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Unearthing factors influencing curriculum implementation by SADTU Mathematics teachers

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Abstract

Reflections on perceptions and practices of South African Democratic Teachers Union teachers of Mathematics attending a conference are articulated in this article. The conference was attended by teachers from both primary and secondary schools. Both inter-professional and intra-professional development of the Trimensional Aggregate (Pure Maths, Maths Literacy and Technical Maths) of Mathematics are emphasised, along with classroom assessment and a broad spectrum of educational goals. Teachers from all districts in KwaZulu- Natal participated in a collaborative and networking experience providing prized material on Mathematics assessment and curriculum dynamics. Relevant stakeholders from tertiary institutes and governmental officials aligned to the Mathematics field provided the impetus to discussion on Mathematics being a vital springboard to increasing economic development in South Africa; teachers need to become operative communicators and regulators of curriculum delivery for this to be realised. Learners thrive under the control of agents grounded in a robust human effort that directs curriculum content in Mathematics at their schools. Participants of all phases put forward evidence of their challenges and impediments that diminish learner performance in controlled assessments. The findings from the focus groups offer treasured information that creates a link for regulating Mathematics and provides ways of modifying teaching programmes. . Findings at this symposium gave rise to recommendations for the adoption of all Mathematics forms as a measure of teacher self-regulation, assessment and remediation both via formal and informal activities.

Keywords: Inter-professional; intra-professional; teachers' perceptions; self-regulation

Introduction

The South African Democratic Teachers Union (SADTU) of KwaZulu-Natal hosted a Mathematics (Maths) conference aimed at familiarising academics, researchers and practitioners with the realities (both in primary and secondary schools) of this gateway subject. The primary objective of the conference was to highlight the critical need for Maths in our schooling system. In addition, it sought to highlight that if there is no critical emphasis placed on Maths, Science, Technology and Innovation will be abolished from our schools. Teachers concluded that by expanding our learners' thinking capacity, we will be setting up perpetual progression and expansion of all sectors in South Africa.

Relevant stakeholders attended, extending from novice to veteran teachers from both primary and secondary schools. Department of Basic Education (DBE) representatives and high-profile academics converged at the conference to get empowered and to empower one another through collaboration and networking about the status of Maths. The Curriculum and Assessment Policy System (CAPS) provided the framework for the deliberations. The teacher's repertoire of principles/strategies in Maths teaching and learning processes assists learners to think critically and become independent and self-regulated (Arends, 2001). This understanding was unearthed during focus group discussions with attendees and from presentations from influential speakers in authoritative domains in the DBE. The sources at the conference were also from tertiary institutions and the independent regulatory body, Umalusi, that oversees matric results in South Africa. The author observed that this conference hosted a **Trimensional Aggregate (TA)**[9] of Maths teachers from SADTU who teach Pure Maths (PM), Maths Literacy (ML) and Technical Maths (TM).

The premise of involving both novice and veteran teachers at this forum was to empower and get empowered about the effectiveness of Maths teaching in South African schools as a whole, not only in KwaZulu-Natal. The accountability of teachers in public schools is the same for all schools in the republic—irrespective of the unique challenges faced by the school in terms of diversity and inclusivity; urban or rural location; level of resourcing; and level of functionality.

[9] Trimensional Aggregate refers to the three subsets of Math teachers which encompass, Pure Math, Math Literacy and Technical Math.

Teachers were presented with roadmaps or a compass about the nature and domain of Maths knowledge in their own trimensional space. In accordance with the relevant domains of knowledge, insight into the material and formal elements of the work of teachers was elaborated on. As stated by Maharaj (2019), the elements identified resonate with Morrow (2007) who separated the elements into seven categories. The content knowledge of Maths forms the first domain. Second is the pedagogical content knowledge of Maths, which is a unique amalgam of content and pedagogy that is exclusively the province of a teacher of either PM, ML or TM. It is the teacher's individual professional practice. The third is the pastoral domain—having "under the radar" knowledge of learners, including their unique characteristics. Fourth is the domain that appears to transcend subject matter—it irradiates pedagogical content knowledge but with a distinctive orientation towards a set of principles and strategies that illuminates Maths classroom management as well as the organisational skills adopted by PM, ML and TM teachers. The fifth prerequisite is vital for Maths teachers—the knowledge of educational context, including working with subordinates, management, governance, financing, communities and culture.

Sixth is the all-important knowledge about the CAPS content which forms the "tools of trade" for TA. The seventh domain of knowledge for a Maths teacher is knowledge of educational ends, purposes and values, and their philosophical and historical roots.

The rationale of this conference was to address the TA that serves the diverse and complex society of learners. The first task was to ascertain factors that directly contribute to poor performance in examinations by learners at primary and high school levels. The second was the important task of determining the reasons for learners choosing PM, ML or TM. The third was to find out the basis for teachers of PM, ML and TM having positive dispositions towards the teaching of their Maths content. Fourth, stemming from discussions at the focus groups, brainstorming sessions and academic addresses, was understanding how teachers handle CAPS demands and teaching and learner development. Lastly, also arising from the focus group discussions, teachers gave insights into the challenges they endure in the physical and social settings at their workplace.

The accountability of Maths teachers has shifted over the years—internally to school management and externally to educational authorities and the greater community (including parents and funders); each of the above concerns was extensively scrutinised by the TA.

Factors that contribute to poor performance in examinations

The CAPS objectives of Maths are manifold in that CAPS aims to include Mathematics-associated life skills to prepare learners to become independent and fruitful citizens in South Africa Learners are ubiquitously confronted with mathematical concepts, whether at home or in their community. This informal associative process varies from counting to weighing, measuring distance, timing, making choices and so on. In some instances, mathematical ideologies are used for survival processes.

Mathematics is a comprehensive term used for Pure Maths (PM), Maths Literacy (ML) and Technical Maths (TM). According to CAPS, the content of the TA of Maths needs to be attained by learners so that they can engage individualistically with mathematical concepts. At a foundation phase[10] level, PM is referred to as numeracy, but in both the intermediate phase[11] and senior phase[12] learners do PM. However, in the Further Education and Training Phase[13], TA is introduced and this is where learners are given individual choices for embarking on Mathematics at any of the three abovementioned (TA) intensities of the subject.

Pure Maths can be regarded as a mathematical science or a discipline in its own right whereby learners are exposed to theories in the language of specific mathematical terms and symbols. These use abstract associations whereby learners are expected to observe configurated patterns and carry out integrated logical thinking. The ML option makes learners aware of the problem of focus and provides an understanding of the purpose Mathematics plays in society. It also offers learners the chance to practice mathematical concepts and relate these concepts in their day-to-day lives so that they can deal with the requirements of contemporary living. Technical Maths (TM) deals with basic mathematical concepts and their application in a planned and formal way. There are distinct levels of complexity in the subject content of the TA. Umalusi[14] has to provide statistics of performance in Maths on an ongoing basis, and the growing concern is the poor performance in PM and the increase in learners opting to do ML or TM. As argued by Okyere and Larbi (2019), teachers at this forum gave their perceptions on how and why learner performance in Maths was compromised. The problems that were

[10] Grade 1, Grade 2 and Grade 3 learners form this cohort.
[11] Grade 4, Grade 5 and Grade 6 learners form this cohort.
[12] Grade 7, Grade 8 and Grade 9 learners form this cohort.
[13] Grade 10, Grade 11 and Grade 12 learners form this cohort.
[14] The independent examination body that oversees assessments that are regulated in South Africa.

outlined in the focus groups irradiated the daily setbacks and challenges teachers experience at their schools. The lack of suitably qualified people and insufficient technological resources and infrastructure were identified as pressures that teachers face in the execution of their teaching. Teachers' heavy workload directly explains the above concerns where, in some schools, teachers teach classes to meet the regulated workload; hence, not all classes receive quality service delivery. Unqualified and underqualified teachers are a further human resource concern because management has to deploy the "tools for task" with the manpower that is s supplied to the school. Third, teachers tend to shorten their stay in rural schools, preferring to be in urban or suburban schools; the departure of teachers for the city is a regular occurrence that plagues Maths learning ; there is a substantial volume of literature to support this. The above three major concerns raised by the focus groups serve as an indication of how and why the performance in regulated assessments is substandard and disappointing.

What influences learners in selecting PM, ML or TM

The CAPS requirements for different TA components of Maths differ both in content and complexity. The pendulum swing in terms of the curriculum demands between PM, ML and TM varies regarding abstract relations, accurate use of calculation procedures and the control of number sense which lie beneath the ability of learners that choose either of the TA to apply such processes and techniques prudently. Besides looking at CAPS content level variations from a cognitive understanding, one cannot discount prerequisite mathematical concepts, processes and skills. According to Kruger and Swart (2014), these prerequisites include the need to understand concepts of numbers and operations, algebra, geometry, measurement, data analysis and properties. Kruger and Swart (2014) state that processes and skills like those in the CAPS curriculum content for Maths, are aimed at enabling the use of mathematical knowledge in intricate and complex situations.

According to Kruger and Swart (2014, p. 214), breaking down Maths into various levels of concepts is linked to developmental levels. First, the content level necessitates a strong knowledge of counting and the use of basic operations. The second tier involves learners relating concepts in Maths to practical situations—thereby using their educational understanding to solve environmental problems. The third tier is the emotional level, in that learners need to adopt a positive attitude to Maths. Last is the contextual level whereby Maths is used in learners' daily lives. Unpacking these levels demonstrates that learners have to

develop to various levels to have the necessary tools available to participate in TA Maths. Kruger and Swart (2014) have separated the knowledge into three stages, the foremost being declarative knowledge which involves knowing the basic mathematical facts. Next, procedural knowledge requires learners to be able to utilise procedures or actions to resolve mathematical problems. Lastly, condition or conceptual knowledge requires the synchronised interplay of the above two knowledge levels to find solutions for mathematical problems. A learner's ability to utilise these three knowledge concepts depends on their cognitive level of development, based on how effectually or efficiently the skills can be grasped. TA Maths relies on suitable strategies that utilise assimilated or developed knowledge to allow learners to execute explicit mathematical tasks. Having acquired their own knowledge of concepts and processes (metacognition), learners can apply their knowledge to utilising complicated mathematical skills that require abstract thinking strategies.

Teachers asserted that several factors deter learners from selecting PM over ML or TM. Among others, these include learners' self-regulation where their metacognition skills need to be aligned to emotional, motivational and behavioural management and self-control processes (Kruger & Swart, 2014; Nsikak-Abasi, & Akanaono, 2017). Besides the conceptual development explained before, one can anticipate the need for learners to have the capacity to handle mathematical content knowledge. This begins at a concrete level, advancing thereafter through a semi-concrete level, then progressing to an abstract level requiring learners to work minus tangible devices. Contributory factors identified by the focus groups as to why learners fail to reach an abstract level pointed to support structures (including parents and peers) not being in place or adequately involved, and teaching strategies and methods failing to ensure the learner has a sufficient grasp of concepts and processes. A learner that has attained a lower- level cognitive knowledge becomes overwhelmed in solving mathematical concepts, skills and processes at a higher level.

Teachers expressed that learners at some schools in KwaZulu-Natal have to face extrinsic risk/systemic challenges. Even though the Annual Teaching Plan is regulated and learners should be exposed to all aspects of the skills, concepts and processes, there is the risk of unforeseen setbacks ranging from absence to changes of school/teacher. An absentee learner automatically is at a disadvantage because of the gaps caused by missing concepts.

Further, learners may face health or socio-economic challenges which worsens the burden of keeping pace and catching up with work that has been taught.

The various reasons for learners choosing PM to ML and TM can be separated into links that include both internal and external risk factors. The intrinsic and extrinsic barriers to mastering mathematical knowledge skills and processes also increase the permutation of learners choosing ML or TM over PM. Extrinsically learners are faced with systematic challenges at school or in their communities. The intrinsic barriers are embedded within the level of self-regulation of the learner, and deficits in their self-control can create a cognitive deficiency. The learner may thus find it difficult to diagnose a mathematical problem and hence there is difficulty in choosing a suitable strategy to solve the problem; this in turn inhibits the learner from selecting PM or ML.

Another significant contribution to this conference was the feedback from Maths teachers that if they are unqualified or underqualified, learners cannot be supported or taught adequately. This is an extenuating factor leading to learners choosing a watered-down level of Maths merely to achieve a pass at the end of each year. In the South African context, one cannot discount the quality of training that teachers were exposed to before 1994 (Maharaj, 2019). Hence, if the teacher training did not imbue erudite knowledge of concepts and processes, the learners are unfortunately compelled to learn from teachers that have insufficient or inadequate tools for their trade in the classroom situation. Learners that find the regulated assessments difficult to pass resort to disregarding PM because of cognitive distress from pressure to pass; hence we find the majority of our learners choosing ML and TM over PM.

Although I have mentioned many areas of concern and the lack of equality in the teaching of Maths, not everything is doom and gloom; the conference cohort made suggestions and identified encouraging notions about why teaching Maths is gratifying to them.

Positive disposition of teachers towards PM, ML and TM

Teachers from the various focus groups confidently noted that the community and stakeholders acknowledge them as rare assets at a school; Maths is necessary to transforming education that can support a dynamic and positive South African economy. Technologically oriented careers require Maths to qualify to study at a tertiary institution.

Teachers also added that the announcement of Maths results (symbols and pass rate) gives them the verve to take the subject to greater heights because their inputs to the growing economy are noticed and this is motivational.

According to the focus groups, teachers advocated the formation of scaffolding from professionals within the department of education as well as academics; this could build a knowledge and support base for Maths, and encourage inter- and intrapersonal professional development.

Findings that stemmed from collaborative focus groups, brainstorming and academic addresses contributed to the body of knowledge on how teachers manage curriculum demands (CAPS) in achieving teaching and learner development.

Above I outlined proposals from the focus groups for scaffolding of inter- and intrapersonal professional development among teachers. This directly engages with the South African Schools Act No 84 of 1996 which stipulates that Professional Learning Communities can be constructed within a school and outside the institution to enable teachers to engage in discussions, activities, professional development and positive self-regulation offering support for both novice teachers and veteran teachers.

Data analysis and discussion of findings

Emanating from the discussions, there were opposing views from teachers about belonging to a Professional Learning Community outside school. The majority welcomed the notion that there would be collaborative support for the framing of uniform assessment tasks. Those in favour of this community saw it to be cooperative and supportive of learning and exceeding the traditional assistance available to Maths teachers for acquiring/syncing regulated CAPS requirements on academic content and skills. It was also seen to help address pertinent transformational educational goals. Teachers in this cohort agreed that engaging with other skilled teachers that are teaching Maths would be an advantage because the interchange of information enables teacher development; the interchange would also help to bring teachers on par with their counterparts.As argued by Umugiraneza, Bansilal, and North (2017), undertaking to attain greater competency, , teachers can try new things, strive to learn from the experiences of their counterparts and work to adopt and embed the teaching of Maths practices that work best.

Professional Learning Communities will permit Maths teachers to improve the implementation of CAPS content through interactions with proficient teachers. The Annual Teaching Plan of CAPS is a process, not an event; therefore, Professional Learning Communities will enable the curriculum content to gradually be executed to ensure the fruits of success. The CAPS philosophies can be managed together in steps to maximise performance in Maths. The requisites stipulated by policy can be addressed through appropriate projects initiated by the DBE; the alternative is that accomplishment and achievement will fade away as Maths teachers struggle to manage competing priorities. The cohort also expanded on the notion that no matter how marvellous an educational idea or intervention is on paper, what matters is how this manifests in the day-to-day work of Maths teachers. Professional Learning Communities will be the relevant forum for enabling this manifestation.

Professional Learning Communities were recognised by the teachers to be a place where connoisseurs of Maths can display their leadership skills, which in turn will be conducive to transforming the teaching and learning of the subject. Problem areas need to be well-defined so that appropriate programmes can be identified and implemented by the Professional Learning Communities. To judge the readiness of teachers to carry out Maths teaching, the cohort agreed to create a leadership implementation plan. Teachers would be assessed in terms of their capacity to plan and deliver a CAPS-compliant Annual Teaching Plan. The innovative idea of creating a pool of available resources resonated unanimously with the cohort. Such a resource pool was seen as serving a common purpose, being time-efficient and conducive to creating uniformity within structures in education. Another benefit of Professional Learning Communities that resonated amongst the teachers which is emphasized by Okyere, Kuranchie, Larbi and Twene (2018) related to their potential for providing support to staff, monitoring progress in assessments/tasks and problem-solving. They were also seen to be useful in adapting strategies within a team and strengthening professional development (particularly when teachers are in too much of a comfort zone among colleagues at their school). Particular importance was placed on Professional Learning Communities enabling novice Maths teachers to plan their assessments so that they can gain experience from the veterans in the subject.

Although Professional Learning Communities were seen to be beneficial, the adverse side to the formation of such a band of teachers was seen to be that schools that were resourced and producing outstanding results would underrate teachers at schools that did not perform well.

An additional perspective on Professional Learning Communities is that if teachers had underperforming leadership in their Professional Learning Communities, this would have a domino effect on teaching and learning. However, a solution was found to this legitimate concern.

There was a range of stances among the teachers regarding the need for upskilling and keeping abreast of trends and strategy shifts in Maths. Teachers alluded to different workshops and conferences that could be exploited to garner information that could unfortunately be used for transforming the subject through self guided initiatives.. However, it was agreed that there should be improved access to resources and technological support on Maths. This support comprises interconnecting common goals and designing suitable/appropriate learner and teacher support; such support will ensure the cascading of quality Annual Teaching Plan content.

Input from Professional Learning Communities would enable novice and veteran teachers to organise their lessons and methodology based on academic principles/skills. These provide professional leverage in the classroom, enabling the teacher to deal with social and personal difficulties experienced by learners. Professional Learning Communities to support teachers of Maths can be created either internally or externally. The team teaching approach received was supported by the majority of Maths teachers. Those in support vouched that Maths teachers that belong to team teaching projects benefit because it enables them to achieve goals. Team teaching is relevant to all teachers of Maths, irrespective of their expertise or skills; however, it requires teachers to work in harmony, no matter their level of experience. Such teaching invariably has a positive impact, improving Maths learners' performance in essential academic tasks. Team teaching unwaveringly helps learners meet assessment requirements despite teachers engaging in various approaches and methodologies, and exhibiting a range of attitudes to the teaching of CAPS content.

Authorities must make a concerted effort to carry out ongoing in-service training with government and non-government institutions so that there is balanced knowledge for all teachers of Mathematics. This in-service training could be undertaken during school holidays, after school or at weekends. The emphasis on abstract and symbolic thinking that Maths demands from the TA will be given attention so that assessment results will improve.

A detailed explanation of teachers' working in a context of adversity is illuminated in a study undertaken by Maharaj (2019); this gives a detailed account of the injustices and unequal education adopted after 19 education departments amalgamated nationally into a single ministry. The imbalances in socio-economic circumstances and teacher training were ignored while teachers across the board were nevertheless expected to embrace the changes in the curriculum. The latter seemed to phase in a new educational approach, yet overlooked the quality of the basic and tertiary education teachers of Maths had received. The curriculum nevertheless specified a single regulatory benchmark for assessing subjects. The 2019 study made an urgent demand for authorities to adjust the imbalances by undertaking a needs assessment of schools (especially for teachers of Maths) so that results could greatly improve. Besides the contextual aspects addressed above, another common difficulty related to transformative change that teachers in South Africa face is challenging behaviour in the classroom. Undisciplined behaviour directly interferes with teaching and learning; the escalating tide of disruptiveness is multifaceted but teachers gave their opinions on the causes. The view was expressed that disruptive behaviour stems largely from dislocated family and communal life. The manifestations of behaviour problems arise from parental neglect and the basic/emotional needs of learners not being met. This in turn leads to emotional insecurities and a decline in respect for human rights, and also a decline in morals and values However, teachers did acknowledge that challenging behaviour differed from school to school and from area to area.

The negative effect of setbacks at schools was acknowledged in the focus groups; this added a new swirl on explanations from the cohort present for the poor performance in Maths at schools in KwaZulu-Natal. The curriculum content in Maths is not entrenched in the context of the culture and life world of learners; therefore the knowledge is not meaningful to them, resulting in poor performance. Interestingly, focus groups explained that their teaching was debilitated by those learners that cannot find meaning in the curriculum requirements— given overcrowded classes and the difficulty in conveying subject content at an appropriate level, especially when required support is not to hand.

The organisation at schools also seems to impact on the position of Maths at both primary and high schools. Underqualified and unqualified teachers are deployed to teach the subject, either because of being appointed to a position or when schools annually rotate Maths teachers.

This policy undertaken by management has a long-term effect on the ability of learners to grasp foundational knowledge of Maths concepts and processes; hence, we find learners either abort their maths studies Maths or weave between ML and TM.

Concluding remarks

In this denouement, the outcomes of the reports tabled at this SADTU conference achieved its ultimate goal in that concerns were raised and inputs were obtained from teachers. Inter-professional development came from keynote speakers, feedback from teachers and suggestions from the academic forum; this was enabled by interactions in focus groups. The union has thus been able to increase collaboration and networking at a professional level to enable Maths benchmark tests to obtain a higher pass rate in future. Teachers across the province of KwaZulu-Natal will be engaged in ongoing workshops and training to improve their knowledge and insights into mathematical difficulties. This will change their self-regulated attitude towards CAPS requirements in Maths and in so doing improve learner performance.

This consultative process, timed for the beginning of the school calendar, certainly allows for substantial and effective remediation of Maths Professional Learning Communities. I also believe findings resonate with the development of compliant Annual Teaching Plans that ensure suitable assessment strategies and methodologies. In my opinion, the Maths classroom is a system on its own comprising a set of interconnected elements, each with its own structure, dynamics, and control; this transformational process is the face of teaching Maths. Each teacher of Maths designs their own lessons in executing their work that resembles a fixed procedure. Each fixed procedure is aimed at the knowledge of the Maths teacher of the regulatory requirements and their state of compliance with policies and laws.

Whether novices or veterans, the attentiveness of teachers to achieving their goals and overcoming their shortcomings will be affected by their level of self-regulation. This will ultimately affect their success and accountability in meeting the CAPS requirements.

Both in primary and secondary schools, the teacher of Maths is directly involved in the essential constituents of controlling this subject they teach.

They are measured by their self-regulation, and Maths assessment and remediation measures—via both formal and informal activities. To take their subject teaching to greater heights, the teacher of Maths has to be capable of acting promptly and appropriately to fluctuating classroom situations and learner challenges.

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