation between teaching experience and higher students' achievement. In fact, teachers with more than five years teaching experience were found to be the more effective than those inexperienced ones. Greenwald et al. (1996) in their meta-analysis of data from 60 studies indicated that teachers' years of teaching experience positively correlates with students' achievement. Similar results were also found by Rivkin, Hanushek and Kain (2005). Their study showed that students of experienced teachers achieved better than those taught by novice teachers. It was reported in Darling-Hammond (2000) that teaching experience is related to students' achievement even though the relationship curvilinear. Darling-Hammond established that mathematics students taught by teachers with less than five years experience had lower levels of achievement. In particular, the achievement of students tends to increase as teachers spend more years teaching. Strangely though, there was no significant difference between the achievement of these students and those taught by teachers with more than five years of experience. The reason for this somewhat weird observation, as Darling-Hammond (2000) explains, could be that there is a tendency to be complacent by teachers after some years of teaching as result teacher effectiveness deteriorates. Another possible reason advanced by Darling-Hammond is that for some reason teacher's enthusiasm fizzles out and this leads to low morale. Contrary to these findings, a few studies like Hanushek (1997), Martin et al. (2000) and Wenglinsky (2002) revealed that the number of years in teaching is not associated with students' achievement. These findings could be attributed to the teachers' high level of preparedness as a result of good quality pre-service education and training obtained. The current study intends to contribute more on the issue of relationship between students' achievement and teaching experience.

Professional development

Another aspect considered critical so far improving student achievement in mathematics is concerned, is teachers' professional development. Loucks-Horsley et al. (1998) refers to teachers' professional development as the opportunities offered to practising teachers to develop new knowledge, skills, approaches and dispositions to improve their effectiveness in their classrooms. In other words, it is advancement/enhancement of teachers' knowledge of the students, the subject matter, teaching practices, and education-related legislation Professional development programmes could include formal and informal means of helping teachers to not only learn new skills but also develop insight into pedagogy and their own practice, as well as exploring new or advanced understanding of content and resources. Professional development, for example, can take place through workshops, cluster meetings, formal presentations by the more knowledgeable persons, further studies and self-evaluation of one's own practice.

However, for some reasons, there have been concerns raised in some quarters about the ineffectiveness of teachers' professional development offered. Ball, Lubienski and Mewborn (2001) reckon teachers' professional development is intellectually superficial, disconnected from deep issues of curriculum and learning, fragmented, and non-cumulative. Little and McLaughlin (1993) argued that professional development programmes only update teachers' knowledge instead of providing an opportunity for sustained learning on issues pertaining to curriculum, students or teaching. On the contrary, Varella (2000) and Franke (2002) indicate that teachers' professional development has positive effects on students' achievement on condition it happens over a considerable time. What is also important for a professional development programme to be effective is what it seeks to achieve or is meant for. For example, the study by Carpenter, Fennema, Peterson, Chiang and Loef (1989) show that professional development rooted in subject matter, focused on students learning and on effective ways to gauge

learning impacted significantly positive on students' achievement. Kennedy (1998) who reviewed 10 research studies on the impact of teachers' professional development programmes on students' achievement also came up with similar findings. Kennedy found that teachers' professional development improved students' achievement when it focused on strengthening teachers' content knowledge and related instructional practices; how students learn; and ways to help students understand subject knowledge. Therefore, the focus and purpose of a teachers' professional development programme are of utmost importance. If teachers can benefit from a professional development programme mainly because it focused on and addressed their specific needs, can this change be related to an improvement in student achievement? It is this that the current study seeks to examine.

Methodology

Research design

The study followed a co-relational research design to determine the relationships, if any, between students' achievement and teacher background and professional development, respectively. Students' achievement was also related with each component of teacher background (viz., teachers' subject majors, qualifications, and teaching experience).

Sample

A convenient sample of Form C (Grade 10) mathematics teachers was derived from 54 secondary schools in the Maseru district, Lesotho. Of these schools, 40 (75%) are owned by the Missions, 6 (10%) are owned by the government, 4 (7,5%) are owned by the communities and 4 (7,5%) are owned by private individuals or organisations. Of the 53 teachers that availed themselves for the study, 6 came from government schools, 6 were from community schools, 37 descended from mission schools and 4 were from private schools. A stratified random sample of 40 teachers was selected from the initial 53 to ensure that each type of school was proportional represented in the final sample. Students who took part in the study were those taught by these teachers.

Instrumentation

A self report questionnaire called Mathematics Teaching Opinionate Scale (MaTOS) was used. This is a modified version of a self report survey questionnaire developed by Horizon Research Incorporated (2001) in the United States to gather in-depth information from teachers. The questionnaire was modified by only including sections that elicited detailed information relevant to the present study. The content validity was tested by involving experts in the field of Mathematics Education. Its reliability was determined using Cronbach's alpha coefficient and yielded values of 0,76 for teachers' background and 0,79 for professional development. The questionnaire was also pre-tested with 13 Form C mathematics teachers who were not part of the current study.

A Form C mathematics examination question paper was administered to students during the end of the academic year. This is an examination conducted by the Examination Council of Lesotho (ECoL). Mathematics question papers are jointly set by mathematics teachers and examiners. They are then content validated by the subject officers, specialists and the subject team members drawn from ECoL and the National Curriculum Development Centre. The reliability of the 2006 Form C mathematics question paper was determined by K-R 21 formula which gave a value of 0,92.

Data collection

The MaTOS self report was administered to the participating teachers and data on mathematics students' achievement was obtained from ECoL 2006 Form C examination results.

Results

Students' Achievement and Teachers' Background

Table 1 shows that 65% of the teachers have been teaching for more than 10 years and 80% of the teachers have a minimum of a bachelor's degree. Furthermore, 52,5% of the teachers have majored in Mathematics or Mathematics Education and this implies that there is considerable number of the mathematics teachers who, arguably, could be deemed not to have enough Mathematics knowledge and skills.

Table 1: *Teachers' demographic information* (N = 40)

Teaching Experience	**% of teachers**
0 – 5 years	20,0
6 – 10 years	15,0
11 –15 years	32,5
16 –20 years	12,5
Over 20 years	20,0
Qualification	
Certificate	5,0
Diploma	15,0
Bachelors	67,5
Masters	12,5
Doctorate	0,0
Mathematics/Mathematics Education major	
Yes	52,5
No	47,5

Correlation analysis was then used to determine whether there was any relationship between students' achievement in mathematics and each component of teachers' background (viz., teaching experience, qualifications and subject majors). There results thereof are presented in Table 2.

Table 2: *Correlations between students' achievement and each component of teacher's background* (N = 40)

Variables	**Correlation Coefficients**
Teaching experience	0,393*(Pearson r)
Qualifications	0,547**(point biseral $r_{pt\ bis}$)
Mathematics or Mathematics Education majors	0,467*(biseral r_{bis})

*significant at $p < 0,05$, ** significant at $p < 0,01$

According to Table 2 there were significant positive relationships between students' achievement and each of the components of teachers' background.

On the issue of a curvilinear relationship between students' achievement and teacher experience raised in Darling-Hammond (2000) and Hawkins, et al. (1998), it was determined whether the teachers' years of experience greater than five years and that greater than ten years were respectively related to the students' achievement. Table 3 shows that there was a significant relationship between students' achievement and teachers' years of experience greater than five years. But, there was no statistically significant relationship between students' mathematics achievement and teachers' experience of more than ten years. In fact the data show that the trend of relationship between students' achievement and teacher experience seems to level off round about ten years.

Table 3: *Correlations between students' achievement in mathematics and teaching experience*

Variables	**r**
Teaching experience > 5 years	0,416*
Teaching experience > 10 years	0,313

*significant at p < 0 ,05

Regression analysis was used to examine the relationship between the dependent variable (student achievement) and the independent variables (teachers' qualifications, subject majors and years of teaching experience). It allows for the determination of the variance between the dependent variable and the independent variables as well as to determine the independent variables that are statistically significant predictors of students' achievement in mathematics. Table 4 shows the regression analysis results involving students' achievement in mathematics as the criterion variable (dependent variable) and the three independent variables (teachers' qualifications, subject majors and years of teaching experience).

Table 4: *Relationship between the criterion variable (achievement) and the three independent variables* (Regression analysis) (N = 40)

Model summary					
R	R Square		F		p
0,600	0,360		4,321		0,015
Model	Unstandardised Coefficients		Standardised Coefficients		
	β	Std. Error	Beta	t	p
Constant	0,450	1,070		0,420	0,678
Teaching experience	0,159	0,155	0,188	1,026	0,316
Qualifications	0,771	0,434	0,373	1,778	0,089
Subject Majors	0,348	0,417	0,176	0,835	0,412

Table 4 indicates that the three statistically significant predictors accounted for 36 percent of the students' achievement in mathematics ($R^2 = 0,36$). Teaching experience ($\beta = 0,16$, $p < 0,5$), teachers' qualifications ($\beta = 0,77$, $p < 0,5$) and subject majors ($\beta = 0,35$, $p < 0,5$) demonstrated significant relationships on students' achievement in mathematics. The coefficients of the model indicate that the three regressors can be ranked in order to quantify their relationship with the dependent variable by starting with teachers' qualifications (0,77), subject major (0,35) and teaching experience (0,16). In other words, in the context of teachers' background, teachers' qualifications accounted for 77% variation in students' achievement in mathematics, while 35% and 16% can be attributed to teachers' subject majors and teaching experience, respectively.

Students' Achievement and Professional development

In terms of professional development, the following aspects were looked at: time spent by teachers on professional development in the last three years, the frequency of various forms of professional development programme and the activity carried out during a professional development programme. Each of these aspects was then correlated with students' achievement.

Time spent on professional development

The duration of teachers' participation in professional development in the last three years is shown in Table 5. The table shows that only 20 percent of the teachers have spent 35 or more hours in professional development in the last three years.

Table 5: *Duration of professional development in the last three years* (N = 40)

Time	Percentage of Teachers
None	22,5
Less than 6 hours	17,5
6-15 hours	25,0
16-35 hours	15,0
More than 35 hours	20,0

The frequency of various forms of professional development programmes

Table 6 presents the various professional development programmes the teachers have taken part in during the last three years.

Table 6: *Teachers' participation in professional development programmes* (N = 40)

Programme	% of teachers
Taken a formal college/university mathematics course	22,5
Taken a formal college/university course in the teaching of mathematics	25,0
Observed other teachers teaching mathematics as part of your own professional development (formal or informal)	70,0
Met with a local group of teachers to study/discuss mathematics teaching issues on a regular basis	65,0
Collaborated on mathematics teaching issues with a group of teachers at a distance using telecommunications	32,5
Served as a mentor and/or peer coach in mathematics teaching, as part of a formal arrangement that is recognised or supported by the school or district	32,5
Attended a workshop on mathematics teaching	52,5
Attended a mathematics teacher association meeting	37,5

From Table 6, it is evident that *observing other teachers teaching mathematics* either formally or informally was the most commonly reported form of professional development. *Meeting with a local group of teachers* to study or discuss mathematics teaching issues on a regular basis was the second most frequently used professional development programme while *attending a workshop focused on mathematics teaching* was the third.

Correlation analysis was used to find the relationship between students' achievement in mathematics and the respective indices of the three most popular forms of professional development programmes, namely, observing other teachers, meeting to study or discuss mathematics teaching and attending workshops on mathematics teaching. Table 7 shows that there was no significant relationship.

Table 7: *Correlations between students' achievement in mathematics and variables defining professional development programmes* (N = 40)

Variables	r_{bis}
Observing other teachers	0,05
Meeting to study or discuss maths teaching	0,10
Attending workshop	0,27

The activity carried out during a professional development programme

According to Carpenter et al. (1989) professional development programmes are successful if it is rooted in subject matter and focused on student learning. Table 8 indicates that only 5 percent of the teachers reported that their professional development largely emphasised deepening their mathematics content knowledge, while 12,5 percent reported that their professional development activities largely emphasised understanding student thinking in mathematics.

Table 8: *Emphasis of teachers' professional development activities* (N = 40)

Professional development activity	**Percentage of teachers**					
	No response	Not at all	Slightly	Moderately	Largely	To a great extent
Deepening my own mathematics content knowledge	7,5	5,0	30,0	52,5	5,0	0
Understanding student thinking in mathematics	7,5	5,0	27,5	47,5	12,5	0
Learning how to use inquiry/ investigation-oriented teaching strategies	7,5	5,0	10,0	62,5	15,0	0
Learning how to use technology in mathematics instruction	7,5	20,0	25,0	45,0	2,5	0
Learning how to assess student learning in mathematics	7,5	5,0	12,5	62,5	12,5	0
Learning how to teach mathematics in a class that includes special needs students	7,5	27,5	25,0	12,5	10,0	17,5

The teachers were also asked to indicate how much emphasis was placed on the various professional development activities they participated in the past three years. Table 9 shows the correlation between emphasis on the professional development activities and students' achievement. The table shows that each of the professional development activities that emphasise *deepening teachers' mathematics content knowledge*, *understanding students thinking in mathematics* and *learning how to assess student learning in mathematics* correlate positively but insignificantly with students' achievement in mathematics.

Table 9: *Correlation between students' achievement and professional development activities*

Variables	r_{bis}
Deepening my own mathematics content knowledge	0,318
Understanding student thinking in mathematics	0,353
Learning how to use inquiry/investigation-oriented teaching strategies	-0,224
Learning how to use technology in mathematics instruction	-0,047
Learning how to assess student learning in mathematics	0,125

*p < 0,05, **p < 0,01 (N = 40)

Table 9 shows that professional development activities that emphasised *learning how to use inquiry/investigation-oriented teaching strategies* and *learning how to use technology in mathematics instruction* to a great extend have negative insignificant relationship with students' achievement in mathematics.

Students' achievement correlated with teachers' background and professional development

The respective components of the two main variables (viz., teachers' background and professional development) were then combined and each of the variables was correlated with students' achievement. According to Table 10 teachers' background has a positive significant relationship with students' achievement while professional development has positive but insignificant relationship with students' achievement.

Table 10: *Correlation between students' achievement in mathematics and combined indices of teachers' background, and professional development*

Variables	r_{bis}
Teachers' background	0,552**
Professional development	0,209

*significant at p < 0,05, **significant at p < 0,01

To further verify the results in Table 10, multiple regression analysis of the combined variables with students' achievement was carried out using SPSS. The results of multiple regression analysis presented in Table 11 do confirm that teachers' background correlate significantly with students' achievement while there is no significant relationship between students' achievement and the extent of professional development.

Table 11: *Combined effects of the indices of teachers' background, professional development*

		Sum of squares	df	Mean square	F	Sig.
Teachers' background	Regression	15,134	3	5,045	4,321	0,015
	Residual	26,853	23	1,168		
	Total	41,998	26			
Professional Development	Regression	9,657	5	1,931	1,209	0,341
	Residual	31,953	20	1,598		
	Total	41,609	25			

Discussions

The purpose of the study was to determine if there is any relationship between students' achievement teachers' background and professional development, respectively. The results of the study show that there was a significant positive relationship between students' achievement and teachers' background. The results are consonant with prior findings by Goldhaber and Brewer (1996), Betts et al. (2003), Darling-Hammound (2000), Wilson and Floden (2003). This implies that an improvement in teachers' background can be connected with an improvement in students' achievement. For a country like Lesotho, which has been having a problem of poor performance in mathematics of the years (ECoL, 2005; 2006),

there might be a need to prioritise the improvement of mathematics teachers' background if the students' achievement is to be improved.

Similar results were also obtained between students' achievement and each of the components of teachers' background, namely, teachers' qualifications, teachers' subject majors, and teachers' years of experience. Of the three, teachers' qualification correlated most significantly with students' achievement followed by teachers' subject major and lastly teaching experience. In other words, students whose teachers have higher qualifications are likely to perform better in mathematics than students whose teachers have lower qualifications. This finding confirms those by Greenwald et al. (1996), Goldhaber and Brewer (1996), Betts et al. (2003) and Rice (2003). It can be argued that the strong connection existing between teachers' qualification and students' achievement implies that as teachers acquire additional qualifications their knowledge, skills and attitude tend to improve. In turn the effectiveness of teachers in the classroom can translate into better learning for students (Kriek, 2005).

In addition, the regression analysis results in Table 2 showed that teachers' qualifications are the greatest predictor of students' achievement in mathematics in Lesotho. However, the results also showed that 20% of teachers do not have a degree and 47,5% do not have mathematics major (see Table 1). It may very well be that this unpleasant state of affairs is connected with the prevalent high rate of students' poor achievement in mathematics in Lesotho. Thus, a significant relationship was obtained in this study between students' achievement and teachers' mathematics major. This further supports the earlier findings of Goldhabler and Brewer (1996), Wenglinsky (2002), Wilson and Floden (2003), and Greenberg et al. (2004). The results seems to imply that teachers without mathematics major are not considerably knowledgeable in mathematics content and this tends to affect the quality of the teachers' pedagogical content knowledge which is essential in facilitating meaningful learning.

The result showed that there was a significant relationship between students' achievement in mathematics and teachers' years of experience, even though the correlation coefficient obtained was the lowest as compared to those of the other two components of teachers' background. Nevertheless the results do affirm those by Greenwald et al. (1996), Hawkins et al. (1998) and Rivkin et al. (2005). What also emerged from the results is the issue of curvilinear relationship between students' achievement and teachers' experience. The trend of the relationship tends to level off when teachers reach ten years of service. It may very well be that the teachers' effectiveness fizzles out with time mainly because most teachers (≥80% according to Table 5) have had less than 35 hours of professional development over three years. This is limited to have any significant effect on teacher improvement (Garet, Porter, Desimone, Birman, & Yoon, 2001). Furthermore, the popular forms of professional development for the teachers in the present study (in order) are watching their peers teaching; interacting with peers regularly and attending workshop on mathematics teaching (see Table 6). It can be argued that even though teachers are encouraged to discuss and share their daily classroom experiences among themselves and observe each other teaching, there has to be "an expert figure" to provide corrective feedback and suggestions (Onwu & Mogari, 2004). Therefore, it may be that no new ideas and skills are fed from the external source into the communities of teachers instead ideas and experiences are continually being recycled among the participating teachers. This, then, compromises the quality of professional development programme teachers attended. Hence, as teachers acquire more years of teaching there is little improvement in their students' achievement.

In conclusion the study presented yet further information on the relationship between students' achievement and teachers' background as well as between students' achievement and teachers' extent of professional development. The study showed that the former relationship was positive and significant while the latter was just positive. This implies that the quality of qualifications teachers are exposed to is closely related to how their students achieve. The qualifications should provide teachers with the necessary amount of subject content and skills to become effective in their classrooms. Furthermore, for teachers of mathematics to be competent enough they should acquire the highest possible amount of mathematics in their qualifications.

In terms of the insignificant relationship between students' achievement and the extent of professional development, the issue of quality seems yet again to be at the centre. If teachers are not subjected to a quality professional development programme they tend not to improve and develop (The Professional

Affairs Department, 1999). This means that the teachers' classroom practice fails to improve regardless of the time they spent teaching. It may be argued that the teachers' knowledge of relevant instructional strategies, knowledge of appropriately representing mathematics content for teaching, knowledge of students' conceptions and students' learning difficulties, (see Shulman, 1986), cannot be improved through a poorly structured and badly planned professional development programme. It then tends to follow that the effectiveness of any teachers' professional development programme is essential for the improvement of students' learning. Since the current study only focused on the relationship, possible studies might be necessary to determine the effects of teacher background (as defined in the current study) and the extent of professional development on students' achievement.

References

Ball, D. L., Lubienski, S. T., & Mewborn, D. S. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.), *Handbook of research on teaching.* Washington DC: AERA.

Betts, J. R., Zau, A. C., & Rice, L.A. (2003). *Determinants of student achievement: New Evidence from San Diego*. San Francisco, CA: Public Policy Institute of California.

Brown, C. A., & Borko, H. (1992). Becoming a mathematics teacher. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers and Mathematics* (pp. 209-237). New York: Macmillan.

Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C., & Loef, M. (1989). Using knowledge of children's mathematics thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26*(4), 499-531.

Collias, K., Pajak, E., & Rigden, D. (2000). *One cannot teach what one does not know: Training teachers in the United States who know their subjects and know how to teach their subjects*. Retrieved from http://www.c-b-e.org/PDF/OneCannotTeach.pdf.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy analysis Archives*, *8*(1), 1-44.

Department of Education (2000). *Norm and standards for educators. National education policy act 27 of 1996*. Pretoria: Government Printers.

Examination Council of Lesotho. (2005). *JC 2004 pass list*. Maseru: Examination Council of Lesotho.

Examination Council of Lesotho. (2006). *JC 2005 pass list*. Maseru: Examination Council of Lesotho.

Fennema, E., & Franke, M .L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers and Mathematics* (pp. 147-164). New York: Macmillan.

Franke, M. (2002, April). *Designing professional development to support generative growth in teachers with different knowledge, skills and identities*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Result from a national sample of teachers. *American Educational Research Journal*, *38*(4), 915-945.

Goldhaber, D. D., & Brewer, D. J. (1996). *Evaluating the effect of teacher degree level on educational performance*. Washington, DC: National Center for Education Statistics.

Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of Educational Research*, *66*(3), 361-396.

Greenberg, E., Rhodes, D., Ye, X., & Stancavage, F. (2004, April). *Prepared to teach: Teacher preparation and student achievement in eighth-grade mathematics*. Paper presented at the annual meeting of the American Educational Research Association, San Diego, Calif.

Hanushek, E. A. (1997). Assessing the effects of school resources student performance: An update. *Educational Evaluation and Policy Analysis*, *19*(2), 141-164.

Hawkins, E. F., Stancavage, F. B., & Dossey, J. A. (1998, April). *School polices and practice affecting instruction in mathematics*. Paper presented at the annual meeting of the American Educational Research Association, San Diego, Calif.

Higher Education Quality Committee. (2007a). HEQC Institutional Audit Manual. Pretoria: CHE Publisher.

Higher Education Quality Committee. (2007b). HEQC Programme Review Manual. Pretoria: CHE Publisher.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Horizon Research Incorporated. (2001). *Report of the 2000 national survey of Science and Mathematics education.* Chapel Hill: Horizon Research, Inc.

Ingvarson, L., Beavis, A., Bishop, A., Peck, R., & Elsworth, G. (2004). *Investigation of effective mathematics teaching and learning in Australian secondary schools.* Canberra: Australian Council for Educational Research.

Kennedy, M. (1998). *Form and substance in in-service teacher education (Vol.13)*. Arlington VA: National Science Foundation.

Kriek, J. (2005). *Construction and evaluation of a holistic model for the professional development of physics teachers via distance education*. (Unpublished doctoral dissertation). University of South Africa, Pretoria.

Lauer, P. A. (2006). *An educational research primer: How to understand, evaluate, and use it.* San Francisco: Jossey-Bass.

Little, J. & McLaughlin, M. (Eds.). (1993). *Teachers' work: Individuals, colleagues and context*. New York: Teachers College Press.

Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, K. E. (1998). *Designing professional development for teachers of science and mathematics.* California: Crownin Press, Inc.

Mayer, D. P. (1999). Measuring instructional practice: Can policymakers trust survey data? *Educational Evaluation and Policy Analysis, 21*(1), 29-25.

Martin, M. O., Mullis, I. V. S., Gregory, K. D., Hoyle, C., & Shen, C. (2000). *Effective schools in science and mathematics*. Chestnut Hill, MA: International Study Centre, Boston College.

Onwu, G.O.M., & Mogari, D. (2004). Professional development for outcomes-based education curriculum implementation: the case of Univemalashi, South Africa. *Journal of Education for Teaching*, *30*(2), 161-177.

Reynoid, D., & Farrell, S. (1996). *Worlds apart? A review of international studies of educational achievement involving England*. London: HMSO.

Rice, J. K. (2003). *Teacher quality: Understanding the effectiveness of teacher attributes.* The Economic Policy institute. Retrieved November 02, 2006, from http://www.epinet.org/content.cfm?id=1500.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers' schools, and academic achievement. *Econometrica*, *73*(2), 417-458.

Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement*. Knoxville, TN: University of Tennessee.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15,* 4-14.

The Professional Affairs Department. (1999). *Standards of practice for the teaching profession*. Toronto, Ontario: Ontario College of Teachers.

UNESCO. (2006). Teachers educational quality: Monitoring global needs for 2015. Retrieved from http://www.uis.unesco.org/TEMPLATE/pdf/Teachers2006/Teachers_Ch2.pdf

Varella, G. F. (2000). Science teachers at the top of their game: What is teacher expertise? *Clearing house, 74*(1), 43-50.

Wenglinsky, H. (2000). *How teaching matters*: Princeton, NJ: Educational Testing Service.

Wenglinsky, H. (2002). How schools matter: The link between teacher classroom practices and student academic performance. *Education Policy Analysis Archives*, *10* (12). Retrieved from http://epaa.asu.edu/epaa/v10n12/.

Wilson, S. M., & Floden, R. E. (2003). *Creating effective teachers: Concise answers to hard questions*. Washington: American Association of Colleges of Teacher Education.