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Factors associated with high school learners' poor performance: a spotlight on mathematics and physical science

Andile Mji and **Moses Makgato**
mjia@tut.ac.za

This study, using a non-experimental, exploratory and descriptive method, established learners' and educators' views about factors that contribute to poor performance in mathematics and physical science. Participants were purposefully selected from seven schools with poor pass rates in District 3 of Tshwane North. Focused group interviews with ten Grade 11 learners from each school were used as a means to collect data. In addition, one-on-one semi-structured interviews were conducted with ten educators from the participating schools. Results indicated that two factors were identifiable. The first identified to have a direct influence related to teaching strategies, content knowledge, motivation, laboratory use, and non-completion of the syllabus in a year. The second factor, associated with indirect influences, was attributed to the role played by parents in their children's education, and general language usage together with its understanding in the two subjects. Recommendations as well as suggestions for further research aimed at addressing the identified factors are advanced.

Introduction

Education and training during apartheid was characterized by the under-development of human potential, generally, and that of blacks in particular. The teaching and learning of mathematics, science and technology were the hardest hit (Department of Education (DoE), 2001a). Several studies (e.g. Howie, 2003) have reported a number of shortcomings in the teaching and learning on mathematics and science in South Africa. For example, the Third International Mathematics and Science Study (TIMSS) conducted in 1995, in which South Africa participated with 41 others, reports that South African mathematics learners came last with a mean score of 351 (*ibid.*). This mean was significantly lower than the international benchmark of 513. Less than 2% of these learners reached or exceeded the international mean score (Beaton *et al.*, 1996). TIMSS-R conducted in 1999 revealed that Grade 8 learners once again performed poorly. Their mean score of 275 was significantly below the international mean of 487. Also, the South African mean of 275 was lower than that of Morocco, Tunisia, and other developing countries such as Chile, Indonesia, Malaysia, and the Philippines (Howie, 2001; Naidoo, 2004). A later TIMSS-R conducted in 2003 similarly indicated no improvement by South African mathematics and science learners (Reddy, 2004). A different investigation (*cf.* DoE, 2002), targeting Grade 4 learners indicated for example that learners only obtained an average of 30% for numeracy. Another study was conducted by the Monitoring Learner Achievement (MLA) project organised by UNESCO and UNICEF. The MLA's objectives are to continuously monitor the quality of basic educational programs and assess learning outcomes (*cf.* UNESCO/UNICEF: Monitoring Learning Achievement Project, 2005). In this project, Grade 4 learners from a number of African countries were assessed against a set of internationally defined numeracy and literacy learning competencies. Findings from countries including Tunisia, Mauritius, Malawi, Zambia, and Senegal, indicated that South African learners ranked fourth with an average literacy score of 48.1% and rated last with respect to numeracy, scoring at 30.0% (DoE, 2001a).

The research examples presented here paint a gloomy picture of the state of the teaching and learning of mathematics and science in South Africa. This country is in need of suitably qualified teachers, doctors, scientists and many other scientifically oriented professionals. With the status of mathematical and scientific literacy generally poor in the entire schooling system (Howie, 2003; Center for Development in Education (CDE), 2004), it is conceivable that such a system will not be able to produce enough learners who qualify to enrol at universities to pursue further SET studies. Currently, South Africa does not have the capacity to expand economically without importing foreign scientific and technological expertise (Pratzner, 1994; Frantz, Friedenberg, Gregson & Watter, 1996; Ramsuran, 2005; Gardner & Hill, 1999; Department of Arts, Culture, Science and Technology (DACST), 1996). If this country is to participate in the technologically advancing global village, it is necessary that research should inform policy and drive transformation to a mathematically and scientifically literate society. This is extremely important because the lack of expertise impacts on the general economic outlook of the country. For example, to provide employment for all, either through job creation or employment in the labour market, a level of scientific and technological advancement that will enable growth and expansion of the economy is needed. At present, South Africa is far from this ideal situation.

Status of mathematics and science educators

It has been reported that outdated teaching practices and lack of basic content knowledge have resulted in poor teaching standards. The poor standards have also been exacerbated by a large number of under-qualified or unqualified teachers who teach in overcrowded and non-equipped classrooms. The combination of all these factors has in turn produced a new generation of teachers who are further perpetuating the cycle of mediocrity (DoE, 2001a). The National Teacher Education Audit of 1996 followed by the mathematics and science Audit of 1997 produced factual and statistical revelations about teachers and teaching in these areas. Whilst policies and programmes have been produced on a general scale, very little has happened at a systemic level to address the challenges of providing quality mathematics and science teachers. In fact, the mathematics and science Audit revealed that more than 50% mathematics and 68% science teachers have had no formal subject training (DoE, 2001a). The problem of inadequate training was particularly identified in the general education phase of the schooling system (*ibid.*). The Education For All (EFA) 2000 assessment (2005) also reported that, in spite of approximately 85% of mathematics educators being professionally qualified only 50% have specialized in mathematics in their training. Similarly, with 84% of science educators professionally qualified, only 42% are qualified in science. An estimated 8 000 mathematics and 8 200 science educators therefore needed in-service training to address their shortcomings in these subjects (DoE, 2001a). Another problem is that very few students graduating with mathematics and science choose teaching as a career. A consequence of this is a vicious cycle of not many students taking mathematics and science related subjects at universities resulting in an under-supply of educators. In some instances, this has resulted in schools not offering mathematics and physical science (*ibid.*). Even those that offer these subjects do not have facilities and equipment to promote effective teaching and learning. This situation has resulted in the teaching of physical science, for example, remaining at a theoretical level without any experiments to enhance understanding and application of knowledge (*ibid.*).

To address these problems, such as under-qualified teachers and too few students taking mathematics and science related subjects, a number of initiatives and programmes have been developed at national and provincial levels as well as by higher education institutions. From the government side, a typical example is the setting up of *Dinaledi* schools, which are to be increased to about 400. The *Dinaledi* focus schools project is described as:

> The *DINALEDI* Focus Schools Project is part of the National Strategy for Science, Mathematics and Technology, to increase the number of learners studying mathematics and physical science in Grades 10–12; to increase the number of higher grade learners in these subjects — especially girls and formerly disadvantaged learners; to increase the pass rate and achievement in mathematics and science in these grades; to develop the capacity of the mathematics and physical science teachers (Western Cape Department of Education, 2005).

Universities have also introduced bridging courses aimed at improving the content knowledge of mathematics and science students entering university. What has been shown is the fact that a number of issues impact on the teaching and learning of mathematics and science throughout the school system in South Africa. The present study, based on a USAID-TELP sponsored research project, was undertaken to explore some of the factors that possibly contribute to the lack of success in mathematics and physical science among Grade11 learners.

The problem in context

Although the study focuses on Grade 11 learners, a closer look at Grade 12 performance will contextualise the problem far more. Grade 12 results are good in illustrating problems because these can be analysed in many ways, for example, using school-related variables, gender-related issues of learners and educators, and resources available to individual schools. Also, such analyses are relatively fair because national standards are maintained through the results being examined and moderated by external bodies, to minimize bias (Kahn, 1994). This means that all schools at least write the same examinations and therefore comparisons based on the results should generally be valid. Such comparisons are also useful in indicating the factors that lead to poor performance.

In contextualising identified problems with mathematics and physical science, the 1999 matric results for schools in District 3 of Tshwane North were analysed. District 3 comprises 20 high schools with approximately 100 Grade 12 learners in each school. Included in this analysis were four top-performing, as well as eleven low-performing schools. A second analysis, intended to provide a provincial perspective, focused on the 2003 matric results. It should be noted here that the two respective years were only used for illustrative purposes. However, these years in many ways exemplify performance in any other year. That is, choosing these particular years, does not in anyway distort what has been happening both in the district and provincially. In effect, any two years for example 2003 and 2004 could have been chosen. However, going back in years provides a better illustration of the history of the problems investigated in this study.

Grade 12 District D3 results — 1999

Table 1 shows average passes for both mathematics and physical science that each of the different District D3 schools obtained in 1999 (Gauteng Department of Education (GDE), 1999). It may be observed from the table that of the 15 schools, the low performing 11 schools (73.7%) had an average of 35% or less in mathematics. It can also be seen that the mathematics pass rate ranged between 10.3% and 59.5% among the schools. In physical science the same 11 schools had an average of 43% or less. Here, the pass rate ranged between 20.9% and 63.5%.

Table 1 Average passes (%) of selected schools in Tshwane North District D3 in 1999*

High schools	% Average pass	
	Mathematics	Physical Science
A	59.5	63.5
B	50.3	51.7
C	48.3	47.0
D	47.4	47.8
E	34.9	43.4
F	25.3	36.5
G	19.6	32.2
H	18.0	39.6
I	17.5	31.4
J	15.7	34.6
K	15.0	34.1
L	13.0	36.3
M	11.9	29.9
N	10.4	24.7
O	10.3	20.9

* Adapted from GDE, 1999, analysis of results
School names are not included for ethical reasons

Grade 12 Gauteng results — 2003

To contextualise the performance of learners, Table 2 shows the percentage pass rates achieved by 2003 learners of mathematics and physical science in Gauteng province (GDE, 2003). Whilst this study was not concerned about results and examinations, it is worth pointing out, however, that the examinations and results of 2003 were particularly criticised for poor quality. This point is raised here because it also illuminates problems experienced in the teaching and learning context of mathematics and physical science. Part of the criticism related to scepticism about a 25% national pass rate jump over a five-year period. In fact, critics did not believe that all the provinces could produce this sudden improvement. Regarding the criticisms, an editorial in the Sunday Times (2004) pointed to a strong and growing public perception about the standard of performance in Grade 12 being lower than in previous years. To this effect, Jansen (2004) did not see the value of the passes. In his argument, he pointed to the fact that in critical subjects where learners had to show excellent capacity, more than two-thirds failed in higher-grade mathematics and about 50% failed in physical science. Also, in Limpopo, which achieved a 70% pass rate, more than 55% failed mathematics.

Whilst the results presented in Table 2 appear to be good, further analysis of both the district and provincial results proved the contrary. In fact it illustrated consistent poor performance running through the system. For example, Tshwane North District D3 had an average

Table 2 Mathematics and physical science candidates in HG and SG with percentage passes — 2003*

Subject / Grade	N			%
	Entered	Wrote	Passed	
Mathematics HG	9 109	9 062	6 710	74.0
Mathematics SG	34 390	33 765	17 969	53.2
Physical Science HG	10 804	10 639	7 070	66.4
Physical Science SG	17 382	17 078	11 492	67.3

* Adapted from GDE, 2003, analysis of results

pass rate of 24.6% (mathematics) and 36.0% (physical science). The Gauteng provincial averages meantime were 27.7% and 36.6% for the two subjects, respectively (GDE, 2003). These averages appear to indicate that this district was an average performer with respect to the results of the province.

Purpose

Studies (e.g. Legotlo, Maaga & Sebego, 2002; Mashile, 2001) in South Africa have investigated and reported on different factors that affect teaching and learning, in general, and those of mathematics and physical science in particular. The recurring poor performance in these subjects calls for a concerted effort on measures that will help improve the *status quo*. One important element in an endeavour to find solutions to the problems of poor performance by learners is to undertake investigations that will help inform stakeholders. Research investigations on reasons why learners fail are important because they help to identify the problem that needs to be resolved. A number of factors can be attributed to the fact that very few learners take mathematics and physical science at school and even those who do so do not perform well in these subjects. It could be, for example, that learners are not motivated to study these subjects because they observe the high failure rate and are scared off. The purpose of this study was therefore to investigate some of the factors that could be associated with high-school learners' poor performance in mathematics and physical science. In focusing a research spotlight on mathematics and physical science, the intention was to give a voice to educators and their learners, who in a sense are directly at the 'coal face'. In particular the investigation sought to determine:

- Which factors educators perceived to be associated with poor performance in mathematics and physical science by Grade 11 learners; and
- which factors Grade 11 learners perceived to be associated with their poor performance in mathematics and physical science.

Method

In this study, a qualitative, non-experimental, exploratory and descriptive (Babbie, 1998) approach was followed. This approach was seen as ideal, because the aim was to capture in-depth views of both the educators and their learners. Such views would hopefully put into perspective, the context in which the teaching and learning of mathematics and physical science takes place. Also, the views would provide an empirical basis of what could be done to counter the contributory factors to poor performance in these subjects.

Participants and study context

The target population for the present study were schools in District 3 of Tshwane North. Consent to conduct the present investigation was given by authorities in all the schools. A convenient sample of seven schools from Soshanguve were chosen. This sample was chosen in respect of poor average performance by all schools in this area. In fact, the seven schools had produced low pass rates in Grade 12 mathematics and physical science in 1999. Also, targeting the seven schools allowed for coverage of different areas of Soshanguve.

Table 3a Learners: characteristics of the sample

Gender	Age range	N	%
Girls	16 – 19 years	190	54.3%
Boys	16 – 19 years	160	45.7%

Table 3b Educators: characteristics of the sample

School	Gender	Age	Subjects taught		Experience (years)
G	Female 1	33		Physical Science	7
I	Female 2	34	Mathematics	Physical Science	9
K	Female 3	30	Mathematics		5
O	Female 4	29		Physical Science	5
K	Male 1	32		Physical Science	7
O	Male 2	30	Mathematics		7
J	Male 3	36	Mathematics	Physical Science	9
G	Male 4	38	Mathematics		12
M	Male 5	33	Mathematics	Physical Science	9
N	Male 6	40	Mathematics	Physical Science	15

Tables 3a and 3b show the characteristics of the sample. The participating schools had approximately 350 Grade 11 learners. The sample included 10 educators from the selected schools. It may be seen from the table that three schools (School G, K and O) had one educator teaching mathematics and another educator teaching physical science. The other four schools had one educator teaching both subjects. Although all were teaching either mathematics or physical science, only half of the educators had proper qualifications to teach the subjects. Also, all the educators had a teaching experience of five years or more.

Focus group interviews with ten Grade 11 learners from each of the seven schools were used as a means of collecting data. The learners were randomly selected such that boys and girls were representative of classes at each participating school. In doing this, girls were selected, for example, with respect to how they were performing among themselves and in the entire class. In doing this girls, for example, were grouped into two groups. One group comprised those who had aggregate test marks that were greater than or equal to 50% whilst the other group's aggregate marks were below 50%. From each of the groups, five learners were randomly selected. Here the researchers wrote learners' names on pieces of paper and in a raffle format selected ten girls. Out of the ten girls, five were then selected to participate in the study. The same selection process was followed for boys resulting in sub-samples of ten learners in each school. Following the focus group interviews, two learners from each school participated in a follow-up interview schedule. These two learners were chosen from those that had previously been interviewed. The follow up interviews were meant to cross-check what learners had said and to ensure that the researcher's impressions were a true reflection of the learners' views. One-on-one interviews were also conducted with each of the ten teachers. Procedures to be followed were explained to participants and all indicated they were comfortable with being tape recorded for example. In most instances the interviews were in Sepedi, hence the need to record. This language was preferred because all learners, their teachers, and the researcher were first-language speakers. Also, the researcher felt that interviews conducted in participants' mother tongue would allow them to be as candid as possible. Learners were asked to indicate (a) what they thought contributed to the high failure rate in South Africa in mathematics and physical science; (b) what they thought was responsible for poor performance in their schools; and (c) what they attributed their own sources of success or failure to in these subjects. The questions were intended to be as neutral as possible in order not to influence the participants in anyway. Based on responses, further probing questions were advanced. Educators responded to similar questions which were an adaptation of learners'.

Findings

In analysing the data, the researchers read and independently sorted responses from both the learners and their educators. In sorting the responses, statements projecting similar ideas were grouped together. For example, a statement like, "... *we never receive help from our mathematics teachers* ..." would be grouped together with a statement like "... *I wish my mathematics teacher could help me understand geometry* ..." The sorting process was followed by the researchers initially cross-checking common agreements. For approximately 5% of the statements there was disagreement as to how to classify these. The researchers deliberated on the disagreements in an endeavour to reach consensus. In all instances consensus was reached and mismatches were eventually classified. From the classifications, seven batches each representing a similar group of statements emerged. The researchers inspected the different groups for further commonality and trends amongst each. Out of this process two distinct categories emerged. One category was interpreted to represent factors with direct influences on the teaching and learning context whilst the other represented factors with indirect but important and related influences. It should be noted here that in all instances where learners' names are indicated, these have been changed as anonymity was promised.

Direct influences

Five areas identified by the participants were collectively classified under this category of factors. These related to (a) Teaching strategies; (b) Content knowledge and understanding; (c) Motivation and interest; (d) Laboratory usage; and (e) Syllabus non-completion. In the following section, excerpts illustrating what was reported about each of the categories are provided.

Teaching strategies

About teaching strategies, Mapula, in reflecting her inabilities and a need to be helped indicated "... *my problem is that the teacher is too fast ... I do not understand maths. I want someone who is patient and does not get angry with me*". On the same sentiments, another learner, Thabo said: "... *you find that you tell the teacher that you don't understand he ends up shouting and asking ... how come you don't understand such an easy sum? ... you just don't use your brains* ...". In another context learners blamed others for disturbances and unwarranted conduct. To that effect, Refiloe insisted that "... *sometimes there are those who are not serious and want to disturb those who are willing to learn*". Educators on the other hand saw things differently. For example Female 2 from school I, indicated "*Our children don't want to learn ... teachers try their best but they ... they never even want to try*". Male 5 from school M similarly indicated "*If our students could be serious about their studies everything would be well*".

Content knowledge and understanding

Regarding content, learners indicated that they battled with both subjects. For example, Mabatho indicated "... *I sometimes wonder why the teacher talks about things done last year instead of teaching it now* ..." In another pertinent instance, learners insisted "... *we are memorizing. We don't understand. When we ask the teacher ... he does not know. What can we do?*" Educators, on the other hand, admitted to shortcomings they had with respect to certain sections of the content they were teaching. An example here was one who confessed "*truly speaking with linear programming, when I touch that area I'm dead* ... (laughing) ... *I get sick for a week*".

Motivation and interest

With respect to motivation and interest, learners did not seem to identify shortcomings from their side. Blame was for example apportioned to educators, a lack of textbooks, and even the school. Here a learner, Kgomotso pointed out "*I do not see how I can be motivated, there are few textbooks at school ... nobody cares*." Interestingly, the educators generally questioned the learners' commitment. One educator insisted "... *if they* [learners] *can behave ... come to school on time, do the homework, concentrate in class ... motivation would not be a problem*".

Laboratory usage

Attending laboratory sessions is important in learning physical science because practical work in a way brings to life what is explained in textbooks. By seeing educators demonstrating or conducting experiments themselves, learners supplement what is in textbooks and as a result learning is enhanced. An advantage of laboratory usage is that it helps improve learners' higher order learning skills such as analysis, problem solving, and evaluating. One of the points that learners complained about was the lack of laboratory equipment. A number of the learners expressed a similar view as articulated by Thabang,

> *I think it would be better if when they teach science and physics that they should show us when they ask about sulphuric acid, I don't know what is sulphuric acid, it will just be an abstract thing, that name, when they tell you that when you mix this and that gives you that, you don't know what is that.*

Educators shared a similar view as their learners. To this effect, Male 1 from school K stated

"*... with science you cannot just teach theory ... we don't have equipment, I can go with you and open the laboratory it is empty ...*"

Non-completion of the syllabus

With respect to the non-completion of what is supposed to have been taught over a year, learners and their educators had differing views. Learners for example generally thought a lot of time was spent teaching what they perceived their educators knew best. About this Karabo said, "*... we spend most of the time learning algebra which is easy but what about geometry which is difficult? That is why we do little geometry ...*". Also, educators were seen to come late to class which over long periods meant a lot of lost time. Kidibone corroborated this. She stated, "*Everyday ... you sit for five minutes waiting for the science teacher ... how many minutes a month ...*". Educators, on the other hand, identified activities like sport and breaks in teaching as time consuming and impeding. Almost all the educators mentioned the fact that they generally did not have enough time to complete the syllabus content.

Indirect influences

Here, two areas are classified under this category of factors. These related to (a) Parental role and (b) Language. Both learners and their educators identified parents as very important participants that affected or could play a role in improving learners' performance at school. In spite of this identified importance, it seems both parties agreed that parents were however not involved. About this, Male 1 from school K said "*Parents never come to meet us and ask about their children ... but sometimes I understand they do not have the time*". Regarding parental involvement, Lehlohonolo for example indicated "*I think we must involve our parents ... we must not always blame our teachers only*". When asked how parents could be involved Kganelo indicated "*I don't know ... my parents don't know maths and physics so how can they be involved ...*"? This is a point that learners could however not find a solution about. Educators mentioned the problem of learners taking subjects whose content parents did not understand. Suggestions here included parents just checking whether school work including homework was done. Educators in a way wanted the parents to see to it that children attempted given homework and not present excuses at school. Parents could also see to it that time was allocated for homework and monitor that it was at least done. The educators felt that this level of involvement was reasonable and it should not affect parental daily business.

With respect to the language of instruction, it was apparent from the interviews that learners had problems. Some learners complained that it was difficult to understand some of the concepts used in both mathematics and physical science. In one way, the language of instruction — English in this case — is generally a problem on its own. Considering that mathematics and science use a language sometimes peculiar to the subject, overlaps in usage tend to affect learners' understanding of the subject and result in alternative conceptions. A typical example may be seen from a statement by Kagiso, "*All these things are abstract like speed, velocity, acceleration ... how can you see a difference ... speed is speed, it is moving fast ...*". It appears here that Kagiso associates speed with 'moving fast' — an English definition. On the other hand, to her speed does not seem to make conceptual sense when defined scientifically. The findings reported here are consistent with those identified in literature (*cf.* Sibaya & Sibaya, 1996). Educators corroborated the language problem. Most felt that it was sometimes difficult to explain things in the vernacular because it brought confusion and a misinterpretation of ideas. Asked how they coped with the language issue, Male 3 from school J pointed out "*I stick to the language of the textbook and hope that learners will understand it as I explain*".

Discussion

In the present study, learners' and their educators' responses to factors that could be associated with poor performance in mathematics and physical science were categorised into direct and indirect influences. Factors with a direct influence related to teaching strategies, content knowledge, motivation, laboratory use, and non-completion of the syllabus content over a year. On the other hand, indirect influences were attributed to (a) the role played by parents in their children's education, and (b) general language usage.

The DoE's (2000) Norms and Standards for Educators lists the roles of educators as being, among other things, learning mediators; designers of learning programmes and materials; and learning area/subject/discipline/phase specialists. It is noticeable that the direct influences reported in the findings of the present study resonate with the norms outlined by the department. It appears that for such norms to be attained and the quality of passes from schools to improve, a number of issues need to be addressed immediately. Such issues include the provisioning of resources at the schools, and perhaps importantly an enabling environment that encompasses educators' pedagogical content knowledge (PCK). PCK is described to relate to

> ... ways of representing the subject which makes it comprehensible to others ... [it] also includes an understanding of what makes the learning of specific topics easy or difficult ... (Shulman, 1986:9).

With respect to the provisioning of resources, this should help dispel excuses of no textbooks and laboratory equipment and such. Regarding an enabling environment, research (e.g. Pfundt & Duit, 1994) into students' learning about science has generally outlined the prevalence of alternative conceptions about ideas in science among learners. Such research, which is linked to social constructivism, has described learning to be influenced by learners' cognitive frameworks that are related to prior experiences and their cultural influences (Driver, Asoko, Leach, Mortimer & Scott, 1994). It is important therefore that educators should be aware of such influences if utterances such as Mapula's "*... I do not understand maths. I want someone who is patient and does not get angry with me*" are to be adequately addressed. Mapula's concerns could be addressed through the knowledge of the scope and sequence of teaching programmes and the materials used in them (Huckstep, Rowland & Thwaites, 2005). Further, her concerns could be addressed by incorporating PCK which includes knowledge of common misconceptions, and strategies for addressing them. This is consistent with findings that learners admired good personal qualities and teaching techniques, as well as teachers who were patient and explained things clearly (DoE, 2000a). Desirable teacher qualities are reportedly linked to good subject knowledge, teaching skills and classroom management, relationships with learners, dedication, accessibility, and hard work (*ibid.*).

It has been argued that "a common maxim in the educational profession is that one teaches the way one is taught" (Thomas & Pedersen, 2003:319). This suggests for example that an educator who was educated in an incompetent manner will have learnt bad practice and is likely to use such in teaching others. About this, Hiebert, Morris & Glass (2003:201) have stated,

> People learn to teach, in part, by growing up in a culture — by serving as passive apprentices for 12 years or more when they themselves were students. When they face the real

> challenges of the classroom, they often abandon new practices and revert to the teaching methods their teachers used.

It is critical therefore that educators are involved in refresher courses, which because they will be conducted by different people, should hopefully result in changes from their normal practice. In a sense, motivation is a function of confidence. It should follow that if educators are confident with respect to knowledge of the subjects they teach, have a grasp of common misconceptions learners present in the classroom, and possess strategies for inducing learners' conceptual change through PCK then motivational issues would be much easier to handle. That being the case, hopefully, learners will see the value and importance of education. Also, with motivated and confident educators, statements such as "*... if they* [learners] *can behave ... come to school on time, do the homework, concentrate in class ...*" could be a thing of the past because this would 'rub onto' learners who themselves would be motivated and eager to learn with understanding.

With respect to indirect influences, it is argued here that, in fact, language transcends both direct and indirect influences. This is because second language speakers of the language of instruction generally need tuition in that language, which is English in this case. Because the language used in mathematics and science sometimes overlaps with everyday English whilst not necessarily meaning the same, it sometimes results in misconceptions or at least confusion among second-language speakers. Examples of these occurrences are well documented in literature for both mathematics and physical science (*cf.* Clarkson, 1991; Tartre & Fennema, 1995; Young, 1997). Also in South Africa, studies (e.g. Howie, 2003; DoE, 2000) have documented the relationship between mathematics achievement and learners' proficiency in English.

Another indirect influence was attributed to parental involvement. Studies (e.g. Steinberg, Lamborn, Dornbusch & Darling, 1992) have reported a positive relation between perceived parental involvement and learners' achievement. The positive relationship was unfortunately not replicated among this study's learners. This is a finding that has similarly been reported in other studies in this country (*cf.* Singh, Mbokodi & Msila, 2004). Parents have the distinct advantage over anyone else in that they can provide a more stable and continuously positive influence that could enhance and complement what the school fosters on their children. In this regard, parental involvement is undeniably critical. Also, involvement with respect to participating in school functions, buying necessary school equipment (books, uniforms) is important. However, with regard to the content of what children learn, many fall short because in general they do not possess the necessary education and therefore find it difficult to determine and understand what was done at school (Mji & Mbinda, 2005). This is a point also raised by a learner in this study, "*... my parents don't know maths and physics so how can they be involved ...?*"

Although the results reported here are from a convenient sample, they nonetheless provide important insights and indicators into what could be plaguing the teaching and learning of mathematics and science especially among historically disadvantaged schools characterised by poor resources. It is acknowledged, however, that schools from similar areas have indeed produced good results comparable to more affluent areas. What this suggests is the fact that the results of this study may not be generalised to all historically disadvantaged schools. Also, it is acknowledged that a number of variables that possibly may have had an influential role on learner performance were not investigated (*cf.* Pillay, 2004). One critical variable for example is the socio-economic status and hence work-related demands on the parents. It could be that parents leave very early for work, come back late and tired which results in schooling activities of their children being the last thing they would practically consider participating in. All this notwithstanding, the voices of educators and their learners provide critical insights about factors that in totality with other variables could be attended to in addressing poor performance in mathematics and physical science in South African schools.

In the present study, pedagogical content knowledge has been identified as an important aspect in terms of the impact educators may have towards improving poor performance in mathematics and physical science. It is recommended here that relevant school-based, clustered, provincial and national workshops targeting mathematics and physical science educators should be conducted if the usefulness of PCK is to be enhanced. Such workshops, which would be part of continuous professional development, should provide a platform where educators share their knowledge, strategies that work, problems and frustrations, as well as allow them to be up to date with innovations in education in general. It is critical too that necessary equipment such as books, laboratory equipment and chemicals be supplied to schools in good time for their use to be maximised. While the involvement of teachers in PCK related training may be a medium- to long-term event, it is also only fair that an enabling and conducive learning and teaching environment that gives all the stakeholders a fair chance to perform at their best be generated as is the case in the best performing schools, even within District 3 of Tshwane North.

Regarding the arguments advanced here, and in a quest to improve the poor performance of learners it is suggested that perhaps future studies should determine not only the educators' and learners' voices but include the views of parents. A number of variables have been shown to impact on learners' achievement. For example the relationship reported elsewhere (e.g. Gibson & Dembo, 1984) between teachers' self-efficacy beliefs and learners' achievement could be investigated. Future studies could also investigate the different learning environments within District 3 of Tshwane North, which hopefully will illuminate the impact of disparities among the different schools. Such studies could also include a determination of a number of educator variables such as relevant subject teaching qualifications, teaching experience, teaching workload, and job satisfaction as impacting on learner achievement.

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Authors

Andile Mji is Professor of Research and Innovation in the Faculty of Education, Tshwane University of Technology. His research interests focus on school mathematics and science, learning and teaching, conceptions of and approaches to learning of mathematics, classroom learning environments, and new methodologies in mathematics, science and technology education.

Moses Makgato is Lecturer in the Faculty of Education, Tshwane University of Technology. His research interests focus on teacher education, curriculum and use of technology in teaching. He has 11 years lecturing experience and is the project leader of the National Science week at TUT.