

Art. #1582, 9 pages, <https://doi.org/10.15700/saje.v39n3a1582>

Finding the missing variables: A systematic review of mathematics improvement strategies for South African public schools

Claire Gaillard 

Department of Social Justice Education, Faculty of Education, University of KwaZulu-Natal, South Africa
gaillardc@ukzn.ac.za

The future of South Africa's economic growth rests on addressing critical scarce-skills labour shortages. Matriculants are called on to break the cycle of poverty by entering the scarce-skills workforce. The demonstration of a high level of mathematics, science, and technology competency is viewed as a gateway towards achieving this goal. The South African Department of Basic Education has invested much effort towards improving mathematics, science and technology competencies among learners by implementing various mathematics improvement strategies in public schools. The existing research, however, shows that these initiatives have yielded little success among learners from impoverished schooling contexts. Reasons for this limitation were explored by means of the systematic review reported on in this paper. The review focused on literature relating to mathematics improvement strategies in public schools implemented by the South African Department of Basic Education. The limitations of these initiatives were critically evaluated and gaps in various documented strategies were identified. The findings highlight an evident need for a shift in focus of future interventions if the national goal to address scarce-skills labour demands through educating the impoverished South African youth is to be successfully realised. Suggestions are offered on how this change might happen.

Keywords: critical variables; mathematics improvement strategies; social science; socio-economic inequality; South African public schools; underperformance

Introduction

The nation waits anxiously for the official announcement of the National Senior Certificate (NSC) results. At a widely publicised awards ceremony, the minister of education applauds successful schools; the names of underperforming schools are publicly declared. This scenario plays out annually at the commencement of the South African school year.

However, soon after the excitement of the matriculant pass rate has settled, the ensuing academic year will usually see underperforming schools receiving special attention from the Department of Basic Education (DBE) (Campbell & Prew, 2014; McCarthy & Oliphant, 2013). In an attempt to improve overall school-culture and performance (Heystek & Terhoven, 2015), the academic and professional activities in such schools will be placed under close surveillance; remedial interventions will be implemented and closely monitored. Interestingly though, for the teachers and learners of underperforming schools, much of the assistance that they receive from the DBE is specifically focused on improving mathematics results. The Second Chance Matric Programme is one example of such assistance (Allais, 2017). Introduced by South Africa's national Department of Basic Education in 2015, this initiative offers a structured support programme for matriculants from underperforming schools who have not passed the NSC examination and wish to rewrite the examination in the subsequent academic year.

The importance of showing a high level of competency in Mathematics is of critical concern for matriculants themselves – particularly those from impoverished communities. This interest is bolstered by an awareness of the link between the NSC examinations, mathematics achievement levels, national poverty alleviation goals, and gaining entry to the highly remunerated scarce-skills labour domain (Allais, 2017). Relatedly, in a media report released by the DBE, the Minister of Basic Education, Angie Motshekga, reaffirmed the DBE's commitment to “eradicating the legacy of Bantu Education with a focus on improving quality of mathematics, science and technology education across the sector” (DBE, Republic of South Africa, 2015:para. 11). She claimed the following:

The oppressive Bantu education system denied many Black learners the opportunity to study mathematics at high school level. Thus learners, who were capable of being accountants, engineers, actuarial scientists, pharmacists, medical doctors, and other professions requiring mathematics as a prerequisite, were denied the opportunity to fulfil their dreams. This included mathematics teachers. (DBE, Republic of South Africa, 2015:para. 12)

Among South African leaders, mathematics proficiency is not simply perceived as a gateway to specific scarce-skills career paths (Campbell & Prew, 2014; McCarthy & Oliphant, 2013), but ultimately as a means of achieving socio-economic justice, specifically among historically deprived communities.

Despite communal pressures on underperforming South African schools to improve mathematics output rates, statistics show that many do not achieve the projected targets (McCarthy & Oliphant, 2013). A report commissioned by the Centre for Development and Enterprise (CDE) states that the teaching of Mathematics in South Africa at that time (2013) was globally deemed to be “among the worst in the world” (McCarthy & Oliphant, 2013:3). This significant and distressing description is a further reason why mathematics instruction (and more precisely, mathematics teachers' capabilities) remains high on the DBE's agenda (McCarthy &

Oliphant, 2013). Interestingly though, research (Campbell & Prew, 2014) shows that despite many proficient teachers' efforts to improve learners' mathematics scores, mathematics pass rates may even plummet in some schools and a simultaneous increase in Grade 11 and Grade 12 drop-out rates can be anticipated. One can also expect a notable decline in Grade 10 learners opting to study Mathematics as a core subject for the remainder of their schooling careers.

The resignation by many teachers in underperforming schools further compounds the DBE's efforts to address underperformance in Mathematics among South Africa's matriculants. Although the exodus of teachers is largely due to teacher frustration and burnout (Johnson & Naidoo, 2013, 2017), it may also be attributed to many teachers who are unable to meet the mathematics pass rate targets – despite their personal efforts to prevent their professional reputations from being tainted (Heystek & Terhoven, 2015; MacKinnon, 2008).

The distressing underperformance rates in Mathematics in South African public schools, the primary accountability for these concerning trends being ascribed to mathematics teachers, and the resignation of many mathematics teachers, prompted the systematic review reported on in this paper. The aim of the review was to determine in what ways missing critical variables might be addressed in future designs of mathematics improvement strategies for public schools, if the DBE's goals to improve mathematics scores among underperforming learners are to be significantly achieved. In order to determine this, it was necessary to identify variables that the DBE seemingly considered to be effective in swaying matriculation pass rates in Mathematics. In this paper, these variables are referred to as critical variables. To suggest how the identified critical variables might be addressed in future designs of mathematics improvement strategies, it was important to identify variables that have been discounted by the DBE in their current initiatives. In this paper these variables are referred to as missing variables.

Research Design and Methods

A systematic review approach was employed for the research inquiry reported on in this paper to gather, analyse, and interpret relevant literature. Methodological guidance was drawn from the writings of Hallinger (2013), Petticrew and Roberts (2006), and Victor (2008). These authors have written extensively on the stages of the systematic review approach to research. More importantly though, their writings centre on conducting systematic reviews in social science research; hence most relevant to this study. Due to the limited scope of this paper, only a brief outline is

offered on how suggestions provided by these authors were applied to the research.

The first step of the systematic review was to identify the significance, aims, and objectives of the research and the key questions to be answered (Hallinger, 2013; Petticrew & Roberts, 2006; Victor, 2008). Regarding significance, Victor (2008) explains that systematic reviews have three main intentions. Firstly, "systematic reviews may be particularly useful for disseminating the key findings of large, complex bodies of research literature to policymakers and practitioners who are unlikely to have the time themselves to consider carefully the validity and reliability of individual studies" (Victor, 2008:1). In line with this intention, the current research was conducted primarily with educational policymakers and practitioners in mind, who, due to numerous factors (Heystek & Terhoven, 2015; Johnson & Naidoo, 2013, 2017), are unlikely to conduct a study of this nature on the phenomenon under consideration. Secondly, Victor (2008:1) claims that systematic reviews "also offer an opportunity for the social research community to consider its own efforts in terms of quality of existing research and its reporting and to avoid duplication of effort." Finally, Victor (2008:2) asserts that "the synthesis of efforts in some of the particular ways used in systematic reviews may also produce new findings in relation to a social policy or issue." This corresponds with the researcher's professional goals for employing a systematic review approach to the reported research.

Once the significance of the research, the underpinning research aims and objectives, and the research question were determined, the next step was to source literature that would best address the research inquiry. Literature most relevant to addressing the key questions was obtained. It was important, however, to not merely review broad and general published works on the subject, but rather to carefully decide on the selection of the sources (research reports, national policies, journal articles, books, and so forth) and their relevance to addressing the research questions. In this regard, one should keep in mind that the quality of the selected literature is a crucial aspect to consider when choosing literature for systematic review research; since it is **the quality of the selection** that differentiates a systematic review from a traditional literature review (Hallinger, 2013; Keele, 2007; Petticrew & Roberts, 2006).

In addition, assessing the quality of selected studies is important in allaying concerns about the validity and reliability of the selected works. In this regard, Keele (2007) and Petticrew and Roberts (2006) offer a range of templates and checklists that may be used to assess the credibility of different types of selected works (for example, research reports, policies, journal articles, and

books). Their templates are also useful in locating any biases within the selection. Keele (2007) and Petticrew and Roberts' (2006) writings were therefore equally valuable in assessing the quality of the selected sources reviewed for the research reported on in this paper. Keele's (2007) templates were also applicable in assessing, arranging, and rearranging the selected literature and to ensure that what was analysed remained in line with the research inquiry.

Thereafter I explored conceptual understandings of variables as referred to in the social sciences. This was carried out in light of Trochim's claim (1999:6) that "we won't be able to do much in research until we know how to talk about variables." A conceptual model was hence designed to identify, arrange, and interpret the variables from the literature reviewed for this paper, and to guide the analysis and findings emerging from the literature. More specifically, it enabled the categorisation and analysis of research reports and credible journal articles – particularly those relating to mathematics improvement strategies implemented in South African public schools in the recent past (2010 to 2017). From this model, it became clear which variables were considered as being critical in swaying mathematics results by the DBE leadership. It also became evident which fundamental variables had been flouted in the DBE's implemented mathematics improvement strategies. Critical variables that needed to be foregrounded in the DBE's future design of mathematics improvement strategies for public schools were thus emphasised.

In order to determine how the missing variables might be addressed in future mathematics improvement strategies, the next step of the systematic review process was to synthesise findings emerging from an analysis of the selected literature. Keele's (2007) templates for synthesising emergent findings were found to be most useful in this process.

Discussion

Exploring the Variables of Mathematics Improvement Strategies for South African Public Schools

A broad literature survey on variables, their definitions, and applicability to this paper unveiled an overwhelming spectrum of variable types, showing that different sets are applicable to different theoretical domains, research intentions, and methodological approaches. Considering that this paper aims primarily to contribute to the social science scholarship, only those variables relevant to the social science research domain were considered in the current research. Consequently, only dependent, independent, mediating, moderator, extraneous, and confounding variables, in relation to the DBE's national mathematics improvement

strategies for public schools, are "talked about" (Trochim, 1999) in this paper.

It is important to note that I am aware that the talked about variables may be applicable to all subjects in the entire schooling experience, and not exclusively to mathematics teaching and learning. However, while other subject areas may benefit from the mathematics improvement strategies employed by the DBE, interventions appear to be chiefly aimed at improving mathematics scores. The probability that the output rates of other subject areas might improve may be an incidental benefit of these efforts. Consequently, in this paper I refer to such interventions described in the literature as mathematics improvement strategies.

Dependent and independent variables

Dependent and independent variables can be described as "cause and effect variables" (Cherry, 2016). An independent variable denotes a characteristic that is manipulated for change (Cherry, 2016). Hence it is the variable changed by the experimenter on the assumption that any change will directly affect the dependent variable. A dependent variable is therefore affected by the independent variable in the sense that any changes to the independent variable will automatically result in changes to the dependent variable. If one then relates this description of dependent and independent variables to South Africa's national mathematics improvement strategies for public schools, the independent variable will denote the studying required by learners in preparation for their matriculation examinations. The results achieved will denote the dependent variable. Consequently, the success of the dependent variable (in this case, an improvement of the results) will depend primarily on the independent variable (in this case, studying) having been successfully undertaken.

However, the desired outcome will not only be affected by study, but rather by the forms that studying will take. These would include a range of classroom and homework activities and independent learning in preparation for formal assessments. In social sciences the various forms of preparation are more commonly referred to as mediating variables (Baron & Kenny, 1986; MacKinnon, 2008; Sobel, 2008). The mediating variable (i.e. classwork, homework, individual learning, and extra tuition) manipulates the independent variable (studying undertaken), which is manipulated for changing the dependent variable (results achieved).

Mediating and moderator variables

In social science "mediators explain how external physical events take on internal psychological significance" (Baron & Kenny, 1986:1176). Mediators can thus be described as being

intermediate in the causal relationship between two variables, such that an independent variable causes the mediating variable, which causes the dependent variable (MacKinnon, 2008). Referring to the research at hand a mediating variable would denote the form that studying takes in preparation for National Senior Certificate formal assessments (Trochim, 1999). The DBE views these mediating variables (homework tasks, assignment activities, extra tuition) as vital in preparing learners for their mathematics examinations.

However, one must also pay attention to the notional hours spent on preparation. The frequency of studying, the number of tasks to complete in preparation, and the number of hours that learners spend in preparation for their assessment are referred to as moderator variables. The moderator variables, which include the notional hours that learners to spend on these tasks are thus critical in the success of mathematics outcomes. However, the problem with these moderators lies in the fact that teacher-led instruction is still the preferred means of formal assessment preparation in South Africa (Umugiraneza, Bansilal & North, 2017). Learners are required to attend extra tuition during weekdays outside of school hours, on weekends, and during holidays. These issues create logistical challenges for learners from low-income and impoverished communities, who do not have the means (financial and transport) to attend these initiatives. After-school chores, which are not under the children's direct control also present a barrier to the effectiveness of these mediating and moderating variables. For many children from impoverished communities this involves, among others, parenting responsibilities to younger siblings (Prinsloo, 2008; Somsetsu, Erasmus, Lukelelo & Roman, 2015). It seems as though the DBE did not consider these factors when designing the mathematics improvement strategies. In social sciences research these external forces are referred to as extraneous and confounding variables (Trochim, 1999). Although the literature survey indicates that addressing specific extraneous variables is evidently critical to mathematics improvement strategies, many escalate into confounding variables. The following section expounds on this in more detail.

Extraneous and confounding variables

Like an independent variable an extraneous variable causes changes to a dependant variable. However, whereas an independent variable can be chosen and controlled, an extraneous variable causes an unplanned, and therefore undesired, effect on the dependent variable (McLeod, 2018). A literature survey on the national mathematics improvement strategies for South African public schools uncovered a number of extraneous variables ostensibly considered the reason for low

mathematics performance. These variables include children's biological ages at the stage of intervention, classroom overcrowding, ill-health, and poor quality of teaching. Due to the limited scope of this paper these variables are discussed in brief, with the main purpose of delineating the impact that each could have on the South African NSC mathematics scores. The DBE's efforts and limitations in addressing each are also briefly outlined.

Children's biological ages at the stage of the intervention

This variable relates to the phases of schooling (and hence the biological ages of children) at which the DBE intervenes to improve mathematics results. In this regard, the Centre for Development and Enterprise (CDE) conducted a project into the mathematics score trends in South African education (McCarthy & Oliphant, 2013) and found that remedial interventions for public schools target older children – learners in high schools, and more specifically, those in Grade 12 (McCarthy & Oliphant, 2013). Further research into this phenomenon (McCarthy & Oliphant, 2013; Spaul & Kotze, 2015) emphasises that failing to address a learners's learning deficits earlier on in formal schooling will inevitably result in their underperformance in later years. For this reason, Spaul and Kotze (2015) advocate for remedial interventions in the early stages of a child's schooling. Spaul and Kotze's (2015) research revealed that poor children who attend Quintile 1–3 schools (Mestry, 2018) are three years behind their Quintile 5 peers. This is predominantly because poor (Quintile 1–3) schools lack the resources to implement nationally prescribed learning programmes. More financially viable public schools (Quintile 5), are not restricted by this challenge; they can rely on parents to meet the financial costs of implementing remedial learning programmes in such contexts.

However, the DBE has not altogether abandoned the junior phases of learning in terms of providing mathematics teaching and learning support. The Thutong portal, for example, was designed to address mathematics-learning barriers in the lower levels of schooling (Schiefelbein & McGinn, 2017; Verster, 2011). However, an online search of the resources uploaded onto the Thutong portal demonstrates clearly that this support initiative mainly provides resources to mathematics teachers in the form of prescribed syllabi, lesson plans, textbooks, and clear, standardised assessment tasks and criteria for all South African public schools. At the time of this research, support for learners (especially those who experience learning difficulties) and caregivers (who require guidance in assisting these learners) was not evident on the Thutong portal.

Classroom overcrowding

Overcrowded classrooms significantly confounds mathematics performance in South African public schools (Bayat, Louw & Rena, 2014a, 2014b; Bush, Joubert, Kiggundu & Van Rooyen, 2010; Sibanda, 2015; Uduku, 2015; Visser, Juan & Feza, 2015). Overcrowding is not caused by learners, but by a lack of classrooms (Bush et al., 2010) and mathematics teachers. Whatever the cause, learners' individual achievement may be gravely compromised by learning in an overcrowded classroom. All learners, irrespective of their intellectual abilities, will struggle to concentrate and may become demotivated to learn in an overcrowded, hot, noisy, and (in many cases) unhygienic room (Marais, 2016). The DBE's interventions (and failures) in addressing these infrastructural challenges are widely documented (Bayat et al., 2014a, 2014b; Sibanda, 2015; Uduku, 2015; Visser et al., 2015). However, one must keep in mind that the DBE's efforts to raise funds for building more classrooms and employing more teachers cannot be instantaneously achieved (Marais, 2016). The problem of overcrowded classrooms will, therefore, not easily be resolved in the short term.

Ill health

Bush et al. (2010) describe this variable as one which subsumes a wide range of factors causing children to become listless, despondent and demotivated, namely, hunger, poverty, infections, and intestinal infestations (Fleisch, 2008). An unhealthy child might not focus as well as a healthy child (Hochfeld, Graham, Patel, Moodley & Ross, 2016). As mathematics requires focus and concentration, the South African government has done well to address health and nutritional needs in schools by collaborating with the Department of Social Welfare and the Department of Health. As a measure of poverty alleviation the national government has initiated feeding schemes in schools. The Department of Health regularly undertakes disease eradication initiatives by providing free critical inoculations to all learners in public schools. On the other hand, one could also criticise the DBE's perception of these vital health improvement initiatives as being the foremost solution to improving whole-school performance results (Fleisch, 2008). A lack of concentration due to ill health, however, goes much deeper than being hungry or sick (Fleisch, 2008). Focus and concentration becomes difficult due to noise, disruptions, and discomfort in overcrowded classrooms.

Furthermore, healthy learners may also fail to concentrate on their mathematics homework in a home where the living environment is not conducive to academic work. A child who is fed, dewormed and inoculated at school, would still

need to negotiate learning in an uncomfortable home context – such as one occupied by many family members, or one where children have additional after-school responsibilities like parenting younger siblings, or one situated in noisy surroundings.

Furthermore, in creating spaces outside of the school parameters in which learners may prepare for formal (mark-carrying) assessments, joint partnerships between communities and the DBE are not apparent, despite the fact that homework tasks critically contribute to a learners' final mathematics scores, according to the criteria in the Curriculum and Assessment Policy Statements (CAPS) (Umugiraneza et al., 2017). Personal challenges may hinder many impoverished learners from satisfactorily completing homework tasks and assignments. In turn, learners' discounted out-of-school personal challenges might negatively affect optimum in-school academic performance and achievement. In joint interventions between communities and government in addressing this shortcoming, Psychosocial Non-governmental Organisations (NGOs) have collaborated with the Department of Social Development to create safe and supportive psychological and social spaces for children (Mwoma & Pillay, 2015). However, the DBE leadership's role is again not apparent in these out-of-school partnerships.

In addition, documented accounts of collaborative government-NGO initiatives suggest that children who are primarily targeted by such initiatives are the orphaned and vulnerable children (OVC) of South Africa. OVCs include children who become orphaned when their primary caregivers die from illnesses related to Acquired Immune Deficiency Syndrome (AIDS). OVCs also include children who become vulnerable when their primary caregivers are infected with the Human Immunodeficiency Virus – more commonly known as HIV (Mwoma & Pillay, 2015). Apart from OVCs, Kaminer and Eagle (2010) recognise other children who may require psychosocial support. These include children who may have experienced trauma due to “exposure to criminal and family violence, injury in motor vehicle accidents ... sexual abuse and child rape” (Kaminer & Eagle, 2010:127–128). Notwithstanding, the challenges and shortcomings in NGOs extending psychosocial support to children in places like schools has been widely documented (Mwoma & Pillay, 2015; Van Deventer, 2008). In such reports the absence of professional counsellors, psychologists, and social workers in most public schools is identified to be among the main deficiencies experienced. Where such services are allocated to clusters of schools within districts, the monitoring strategies of such services provision are unsatisfactory (Mwoma & Pillay, 2015).

Even though all public schools do have DBE appointed Life Orientation teachers, Mwoma and Pillay (2015:5) note that “life orientation skills such as caring for the sick, running errands at home, having relationships, and issues such as peer pressure and sexual abuse, were not adequately addressed in schools.” When such topics are discussed, they are broadly and briefly discussed. They are discussed as part of a formal Life Orientation academic syllabus, by the appointed Life Orientation subject teacher, in an instructional way and in a classroom setting. Hence, little, if any, structured or personalised support is provided in public schools for children dealing with personal trauma (Kaminer & Eagle, 2010; Mwoma & Pillay, 2015; Van Deventer, 2008). Kaminer and Eagle (2010:144) criticise the manner in which schools deal with these issues as being “preventative rather than curative interventions.” Therefore, when learners arrive at school, they may be expected to automatically disconnect from their personal lives and the unique challenges that confound their individual focus. As a result concentration in schools (and in mathematics learning in particular) may be confounded by mental and emotional trauma with which some learners need to cope without having adequate in-school psychological and emotional support, which may cause their schoolwork to deteriorate (Kaminer & Eagle, 2010). In failing to consider each child’s unique out-of-school social challenges, many South African learners’ learning – and hence preparation for mathematics assessments – may fall through the cracks of an emotionally desensitised and administratively homogenised schooling system.

Poor quality of teaching

Several researchers cite this variable as a major contributing factor to learners’ underperformance in mathematics (Bush et al., 2010; Modisaotsile, 2012; Spaul & Kotze, 2015). However, the research reveals that when one speaks of poor quality of teaching, one is not merely referring to a teacher whose mathematics teaching skills are lacking. One is, hence, not simply referring to a teacher who has a specific weakness in subject knowledge and uses inadequate teaching methods to cater for the learning of all learners. “Poor quality of teaching” rather relates to teacher absenteeism (Bush et al., 2010). Drawing on the findings of a study commissioned by the Human Science Research Council, Modisaotsile (2012) claims that in South Africa in 2012 “almost 20 percent of teachers [were] absent on Mondays and Fridays. Absentee rates increased to one-third at month end” (Modisaotsile, 2012:4). In an effort to resolve this, the DBE undertook to engage regularly with teachers on these challenges (Heystek & Terhoven, 2015), and simultaneously attempted to improve teachers’ mathematical

proficiencies by retraining them. Research into this issue recognises resistance against teacher engagement and retraining, as many teachers view retraining as unnecessary and an insulting inference to their lacking competency to teach mathematics (Heystek & Terhoven, 2015; McCarthy & Oliphant, 2013). Heystek and Terhoven (2015:627) explain as follows:

The Department of Basic Education provides development opportunities for staff members to help them cope with changes in the curriculum and in methodology. At present, these compulsory training sessions normally occur in the school holidays. As a result, these developmental opportunities, which are meant to motivate teachers, have the opposite effect because teachers may be emotionally or physically exhausted at the end of the term; even if this exhaustion is just a psychological effect because teachers were used to having holidays.

In addition, despite the broadly held view that empowered teachers would produce better learners, teachers, and particularly those from impoverished school communities, argue that they “spend more time responding to the social needs of learners than they do teaching the core curriculum” (Heystek & Terhoven, 2015:672). Such challenges include “the effects of poverty, vandalism, crime, violence, poor infrastructure, lack of resources, absenteeism, high drop-out rates, overcrowded classes, gangsterism, drug abuse, teenage pregnancies and a large number of learners from one-parent households” (Heystek & Terhoven, 2015:627). Such insights once again infer that both the problem and solution relating to underperformance emanates from the children’s out-of-school lives and broader social and educational system challenges.

In addition, Heystek and Terhoven (2015:627) claim that, while it is the DBE’s “role to motivate teachers to do their utmost to improve the quality of teaching – especially in underperforming schools – teachers, like other people, are not all motivated to work hard and do the maximum of what’s expected of them.” However, Heystek and Terhoven (2015) go on to clarify that not all teachers who are demotivated are simply disinterested in the work that they do. Rather, many teachers become demotivated because their work becomes physically and emotionally exhausting (Heystek & Terhoven, 2015).

From the preceding discussion it is evident that the variables confounding South African school-focused mathematics improvement strategies are more psychologically and emotionally than physically aligned. This includes learners’ and teachers’ emotional and psychological well-being in a social context of fear and trauma, infrastructural frustrations, and physical, mental, and emotional exhaustion. It is thus noted that while physical and infrastructural needs are continuously addressed by the DBE, the emotional and psychological needs

are largely discounted – albeit that they have a profound impact on swaying the dependent variable (the NSC mathematics results in this case). A literature survey underscores an evident absence of DBE focus on such variables in documented South African school-focused mathematics improvement strategies. In addressing the extraneous variables, it is apparent that the DBE has limited its intervention to a one-size-fits-all practical approach. Furthermore, in collaborating with other government departments, the DBE's efforts appear restricted to collectively addressing only children's physical (health and nutritional) needs, thus flouting their unique emotional and psychological needs. Additionally, intervention initiatives are limited to the school parameters and occur during school hours, once again discounting the specific and personal needs and realities of each individual. Instead, the chosen places and times of mathematics improvement strategies appear to be exclusively at the convenience of the DBE (Heystek & Terhoven, 2015). Therefore, the DBE's provision of support is not mutually suitable to all members for which mathematics improvement strategies are intended, hence inferring that the DBE turns a blind eye to what happens in children's lives once the final school bell rings. Little concern appears to be given to how teachers' and learners' personal out-of-school challenges affect in-school teaching and learning outcomes. Consequently, the emotional and psychological (extraneous) variables collectively spiral into what McLeod (2018) describes as confounding variables. This, in turn, sees a downward spiral in learners' overall academic performance, and more specifically, in mathematics achievements.

Conclusion

Using a systematic review approach, I sought to identify variables missing from the DBE's mathematics improvement strategies for public schools. From the review, it is evident that what is missing from the strategies are variables relating to learners' unique individual life experiences. Instead, the preferred intervention approach by the DBE has thus far been a one-size-fits-all approach applied en masse in public schools, thus eclipsing on a spectrum of unique (individual and diverse) variables affecting learners' everyday learning within and outside of the schooling spaces.

Therefore, in further addressing mathematics achievement in schools, it is recommended that consideration be afforded to learners' unique social, emotional, and psychological contexts, and to the ways in which their personal experiences in such contexts affect their mathematics achievements. By incorporating a personalised approach into current mathematics improvement strategies, one might determine how to best address personal and individual barriers impeding learners' academic learning (and in this case, their

mathematics learning). The implication is for architects of future mathematics improvement strategies to create safe and supportive spaces in schools in which each underperforming child's voice about the everyday challenges they experience can be meaningfully expressed and acknowledged in earnest. One may find that, for many learners, academic success (and in this case, success in Mathematics) might stem foremost from emotional and psychological stability, and from knowing unreservedly that their unique lives matter.

Notes

- i. Published under a Creative Commons Attribution Licence.
- ii. DATES: Received: 29 August 2017; Revised: 19 February 2019; Accepted: 22 March 2019; Published: 31 August 2019.

References

- Allais S 2017. Towards measuring the economic value of higher education: Lessons from South Africa. *Comparative Education*, 53(1):147–163. <https://doi.org/10.1080/03050068.2017.1254985>
- Baron RM & Kenny DA 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, 51(6):1173–1182.
- Bayat A, Louw W & Rena R 2014a. Investigating the confluence of factors impacting on underperformance at selected secondary schools in the Western Cape, South Africa. *International Journal of Educational Sciences*, 7(1):41–55. <https://doi.org/10.1080/09751122.2014.11890168>
- Bayat A, Louw W & Rena R 2014b. The impact of socio-economic factors on the performance of selected high school learners in the Western Cape Province, South Africa. *Journal of Human Ecology*, 45(3):183–196. <https://doi.org/10.1080/09709274.2014.11906692>
- Bush T, Joubert R, Kiggundu E & Van Rooyen J 2010. Managing teaching and learning in South African schools. *International Journal of Educational Development*, 30(2):162–168. <https://doi.org/10.1016/j.ijedudev.2009.04.008>
- Campbell G & Prew M 2014. Behind the matric results: The story of maths and science. *Mail & Guardian*, 7 January. Available at <https://mg.co.za/article/2014-01-07-behind-the-matric-results-the-story-of-maths-and-science>. Accessed 24 November 2016.
- Cherry K 2016. *Dependent variable in experiments*. Available at <https://www.verywell.com/what-is-a-dependant-variable-2795099>. Accessed 26 November 2016.
- Department of Basic Education, Republic of South Africa 2015. *Basic Education focuses on improving maths, science and technology education*. Available at <https://www.gov.za/speeches/dbe-focused-improving-maths-science-and-technology-education-17-jul-2015-0000>. Accessed 23 September 2015.

- Fleisch B 2008. *Primary education in crisis: Why South African schoolchildren underachieve in reading and mathematics*. Cape Town, South Africa: Juta.
- Hallinger P 2013. A conceptual framework for systematic reviews of research in educational leadership and management. *Journal of Educational Administration*, 51(2):126–149. <https://doi.org/10.1108/09578231311304670>
- Heystek J & Terhoven R 2015. Motivation as critical factor for teacher development in contextually challenging underperforming schools in South Africa. *Professional Development in Education*, 41(4):624–639. <https://doi.org/10.1080/19415257.2014.940628>
- Hochfeld T, Graham L, Patel L, Moodley J & Ross E 2016. Does school breakfast make a difference? An evaluation of an in-school breakfast programme in South Africa. *International Journal of Educational Development*, 51:1–9. <https://doi.org/10.1016/j.ijedudev.2016.07.005>
- Johnson SM & Naidoo AV 2013. Transpersonal practices as prevention intervention for burnout among HIV/AIDS coordinator teachers. *South African Journal of Psychology*, 43(1):59–70. <https://doi.org/10.1177/0081246312474406>
- Johnson SM & Naidoo AV 2017. A psychoeducational approach for prevention of burnout among teachers dealing with HIV/AIDS in South Africa. *AIDS Care*, 29(1):73–78. <https://doi.org/10.1080/09540121.2016.1201193>
- Kaminer D & Eagle G 2010. *Traumatic stress in South Africa*. Johannesburg, South Africa: Wits University Press.
- Keele S 2007. *Guidelines for performing systematic literature reviews in software engineering*. In *Technical report, Ver. 2.3 EBSE Technical Report*. EBSE. sn.
- MacKinnon DP 2008. *Introduction to statistical mediation analysis*. New York, NY: Lawrence Erlbaum Associates.
- Marais P 2016. “We can’t believe what we see”: Overcrowded classrooms through the eyes of student teachers. *South African Journal of Education*, 36(2):Art. # 1201, 10 pages. <https://doi.org/10.15700/saje.v36n2a1201>
- McCarthy J & Oliphant R 2013. *Mathematics outcomes in South African schools: What are the facts? What should be done?* Johannesburg, South Africa: The Centre for Development and Enterprise. Available at <https://www.cde.org.za/wp-content/uploads/2018/07/Mathematics-outcomes-in-South-African-schools-what-are-the-facts-what-should-be-done-CDE-Report.pdf>. Accessed 25 July 2019.
- McLeod S 2018. *Independent, dependent, and extraneous variables*. Available at <https://simplypsychology.org/variables.html>. Accessed 25 July 2019.
- Mestry R 2018. The role of governing bodies in the management of financial resources in South African no-fee public schools. *Educational Management Administration & Leadership*, 46(3):385–400. <https://doi.org/10.1177/1741143216665838>
- Modisaotsile BM 2012. The failing standard of basic education in South Africa. *AISA POLICYbrief*, 72:1–7. Available at <http://www.purpletod.co.za/docs/FAILING%20STANDARDS.pdf>. Accessed 11 July 2019.
- Mwoma T & Pillay J 2015. Psychosocial support for orphans and vulnerable children in public primary schools: Challenges and intervention strategies. *South African Journal of Education*, 35(3):Art. # 1092, 9 pages. <https://doi.org/10.15700/saje.v35n3a1092>
- Petticrew M & Roberts H 2006. *Systematic reviews in the social sciences: A practical guide*. Oxford, England: Blackwell Publishing.
- Prinsloo CH 2008. *Extra classes, extra marks?: Report on the PlusTime Project* (Report prepared for the Western Cape Education Department, July).
- Schiefelbein E & McGinn NF 2017. *Learning to educate: Proposals for the reconstruction of education in developing countries*. Rotterdam, The Netherlands: Sense.
- Sibanda GM 2015. Motivations, perceptions, and aspirations concerning teaching as a career in South Africa - The story of university student teachers. *Journal of Global Intelligence & Policy*, 8(14):79–102.
- Sobel ME 2008. Identification of causal parameters in randomized studies with mediating variables. *Journal of Educational and Behavioral Statistics*, 33(2):230–251. <https://doi.org/10.3102%2F1076998607307239>
- Somsetsu NW, Erasmus C, Lukelelo N & Roman NV 2015. Experiences of adolescents who lost a parent to AIDS in the Western Cape, South Africa: A qualitative study. *Journal of Community and Health Sciences*, 10(1):1–12. Available at <http://jchs.epubs.ac.za/index.php/jchs/article/view/120#.XSZn6-szbIU>. Accessed 11 July 2019.
- Spaull N & Kotze J 2015. Starting behind and staying behind in South Africa: The case of insurmountable learning deficits in mathematics. *International Journal of Educational Development*, 41:13–24. <https://doi.org/10.1016/j.ijedudev.2015.01.002>
- Trochim WMK 1999. *The research methods knowledge base* (2nd ed). Ithaca, NY: Cornell University.
- Uduku O 2015. Designing schools for quality: An international, case study-based review. *International Journal of Educational Development*, 44:56–64. <https://doi.org/10.1016/j.ijedudev.2015.05.005>
- Umugiraneza O, Bansilal S & North D 2017. Exploring teachers’ practices in teaching Mathematics and Statistics in KwaZulu-Natal schools. *South African Journal of Education*, 37(2):Art. # 1306, 13 pages. <https://doi.org/10.15700/saje.v37n2a1306>
- Van Deventer KJ 2008. Perceptions of Life Orientation teachers regarding the implementation of the learning area in grades 8 and 9: A survey in selected Western Cape high schools. *South African Journal for Research in Sport, Physical Education and Recreation*, 30(2):131–146.
- Verster M 2011. Mathematical literacy online community of practice. *Learning and Teaching Mathematics*, 1(1):36–39.
- Victor L 2008. Systematic reviewing. *Social Research Update*, 54:1–4. Available at <https://pdfs.semanticscholar.org/b142/8505ce37a4520bbd95dcc9bdbd6e03376b1c.pdf>. Accessed 5 July 2019.

Visser M, Juan A & Feza N 2015. Home and school resources as predictors of mathematics performance in South Africa. *South African*

Journal of Education, 35(1):Art. # 1010, 10 pages.
<https://doi.org/10.15700/201503062354>