



Towards primary school mathematics multipronged top-bottom intervention framework

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ABSTRACT

Performance outcomes in mathematics in South African primary schools have reached alarming proportions. This paper seeks to delve deep into the challenges contributing to mathematics underperformance and gain insights from the perspectives of the departmental heads regarding the strategies they deploy in improving performance in their schools. In examining this phenomenon, we conducted semi-structured interviews that targeted departmental heads in primary schools in the Province of Limpopo, South Africa. In addition, quality management theory was used as a lens to frame the study theoretically. The study results demonstrate that departmental heads employ differentiated strategies to mitigate the pertinent challenges facing mathematics performance in primary schools. Amongst the key strategies departmental heads deploy include the following: Collaborative workshops and subject meetings, departmental heads initiated continuous professional development opportunities, provision of resources for teaching mathematics, control and monitoring as accounting measures, and confronting teacher insubordination. This paper is of significant value as it adds to new knowledge in managing and teaching mathematics in primary schools.

Keywords: Mathematics, primary schools, departmental heads, multi-pronged mathematics improvement framework.

Introduction

Mathematics is a critical learning subject, particularly in South Africa. The country has not been performing well in this subject across the schooling levels. Another challenge is inadequate mathematics subject teachers. Some of these teachers are found wanting and do not have convincing foundational grounding both methodologically and content-wise.

These assertions make the management of the subject difficult. Departmental heads (DHs) at the school level are directly responsible for the management of the Department of Mathematics in primary schools. One of their primary responsibilities is to oversee curriculum delivery and serve as the liaison between teachers and the school leadership. They are directly accountable to the deputy principal, who reports to the principal. DHs work at middle level of the school, which is why their description of middle management is significant in the literature on teacher leadership (Marishane, 2016; PAM, 2016; Ogina, 2017; Saul, 2019; Nkabinde, 2020). Nkabinde (2020) further maintains that DHs oversee the teaching of specific subjects and also the coordination and supervision of all educational programs in compliance with established norms and standards.

Mokoena (2017) defines DHs as curriculum managers who have the responsibility of inspiring commitment and confidence in the teachers. Saavedra (2017) argues that for DHs to be respected by the teachers they supervise; they should demonstrate pedagogical comprehension of mathematics. The main purpose of this investigation was to identify the pertinent challenges through scholarly work and then to develop a strategic framework based on the perceptions of the departmental heads interviewed in this study.

Qualities expected from the mathematics departmental heads

The Employment of Educators Act 76 of 1998 as amended in 2016 identifies the core duty of DHs as curriculum delivery. Coupled with curriculum delivery, Saul (2019) states that DHs must also provide professional development opportunities for teachers in their departments. Mashapa (2019) states that DHs must also provide leadership and strategic direction to teachers to enable them to meet the objectives of the subject. This entails making sure that resources are made available to achieve maximum performance. DHs are also responsible for mentoring early career teachers. Zide (2020) defines mentoring as a method of teaching and learning that promotes human performance and acknowledges improvement. Govender (2020) is of the view that using teacher assessments to pinpoint areas of weaknesses that require development is one of the exceptional means of developing employees. Leithwood (2016) further argues that DHs can also use staff and subject meetings as a way of further mentoring teachers in the mathematics subject. According to Perloff (2020) and Marishane (2016), mentoring plays a pivotal role in developing teachers to enhance their performance, especially in areas that are challenging.

Marishane (2016) and Ampofo, Onyango, and Ogola (2019) postulate that in supporting teachers, DHs had to analyze their portfolios, workbooks, and the work of the learners to determine whether teachers were doing their work. Fancy and Razzaq (2017) suggest that motivating teachers is done to increase their work rate and performance. Department of Basic Education (2018) argues that mathematics DHs should also assist teachers in improving their pedagogical comprehension of the subject. Myende and Bhengu (2015) argue that one of the qualities of DHs in the mathematics department is the ability to display exemplary behavior and be a role model for teachers. Suleman (2015) believes that DHs must also deal with learner management issues such as punishment, learners failing to complete assigned work, absenteeism, and school attendance effectively. Regarding leadership, Adler and Mosvold (2017) agree that DHs, as leaders, must be punctual, disciplined, and exemplary. Glewwe and Muralidharan (2016) add hard work as one of the qualities required of DHs.

Pertinent impediments in the teaching of mathematics

There are numerous challenges identified by various scholars that impede expected performance. The following sub-section will now be unpacked from the views of different scholars. A myriad of studies has identified challenges faced by DHs in primary and secondary schools, particularly in Mathematics (Banerjee, 2018; Tapala, Van Niekerk, & Mentz, 2020; Banerjee, 2018; Zide, 2020, and Onasanya, 2020). These challenges directly impact on teaching and in particular mathematics.

Suleman (2015), Banerjee (2018), and Govender (2018) discovered that DHs have difficulties because of a lack of discipline, which is demonstrated by both teachers and learners in schools. These scholars identified amongst others the following: late coming by teachers and learners, period bunking, and poorly prepared lessons. Added to this list, Mashapa (2019) believes that DHs also face challenges that include teachers failing to complete tasks assigned to them by their supervisors. Govender (2018) further identified causes of learner ill-discipline such as high pupil enrolment, drug usage, and excessive exposure to videos which influences classroom performance. According to Govender (2018), teachers also face serious threats from parents. These threats include abuse by parents who feel that their children are not receiving education as expected, and when learners report teachers' perceived misconduct against them to their parents. Bullying from the side of parents is a cause for concern. Govender (2018) and Mashapa (2019) complain that parents in rural and urban regions alike do not communicate effectively with schools, but instead use aggressive behavior when they believe their expectations are not being considered. Further, Govender (2019) and Mashapa (2019) argue that parents threaten teachers with violence. Banerjee (2018) contends that these behaviours demotivate DHs and teachers and may be a cause of their low mathematics performance.

Zide (2020) and Basset (2016) note that workload and too little time appear to be additional challenging issues for DHs. Tapala, Van Niekerk, and Mentz (2020) postulate that DHs perceive their workload as unmanageable, resulting in instabilities between home and work. In most cases, DHs end up suffering from burnout and exhaustion due to overwork. The issue of too much work is also aggravated by uncontrollable teacher absenteeism in some of the schools where there is no order, and the culture of no commitment dominates.

Teachers in most schools are members of various unions, and these unions have a significant impact on DHs' ability to operate their departments effectively. Banerjee (2018), Govender (2018), Onasanya (2020), and Tapala, Van Niekerk, and Mentz (2020) indicate that teacher unions play a significant role and their conduct can destabilize teaching. The researchers further note that teacher unions have frequently opposed the functions and authority of DHs due to their constant demand for accountability and improving performance from teachers.

The theoretical framing of the study

The theoretical lens that underpins this study is the quality management theory of Deming which was developed in 1986. This theory emphasizes quality and is constituted by 14 principles which are intended to guide organizations in transforming and improving the quality of management practice (Deming, 1993; Deming, 2000; Anderson, Rungtusanatham, and Schroeder, 1994; Khan, 2010). Deming (1986) asserts that these principles are predicated on an assumption of how work is completed and how work outcomes should be evaluated. Deming quality management theory's 14 principles emphasize cooperation, learning, and encouraging the application of process quality management theory that should result in continual

improvement of processes, products, services, and employee satisfaction. Anderson et al. (1994) created eight constructs from Deming quality management theory's 14 principles: visionary leadership, internal and external cooperation, learning, process management, continuous improvement, employee satisfaction, and customer satisfaction (Anderson et al, 1994). Deploying this theory enabled us to analyze the perceptions of departmental heads and the development of the intervention framework for improving primary mathematics performance. It is worth noting that not all the principles apply in this study, and the focus was on those elements that are important amongst others, visionary leadership, internal and external cooperation, learning, and continuous improvement.

Research design and methodology

This study is methodologically underpinned by an interpretive paradigm because the construction of the mathematics improvement framework was influenced by the views of departmental heads based on the experiences of their natural settings and in this case schools (Patton, 2015; Leedy and Ormrod, 2015). The qualitative nature of this study necessitated the researchers to conduct in-depth semi-structured interviews with six mathematics departmental heads of primary schools (McMillan & Schumacher, 2006; Macmillan & Schumacher, 2015). To Maykut and Morehouse (2001), Baxter and Jack (2008), and Maree (2011), qualitative studies provide researchers with the opportunity to collect experiential data from real-life settings. The qualification for the selection of the units of analysis (DHs) was based on several characteristics, namely potential for providing rich data, gender mix (male and female), and not less than 10 years of teaching service and at least 3 years appointed as DH in mathematics subject. The research setting was the province of Limpopo, South Africa, and mainly rural underperforming schools in mathematics were selected. We deployed purposive sampling guided by Lamputtong's (2013) argument that this type of sample offers the opportunity to collect reliable and rich data from knowledgeable participants. The interviews were conducted in English and the interview instrument was piloted first and where necessary changes were made to make it accurate. The research ethics were observed. The interviews were recorded and transcribed before the rigorous process of analysis commenced.

Table 1: Biographical data of DHs

Units of Analysis	DH1	DH2	DH3	DH4	DH5	DH6
Gender	F	M	F	F	M	M
Experience as a mathematics teacher	15	19	17	10	16	19
Age	46	48	27	43	45	50
General teaching experience	21	23	22	18	20	25
Experience as DH	05	10	12	08	11	15
REQ in mathematics	IR	IR	R	R	IR	IR

Note: REQ stands for Relevant Equivalent Qualification, R stands for relevant, whereas IR for irrelevant in the table

The table demonstrates that gender is split between males and females. The age of participants ranges from 46 to 50 years and the least general teaching experience is 18 years. These figures paint a picture of departmental heads with experience in teaching and regarding qualifications, it is clear that four of the DHs do not have the requisite qualifications in mathematics. The numbers also indicate that the DHs have been in management for some time with the least number of management experience being five years. The table further indicates a very disturbing picture in which out of the 6 DHs in the study, only two qualify to teach mathematics and the rest, four do not hold relevant equivalent qualifications in the subject.

Results and discussion

Analysis was carried out based on the guidelines of Mouton (2016). This involved engaging in back-and-forth sifting and breaking down of data into themes, patterns, and relationships. This was to ensure that information was easily manageable. The intensive and rigorous data analysis resulted in the following themes:

Collaboration through subject meetings

Collaboration in the teaching field is critical as no teacher can solely succeed without relying on other stakeholders in the schooling environment. As part of the upskilling and capacitating the DHs in the teaching of mathematics and improving performance, DH3 noted strategies such as school-based subject meetings with mathematics teachers. In addition, the Department of Basic Education (DBE) also organizes workshops facilitated by mathematics subject specialists. They further explained that during these subject meetings, they interact with teachers from different schools where there is information-sharing. The DHs expressed themselves as follows:

DH1 notes

“I also attend cluster meetings and workshops that develop us in the subject. Furthermore, I share knowledge with my colleagues and other teachers from other schools who teach mathematics. In turn, I also share the methods or steps of solving mathematical problems as well as teaching strategies. This helps me to acquire in-depth knowledge of the subject and skills because I also learn many *ways of teaching the* subject from them”.

DH3 maintains.

“I must conduct subject meetings with teachers. During these subject meetings, I can discuss everything concerning Mathematics with my teachers”.

These views were corroborated by Saul (2019) who argues that collaboration among teachers, DHs, and curriculum advisors is an influential professional development action that can help them improve their subject knowledge, think about teaching approaches in different ways, and learn new ideas to implement in the classroom. Regular interactions among teachers, DHs, and curriculum advisors in the mathematics department are important because they increase professional and interpersonal relationships. Moreover, teachers depend on each other for support, and they develop relationships based on trust. In addition, subject specialists capacitate DHs on monitoring and supporting teachers in the mathematics department, which they can only achieve through interactions during meetings, either at the school or DBE level. They also capacitate DHs on moderation processes and classroom visits. Meetings are important in that they serve as a platform in which DHs are capacitated to track learner performance in schools to improve achievement when working at schools. These efforts are in line with Demings’s theory (1993) in that these meetings afford mathematics DHs and teachers internal and external cooperation opportunities between critical stakeholders which result in professional learning and continuous improvement.

Continuous professional development for newly appointed mathematics teachers

Teacher professional development is essential in that it ensures that teachers are advanced regarding the best practices in the field. Providing teachers with development opportunities helps enhance learning outcomes which is the core business of teachers. In the words of participants DH1, the following were the expressions:

“I facilitate teacher professional development in the mathematics subject, as teacher professional development is a fundamental tool to close existing gaps and to ensure efficiency. I orientate new appointed mathematics teachers and provides teacher professional development to enable teachers to acquire new skills”.

The expression of DH1 resonates with the sentiments of Perloff (2020) who intimates that providing support to teachers plays a pivotal role. Mentoring is part of teacher professional development. Perloff (2020) further pointed out that DHs should ensure that they provide mentoring to their teachers in schools. This view is corroborated by Marishane (2016) who maintains that teacher support is critical as noted by DH1 regarding professional development.

Providing mathematics teachers with resources

The provision of learner support material should be at the top of the schooling agenda. It will be very difficult for teachers to be expected to perform when they are not armed with the tools of the trade such as relevant quality textbooks, mathematics subject policy guidelines, and other relevant teaching aids. The views of the DHs on this subject matter were captured as follows:

DH2 retorted that:

“I have the duty to make sure that the following documents that are used by teachers in the mathematics department are available: planner and tracker, annual teaching plan and assessment plan. I must check whether teachers use tracker in Mathematics to teach what is needed according to the mathematics policy”.

DH5 in supporting DH2, commented:

“I must make sure teachers have all relevant learning teaching support materials in the mathematics department. I also must make sure that all learners have Mathematics textbooks and exercise books. My role is to make sure that effective teaching and learning take place in the mathematics department. I do this by checking that teachers attend classes according to the timetables *on a daily*”.

Flowing from the assertions of DH2 and DH5, providing teachers with the tools of the trade is a serious consideration. These views link well with the expectations and contents of the Employment of Educators Act, 76 of 1998, as amended in 2016, hereinafter referred to as the EEA (2016). Accordingly, this Act compels the authority to make teaching material available. The same responsibility is demanded and contained in the Personal Administrative Measures (2016) document which clearly states the responsibilities of DHs.

Control and monitoring as accounting measures

The implementation of control and monitoring protocols safeguards the academic agenda. These measures are essential in ensuring that teachers do their work within policy prescriptions and requirements. DHs and curriculum advisors mentioned that they ensure that they develop monitoring instruments to be used in checking and tracking the work of teachers. They indicated that monitoring instruments help determine curriculum coverage, moderation of formal tasks, and audit of written work. Here are the views of **DH4 as he notes:**

“I also try to improve teachers’ performance in the department through monitoring their lesson preparation. I usually monitor teachers’ lesson preparation twice in a quarter. I request teachers to bring their files in order to check the lesson plans. When checking the lesson plans, I verify whether the lesson align with the CAPS policy. I also check the progress of the teachers with regard to teaching and learning which assist me to track curriculum coverage”.

Similarly, DH6 posits

“I also engage in conducting class visits. The class visits are planned and conducted as per planned class visits programme. These class visits are aimed at monitoring and assessing the manner in which teachers conduct their lesson presentation to discover whether it is in line with prepared lesson plans as required by the CAPS policy. This is where I provide support to teachers who have challenges in lesson presentation”.

Management without holding subordinates accountable is problematic as it will be free for all. Control and monitoring promote quality and this finding corroborates the argument presented by Juran (1986) that quality control is needed in schools to check that effective teaching and learning takes place. The author further pointed out that for schools to strive for quality, they should engage in ongoing quality control that involves periodic checks and inspections, and tracking metrics (Juran, 1986). In schools, DHs and principals should develop monitoring tools to be used when monitoring the smooth running of teaching and learning. The monitoring tools should include an audit of curriculum coverage, moderation of formal assessment, and usage of workbooks. O’Neill (2003) further postulate that schools should try to meet learners’ satisfaction by developing a quality system for continuously controlling and monitoring how effectively to meet or exceed learner needs.

Confronting insubordination

Schools like any organization experience teachers who try to undermine the authority of the school management team. Management applies various strategies in dealing with such teachers. The participants indicated that they deploy a mix of strategies ranging from pep talk and face-to-face and hereunder are the perceptions of DH3 and DH5.

DH3 added that:

“In order to deal with insubordination of teachers in my mathematics department, I try to call the teacher and talk to him or her about their behaviour. I also try to express my feelings about the way they misbehave. Further, I also try to remind them of the legislation and guidelines which regulate the space.”

DH5 in emphasizing DH3s’view expressed the view in this manner.

“I talk face to face with teachers who undermine my authority, that it is an offence to disrespect their supervisors in schools. I also encourage them to execute tasks given by their DHs when working at schools”. Disrespectful employees affect the organization in many ways. Schools experience the same phenomenon and DHs must be tough when confronted with such teachers. Failure to deal with ill-discipline can have a spillover effect. Suleman (2015); Banerjee (2018) and Govender (2018) found that DHs have difficulties because of teacher lack of discipline. These findings confirm that there are teachers who cross the line particularly those who are members of trade unions. This view confirms the assertions of Benerjee (2018), Govender (2018), Onasanya (2020), and Tapala, Van Niekerk, and Mentz (2020) who note that teacher unions have frequently opposed the function of DHs due to their constant demand for accountability and improving performance. It is interesting to note that departmental heads take matters into their own hands and confront such behavior. In promoting Deming’s principle of quality, cooperation is emphasized and teachers who are not disciplined are uncooperative.

In the next section, using the findings of the study, we suggest a multipronged mathematics intervention framework for primary schools (see Figure 1) named the multi-pronged mathematics top-bottom intervention framework.

Stages of the multi-pronged mathematics top-bottom intervention framework

The framework follows a distinct approach which is the top intervention bottom implementation approach.

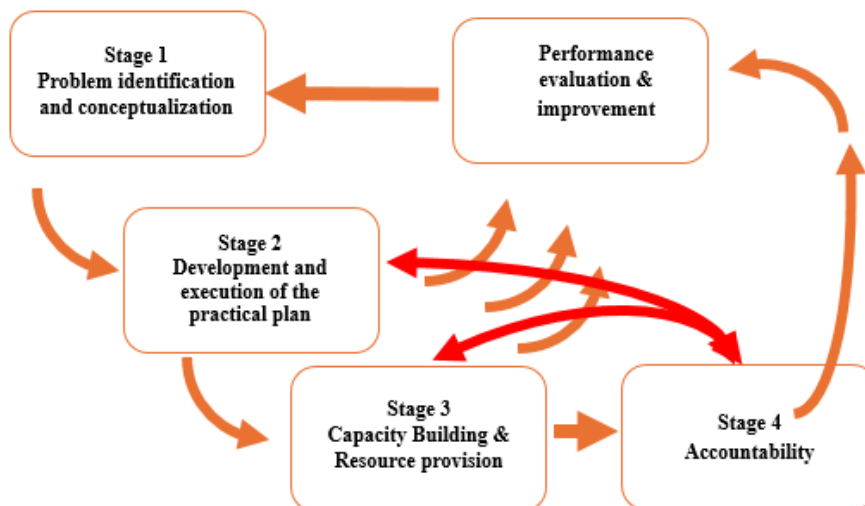
Stage 1: Problem identification and conceptualization: This involves steps that require honest and appropriate diagnosis and analysis of the problems in the mathematics department. All key stakeholders including the DHs for the subject, the school management team, parents, and official/s from the department responsible for mathematics should form part of the diagnosis of the problem. All possible and potential problems identified should be listed and shared with stakeholders.

Stage 2: Development and execution of the practical plan: This stage includes all the stakeholders cited in Stage 1. Focus amongst others should be on the stakeholder relationship between DHs and the union, and teachers. Upskilling of stakeholders in creating and maintaining positive stakeholder relationship is also of critical importance.

Stage 3: Capacity building and resource provision: After the diagnosis, the teachers and also learners should be assisted with relevant learner-teacher support materials and continued capacity building.

Stage 4: Accountability measures: This part of the evaluation demand DHs to consistently conduct accountability sessions to determine whether the plan put in place works. DHs control and monitor teachers' work by policy guidelines.

Figure 1: Mathematics multipronged top-bottom intervention framework



The first strategic intervention stage is creating an enabling positive environment where stakeholders jointly identify impediments, challenges, and issues that contribute towards underperformance. As stated, all stakeholders including DHs, parents, learners, principals, and external stakeholders (for example, officials of the DBE) must collaboratively engage in this diagnostic exercise. The second layer entails exposing DHs and mathematics teachers to capacity-building opportunities to enhance their content and management skills. The third component of the framework focuses on the provision of learner-teacher materials. At this stage, teachers and learners must be provided with LTSM (learner-teacher support materials) to enhance performance. Providing oversight is a fundamental layer of this framework. This is critical in ensuring that what has been done and the resources provided bear positive results and that stakeholders comply. These oversight activities are conducted by the DHs and are done intermittently.

Conclusion

Drawing from the perceptions of the departmental heads in improving performance in primary schools, we suggested a framework that could be significant in addressing the pertinent challenges facing mathematics in primary schools in South Africa. The article indicates that there is adequate and convincing literature that confirms that mathematics performance in primary schools is problematic and not satisfactory. The paper was anchored on a qualitative methodological approach and semi-structured interviews were administered to six purposely selected departmental heads in primary schools in Limpopo. In framing the study theoretically, Demings' quality management theory was deployed. The results of the study demonstrate that departmental heads employ differentiated strategies to mitigate the pertinent challenges facing mathematics performance in primary schools. Amongst the key strategies departmental heads deploy include the following: Collaborative workshops to tackle problematic areas, collaborative workshops and subject meetings, departmental heads initiated continuous professional development opportunities, provision of resources for teaching mathematics, control and monitoring as accounting measures, and confronting teacher insubordination. This paper is of significant value as it adds to new knowledge in the management of mathematics in primary schools.

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