Art. #2423, 11 pages, https://doi.org/10.15700/saje.v45n2a2423

Excellence for some before equity for all: Re-examining the national strategy for mathematics education through the capability approach theory

Michael Kainose Mhlolo

Department of Mathematics and Natural Science Teaching, School of Education, Sol Plaatje University, Kimberley, South Africa

michael.mhlolo@spu.ac.za, mikemhlolo@icloud.com

Abstract

In 2001 South Africa launched its national strategy for mathematics, science, and technology education (NSMSTE), which was anchored in the 100 dedicated (Dinaledi) schools project. At the launch, 5 undesirable outcomes were identified as structural problems that retarded the provision of high-quality education; hence they were targeted for intervention and correction. Although, to date, internal evaluators claim that the intervention was successful, critics refute those claims, arguing that evaluators selected short-term outcomes to seek immediate gratification; hence certain important indicators were ignored. With this article I aim to analyse alternative selections of indicators for the same 5 undesirable outcomes so that stakeholders may gain new insight. Framed within the capability approach (CA) theory, I employed a qualitative research design in the study where secondary data were collected through document analysis. The CA theory argues that in any educational intervention, stakeholders prioritise between two sets of resources – those internal (ability/intelligence) or those external to the learners (social arrangements). Where internal resources are prioritised, the interventions have been successful, but where external resources have been prioritised, interventions have often failed because learner ability was buttressed by external resources. However, while theory should be an important driver of practice, evidence justifies decision-making and informs future practice. While evidence of the tenets of the CA theory abounds globally, in South Africa, a targeting talent project (TTP) launched at the University of the Witwatersrand (Wits) in 2006 prioritised ability by selecting academically gifted learners in Dinaledi schools. To date, the project has nurtured 3,022 gifted learners and achieved an average annual pass rate of 94% with university access. On the other hand, results from the current analysis show that external resources were prioritised, but that the 5 outcomes were not achieved. I recommend that the national strategy should consider prioritising the identification of gifted learners rather than randomly placing any learners in dedicated/focus schools and providing them with external resources.

Keywords: capability approach; conversion factors; Dinaledi; giftedness; O-capabilities; S-capabilities

Introduction

Background to the Study

Although the ability of all learners to succeed in today's technically orientated work environment is increasingly dependent on their understanding of mathematics, science, and technology (herein referred to as mathematical sciences), persistently high failure rates in these subjects kept dogging South Africa since 1994. Viewing this as a pernicious legacy of apartheid, the cabinet launched the national strategy for mathematics, science, and technology education (NSMSTE) in 2001. It has been argued that prior to the launch of the NSMSTE, the government had an egalitarian approach to education. Simkins (2010) described this approach as equity for all before excellence for some characterised by a focus on providing access to all without equal attention to issues of quality. The Centre for Development and Enterprise (CDE) has always been critical about such a deficit approach to education arguing that elevating equity over excellence as a matter of principle was not implementable because, by definition, the more numerous and proficient (excellence) service providers are (including teachers), the more rapidly equity can be achieved for the population at large. So, instead of equity for all preceding excellence for some, it should be excellence for some coming before equity for all. At the launch of the NSMSTE one can see a clear shift towards this excellence for some in terms of (a) subjects – given that the ability of all learners to succeed in today's technically orientated work environment was said to be increasingly dependent on their understanding of mathematical sciences as compared to other subjects, (b) learners – given that exceptionally gifted children and youths were considered as an obvious solution to the skills gap, (c) schools – given the focus on the Dinaledi schools project (DSP) rather than through a dilution of effort across the whole schooling system, (d) previously disadvantaged learners – given the decision to place DSP in presidential nodal areas, (e) top-end performance – given the need to increase the number of learners who would be eligible for university entrance.

The focus on excellence for some is also evident in that the word "dinaledi", means stars; hence, the strategy's first 5-year strategic plan (2005–2009) was formulated under the theme, "creating tomorrow's stars today." Kahn (2019) applauds this vision, arguing that attracting, nurturing, and retaining talent must reside at the heart of any capable developmental state. Similarly, Finn (2014, 2020) describes it as morally correct, educationally sound, economically beneficial, and politically shrewd. Despite this educational wisdom, the concern to date is that the intervention has not been yielding the intended outcomes because of the persistently high failure rates in these subjects. While poor performance is a national problem, the challenges are more severe in those segments of the population that were marginalised under apartheid. Critics, therefore, argue that this does not only rob poorer children of social and economic mobility but also perpetuates the cycle of poverty and undermines national efforts toward transformation (Spaull, 2019). The former deputy president, Phumzile Mlambo-Ngcuka, referred to the marginalisation of poor learners as: "… load-shedding our children." The parallel to load-shedding of electricity was made as Ngcuka issued a dire warning to the government that they were making the same mistake with education as they did with the power utility, Eskom, which resulted in the country being subjected to load-shedding because the government didn't invest enough in the generation of electricity. According to Hanushek (2020), ignoring this economic dimension of education would not only endanger the prosperity of future generations, but it would also have extensive backlash for poverty, inequality, social exclusion, and sustainable development. Hence, according to the Department of Basic Education ([DBE], 2022), proper diagnosis of the mathematical sciences problem should be studied to death before any remedial actions are instituted.

Problem Statement

In South Africa, the CDE pointed to internal evaluators' tendency to spruce performance and conceal deficits, often with the intention of securing further funding (CDE, 2004; Simkins, 2010). The Minister of Basic Education made a candid admission that the extent and depth of the mathematics crisis were often underestimated in favour of reports of progress (Motshekga, 2016). However, before critics label internal evaluators as damned liars with statistics, sociologists caution researchers that social statistics are not numerical absolutes because, from the best to the worst, they are socially constructed in that they are selected, defined, and presented by people who choose what to count, how to go about counting, and which of the resulting numbers they share with others (Best, 2004). Hence, a better metaphor would be to suggest that statistics are like jewels; they need to be selected, they need to be cut, they need to be polished, and they need to be placed in settings so that they may be viewed from a particular angle (Schield, 2007).

However, even if social statistics could be viewed from another perspective, Stabback (2016) cautions that evaluation evidence is not good or bad until it is regarded in relation to the purpose or set objectives. Hence, it is important to start with an understanding of what the NSMSTE hoped to achieve. At its launch, NSMSTE stakeholders attempted to set objectives which are specific, measurable, achievable, realistic, and time-bound (SMART). Among these universally recommended attributes, Knight (1995) places emphasis on the M because measurable goals give stakeholders the criteria to track progress. He further argues that in writing a mission statement, skilled drafting allows us to lay claim to a wonderland of competencies, but if there is no evidence of appropriate assessment of those goals, then the deoxyribonucleic acid (DNA) evidence belies the claim. At best, the absence of assessment suggests that our intentions have not been completely realised; at worst, it says that our intentions were rhetorical for the benefit of auditors and not learners. In the NSMSTE, we see a wonderland of these measurable objectives, e.g., doubling the number of higher grade (HG) passes in mathematical sciences within 5 years, 90% of learners passing mathematics with at least 50% by 2030, reaching 420 points on the Trends in International Mathematics and Science Studies (TIMSS) by 2023, 10% annual growth in national HG passes, and improve top-end ($p \geq 80\%$) performance, among others. Despite the indicators being well articulated, I argue that internal evaluators selected ad hoc indicators which are different from the original ones set for the intervention. For example, in one of the internal reports, the DSP is said to have been successful after scoring a 54% pass at $p \geq 30\%$, yet the project targeted bachelor passes at $p \geq 50\%$. Internationally, the average TIMSS 2019 mathematics scores are said to have increased in no-fee schools by 41 points, from 324 to 365 points (Reddy, Winnaar, Arends, Juan, Harvey, Hannan, Namome, Sekhejane & Zulu, 2022), but the fact that the country fielded Grade 9 learners for a Grade 8 test and that the set target for 2023 was 420 points are all ignored. Given that the internal evaluators' selection of indicators is problematised, social construction requires hypothetical thinking (what if) about alternative ways of collecting, counting, measuring, and presenting data.

Aim of the Current Analysis

With this article I aim to (a) compare performances against the originally set measurable indicators of the NSMSTE, (b) identify possible reasons for success/failure, and (c) propose possible remedial action. This is important because by going back to the same sources of data but selecting different indicators than before, this article could contribute to a better understanding of where the national strategy could be improved.

Research Questions

This study was framed by three research questions:

1) What national goals did the NSMSTE seek to attain, and to what extent were they achieved?
2) What competence levels did the Dinaledi schools have in relation to the expectations?
3) Which inputs or conversion factors were prioritised during the implementation of the Dinaledi schools programme?

Theoretical Framework

I argue that there is less controversy around issues of comparing performance against set objectives and judgement about levels of competence in the DSP because evaluations assess progress made towards the achievement of a project's objectives. Hence the theoretical underpinning for this article does not address the first two research questions. However, the long-standing tension between egalitarian goals and excellence in education comes to the fore when a decision has to be made about inputs which should be prioritised during the implementation of interventions such as the NSMSTE. For example, the World Bank report on the DSP raises an important question about which input combination was most effective at improving performance (Blum, Krishnan & Legovini, 2010). Similarly, Hanushek (2020) suggests that researchers ought to ask such questions about important inputs and how such inputs can be manipulated to effect change in learner performance. To give convincing answers to such questions would be among the most important tasks for evaluators of educational processes. The tension arises when, on the one hand, those who perceive themselves as victims of unequal treatment find a strong proclivity toward equality and an inclination to celebrate it as the superior virtue. On the other hand, those for excellence argue that education must provide opportunities for children to achieve their full potential – anything less is a waste of talent and a blemish on human dignity and flourishing. Therefore, when entering into such debates, a theory is inevitable because it provides a lens through which to support one's thinking on the matter. I argue that rather than resolving tension in favour of either side of the polarity, a theory is needed whereby both equality and excellence may be regarded, not only as compatible, but as requiring each other. The capability approach (CA) theory has the potential to structure arguments that respond to such compatibility.

The first two basic and fundamental concepts within the framework of the CA are capabilities and functionings (Broderick, 2018). A functioning is an achievement of a person or what they manage to do or to be (Sen, 2005). On the other hand, capabilities or conversion factors refer to the means and resources which enable a person to achieve functionings. The main proposition in the CA is that whether someone can convert a set of means or resources into a functioning or achievement crucially depends on certain conditions, which are called conversion factors. Admittedly, there are various ways in which these conversion factors have been categorised, but there is convergence into two broad categories: (a) those factors from within the person (personal characteristics such as ability or level of intelligence/motivation) and those from outside the person (social arrangements). Gagné (2019) refers to them as intra-personal and environmental factors, Robeyns (2020) refers to internal resources and external resources while Gasper (2002) refers to S-capabilities and O-capabilities (see Figure 1).

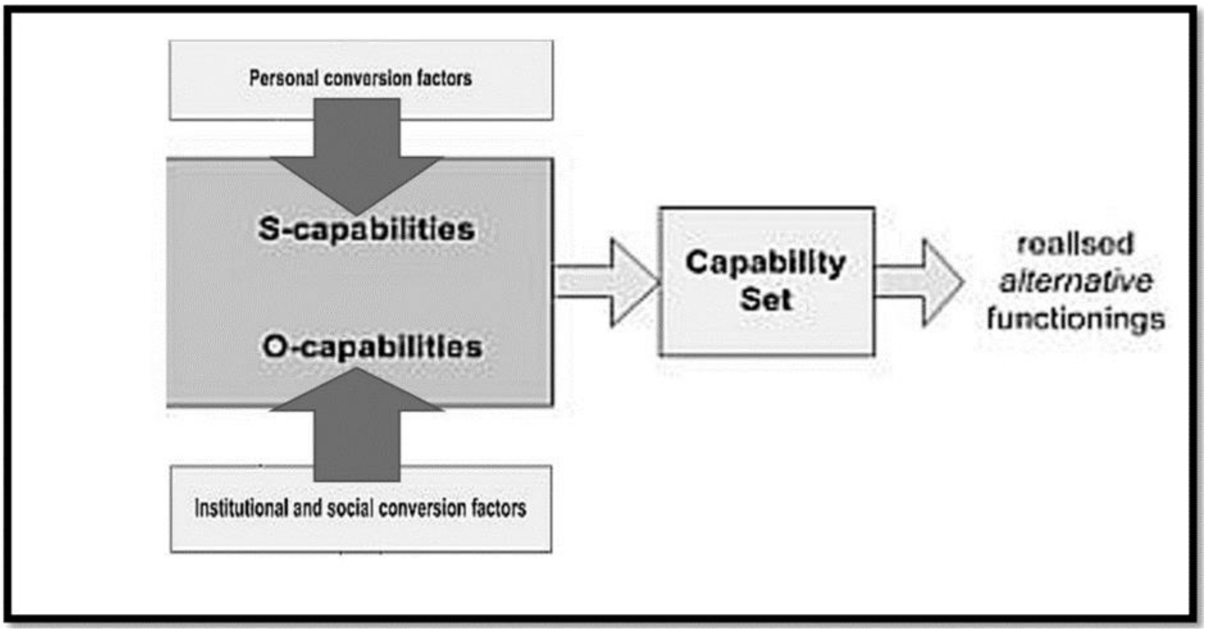

Figure 1 Capabilities and functions

From a CA perspective, for a person to develop an ability, they must have appropriate internal (S-capabilities) and external resources (O-capabilities). According to Sen (2005), an effective political arrangement of distribution would be the one that focuses on the nurturing of human potential as well as providing external structures that sustain that development. So, if institutions want to expand the capabilities of a person or a group, these are the levels at which stakeholders should intervene. However, Sen's main point of departure is that while both internal and external resources are necessary to achieve certain functionings, it should be stressed that the exclusive focus on external resources dismisses considerations about substantial heterogeneity in people's ability to convert them into valuable functionings. Therefore, evaluation that focuses only on means, without considering what particular people can do with them, is insufficient because resources are not the only things that matter, and for some capabilities that we try to expand or try to equalise, resources may not even be the most effective factor of intervention. In terms of the most effective factor of intervention, the conversion argument implies that the importance of O-capabilities (external conversion factors) is derivative of the S-capabilities (internal conversion factors) to convert them into valued functions. Sen illustrates this point with the example of a standard bicycle, which might be considered a generally useful tool for most people to extend their mobility, but which obviously will not do so for a person without legs (Sen, 2005).

The Organization of Economic Co-operation and Development (OECD) summarises many other studies where there is ample consensus on the view that individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, and to overcome obstacles by engaging mental faculties (OECD, 2020). The implication is that differences in later achievements presuppose differences in potential, and by the same logic having more potential implies that given the same educational inputs, a higher level of skill or achievement is likely to be realised. Consistent with this logic, research has shown that certain learners would not succeed in mathematics even if they tried and had the appropriate external resources but did not have the natural potential for the subject (Gagné, 2019). In South Africa, the targeting talent project (TTP) at the University of the Witwatersrand argues in a similar way that while ability is part of the individual-environment transaction, it must be treated as an opportunity available to all, although it may be actualised more frequently by some. Hence, this article is premised on the view that S-capabilities should be considered as a major focus of any intervention because it can be shown that natural potential (gifts) are what enable or facilitate learners' future achievements (talent) in mathematics (Gagné, 2019). Given its heuristic appeal and elegance, I found the CA theory particularly relevant to structure my arguments around the inputs which were prioritised/trivialised during the implementation of the NSMSTE.

Methodology

Research Design

The research design employed in this study was desk-top research, which involved gathering information and data from existing sources (secondary data). Ruggiano and Perry (2019) conclude that secondary data analysis (SDA) involves investigations where data collected for a previous study are analysed by the same or different researcher(s) to explore new questions or use different analysis strategies that were not a part of the primary analysis. One of the four approaches to SDA involves analyses of data from the parent study that appear important but were not sufficiently focused on in the primary analysis.

Sampling

In SDA, sampling cannot always be of people, but texts in documents are sometimes sampled. In this case, documents that are available on the Department of Education website or journal articles were purposively sampled. The inclusion criteria were as follows: (a) the 2001 national strategy for mathematics, science and technology education, (b) its 5-year strategic plans from 2005–2030, (c) internal and external Dinaledi schools' evaluation reports, and (d) journal articles on the Dinaledi schools.

Data Collection Procedures

The focus was on the period between 2001 and 2024, and the keywords used in searching for documents were (a) national strategy for mathematics, (b) 5-year strategic plans for mathematics, and (c) Dinaledi schools. As I reached 20 documents, I was of the opinion that saturation had been reached, which occurs in research when no additional data are found that advance, modify, qualify, extend, or add to the developed theory.

Data Analysis Tools

In this article I argue that the setting of targets is of the utmost importance in project design because it forms the basis for evaluation. In this regard, the NSMSTE identified five undesirable outcomes which were to be transformed into desired future outcomes and against which measurable goals/targets were set. These are (a) increased participation in mathematics, (b) increased participation in higher grade (HG) mathematics, (c) increased top-end performance, (d) focus on learners from previously disadvantaged backgrounds, and (e) prioritisation of exceptionally gifted youths from previously disadvantaged backgrounds. These targets became the criteria for guiding analysis and making judgement about failure or success.

Validity and Reliability

One way of ensuring authenticity in SDA is through triangulation. In this study I employed "within-methods" triangulation in which I sampled reports at different periods in the 20-year existence of the DSP. I collected reports from commissioned evaluators, independent researchers, and local and international organisations. In terms of replication on the findings, South Africa prides itself in terms of archiving accurate and quality data. Soft copies of all the documents sampled for this study are available from the DBE and the Human Sciences Research Council (HSRC).

Results

Research Question 1

What educational goals did the NSMSTE seek to attain and to what extend were they achieved? The results to this research question are presented following the five criteria set according to the NSMSTE.

Criterion 1 – increased participation in mathematics

Table 1 Number of learners enrolled for mathematics in 000s (2008–2022)

2008	2009	2010	2011	2012	2013	-	2017	2018	2019	2020	2021	2022
299	290	263	224	226	242	-	245	234	222	233	254	270

In the wake of the fourth Industrial Revolution, mathematical sciences had come to dominate expectations regarding what is regarded as successful schooling. Hence the NSMSTE aimed at increasing enrolment of learners registering for these subjects. Contrary to the government's intention, Table 1 shows a decline in the number of learners enrolling for mathematics from 299,000 in 2008 to 270,000 in 2022. If one considers that school enrolments had increased in the same period from about 534,000 to 922,034 it is clear that the number of learners registered for mathematics has declined from 56.1% in 2008 to 29% in 2022.

Criterion 2 – increased number of learners taking HG mathematics

Table 2 Number of learners enrolled for mathematics* and Mathematical literacy** in 000s (2008–2021)

Subject	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Maths*	299	290	263	225	226	242	235	264	266	245	234	222	233	259
Maths lit**	263	278	281	275	291	324	312	389	362	313	294	299	341	441

Many learners were migrating from higher grade (HG) mathematics to standard grade (SG) mathematics. The introduction of the NSMSTE was part of the strategy to reverse that trend. The year 2008 is used as the base here as it was then when HG and SG mathematics were replaced by mathematics and mathematical literacy, respectively. Table 2 shows that the department's goal to reduce the number of leaners opting for mathematical literacy has not been met. Not many learners were enrolled for mathematical literacy in 2008 and 2009, but from 2010 onwards, learners have been migrating to mathematical literacy at an alarming rate. At publication the difference was around 180,000 in favour of mathematical literacy.

Criterion 3 – increased number of learners at top-end performance in mathematics

Table 3 Percentage of learners passing with 50% and above (2008–2022)

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wrote	302	304	263	225	226	242	226	264	266	245	234	222	233	259	269
> 50%	21.1	17.7	19.1	18.5	22.7	26.1	22.3	20.3	21.2	22.2	21.7	20.3	22.3	23.1	22.1
> 80%	4.3	2.9	3.6	2.5	2.9	3.4	3.2	2.9	3.0	2.7	2.5	2.0	3.2	2.9	2.7

In this criterion, the DBE (2022) refers to the National Education Collaboration Trust (NECT) which clearly states that it was committed to ensuring a South Africa where 90% of learners passed mathematics with at least 50% by 2030. However, Table 3 shows that the percentage of learners who passed at the 50% level (2008–2022) has never been higher than 30%, while the highest percentage of learners who passed at the distinction level in this period was 4.3%.

Criterion 4 – increased participation and performance of previously disadvantaged learners

Although the DBE rarely disaggregates performances in mathematical sciences according to population groups, TIMSS is one measure dataset spanning 24 years of achievement, which provides performance by socio-economic status (SES). For example, the South African medium-term strategic framework (2019–2024) set the TIMSS target for both mathematics and science at an average of 420 by 2023 at the Grade 9 level. Reddy et al. (2022) analysed the performance of TIMSS in mathematics over an 8-year period from 2011 to 2019.

The most recent average score for South African learners for mathematics in TIMSS (2019) was 389, and judging by the national average scores to date, Reddy et al. (2022) confirm that the country is a distance away from the target of 420 set in the medium-term strategy. However, if the performance is further disaggregated by fee-paying and no-fee-paying schools, it should be clear that the fee-paying schools (at 440) have already surpassed the 2023 set target of 420. So where does the real problem lie? Reddy et al. (2022) show that 72% of learners from no-fee paying schools scored below 400, implying that they had not acquired basic mathematical knowledge by 2019. This is despite the fact that South Africa fielded Grade 9 learners for the Grade 8 TIMSS tests since 2011. It is even more disturbing to note that two thirds of Grade 9 learners attended no-fee schools, while one third attended fee-paying schools. No fee-paying schools are those where parents who cannot afford to pay school fees must apply to the school governing board for conditional, partial, or full exemption from paying school fees. Even though many years have passed since the end of apartheid, poorer schools still find it challenging to overcome inherited socio-economic disadvantages.

It was further argued that the increased proportion of Grade 9 learners demonstrating improved abilities in mathematics and science was strongly deterministic of ultimate outcomes in the mathematics and science pipeline to the exit level matriculation examination and further into tertiary studies (e.g., Reddy et al., 2022). Hence it would also be important to check participation rates at such institutions.

Data provided by the Department of Statistics (2023) clearly show that enrolment in higher education institutions has stubbornly remained most common among Indians/Asians (19.6%), and Whites (17.7.%), while only 5.2% of the Coloured and 5.5% of the Black African population groups were enrolled.

Criterion 5 – prioritising exceptionally gifted children and youths

It is important to recall that policymakers were unanimous that the obvious solution to a skills shortfall in the area of mathematics, science and technology (MST) was to provide additional learning opportunities for exceptionally gifted children and youths. Despite this criterion being a foundational condition for improvement, no records show where learners were ever identified as exceptional. The World Bank made a similar observation; hence, it recommends that obtaining reliable pre-treatment mathematics outcome data is necessary to provide plausible estimates of the effects of the Dinaledi programme on mathematics outcomes (Blum et al., 2010). The director of the Dinaledi unit, David Silman, admitted that there was no history of any baseline assessments done in terms of learners' levels of achievement in the course of the project (Smillie, 2013). Consequently, no specific provision was being made to cater for hundreds of thousands of intellectually gifted children. Silman strongly believes that there must be schools for intellectually gifted children; hence, in 2017, he registered a non-profit company called the Gifted and Advance Learning Academy of South Africa (GALASA).

Research Question 2

What competence levels did the Dinaledi Schools have? I raised this question following a weakness identified in one of the reports wherein previous evaluations measured the average effect of schools assigned to the Dinaledi programme. Averages tend to mask individual performances, as is shown by the fact that a significant number of Dinaledi schools were delisted annually after failing to produce a single pass in mathematical sciences. For this reason, disaggregating performance according to different levels would enable stakeholders to see important characteristics of the different Dinaledi schools.

Data on performance of Dinaledi schools show that between 2001 and 2004 more than 50% of the Dinaledi schools were producing fewer than 15 learners each who passed with a mark of ≥ 50%. The most notable aspect is that a significant number of Dinaledi schools remained in the 0% pass category after 4 or 5 years of intense intervention. As part of their studies, the CDE developed a comprehensive comparative index which displays the performance of individual schools in mathematics and science. This index ranges from (zero), very ineffective, to

(10), very effective, and allows schools to be compared with and ranked against others (CDE, 2004). The argument was that very different trends emerged once the analysis went beyond the simple pass/fail rates provided by the National Department of Education and debated in the media. For example, in 2001, there were 5,789 secondary schools in South Africa, and these were ranked nationally in terms of performance. Although the CDE (2004) used its index to rank all these schools nationally, I only looked at Dinaledi schools to create Table 4.

Table 4 National ranking of Dinaledi schools according to the CDE index

National ranking	Number of Dinaledi schools
Top 500	14
501–1,000	21
1,001–2,000	38
2,001–3,000	15
3,001–4,000	6
4,001–5,000	6
5,001–6,000	2

This table shows variations among Dinaledi schools in the initial year of implementation (2001) with only 14 schools in the top 500 performing schools. Overall, the Dinaledi schools ranged from the second-best mathematics and physical science school in the country to one ranked 5,400th out of 5,789. Despite the criterion for selection being very clear, in 2001 some Dinaledi schools actually did not offer mathematics and physical science in Grade 12, nor did they have any mathematics and physical science educators. In South Africa there are strong views that a blind drive for equity was pursued for the first decade of the democratic government, characterised by a focus on the poorest schools, regardless of the effects of these policies.

Besides ranking them against others nationally, Table 5 shows the distribution of 102 Dinaledi schools in terms of levels of performance on a scale of 0–1, with zero being the weakest and one being the best.

Table 5 Distribution of the Dinaledi schools according to the CDE index (n = 102)

Level	Number of Dinaledi schools
0.75–1	10
0.50–0.74	39
0.30–0.49	37
Below 0.30	16

Table 5 shows that only 10 of the Dinaledi schools were in the top-end level of performance, with the majority (53) falling below the 0.5 level. From these data sets, it should be clear that there were problems in the selection of the schools under the DSP project, demonstrating an inability on the part of the National Department of Education to ensure compliance with its own criteria for awarding Dinaledi status. Even though this pattern emerged in the initial phases of the project, unfortunately, it became the norm in later phases, with schools being delisted annually for failing to meet the basic minimum requirements. Hence it is not surprising that most of the HG passes in Dinaledi schools were achieved by a few high-performing schools while the performance of most other schools remained the same or even worsened.

Research Question 3

Which conversion factors were prioritised in the Dinaledi schools programme? Table 6 shows the distribution of resources from 2002 to 2013.

Table 6 Inputs that were prioritised in the NSMSTE and Dinaledi programme

Year	Learning materials provided	S*	O**
2002	➢ Materials for the first Autumn clinic	X	✓
2004	➢ Provision of micro-science kits ➢ Related training by Somerset Educational Pty ➢ Provision of mathematics teaching aids ➢ Related training by Phambili Education projects ➢ Interim syllabus for Grades 11–12	X	✓
2007	➢ The budget for Dinaledi Schools was R4,5 million	X	✓
2008	➢ 5,700 scientific calculators were distributed. ➢ 14,000 copies of the mathematics 911 workbooks were distributed to Dinaledi Schools ➢ Each Dinaledi school received two copies of the Department of Education (DoE)/Old Mutual Grade 10–12 exemplar papers for mathematics and mathematical literacy. ➢ 200,000 textbooks for Grade 12 for mathematics, science, English additional language	X	✓
2009	➢ 398 mathematics teachers trained ➢ 370 physical science teachers trained		
2010	➢ 370 of the 500 Dinaledi schools received support from companies, higher education institutions and other organisations.	X	✓
2011	➢ R70,000,000 granted to the Dinaledi schools.	X	✓
2012	➢ R100,000,000 budgeted for Dinaledi schools. ➢ Teacher laptop project ➢ R811,000,000 for the expansion of workbooks for Grade 9 learners ➢ 4,400,000 textbooks for Grades 10 to 12 = ➢ 900,000 mathematics workbooks ➢ 900,000 physical science textbooks	X	✓
2013	➢ R105,000,000 budgeted for Dinaledi Schools	X	✓

Note. *S-capabilities or innate abilities. ** O-capabilities or external resources.

Table 6 shows that the NSMSTE strategy focused on providing O-capabilities or external resources while ignoring learners' S-capabilities or innate abilities. However, according to Reddy et al. (2022), narrowing the achievement gap between no-fee, fee-paying, and independent schools is not as simple as improving access to resources.

Discussion

With this article I aimed to provide an alternative lens through which to make judgments about the outcomes of the NSMSTE. The proposed outcomes were (a) to increase participation in mathematics, (b) to increase the number of those registering for HG mathematics, (c) to increase top-end performances, (d) to focus on learners from previously disadvantaged communities, and (e) to prioritise exceptionally gifted youths from previously disadvantaged backgrounds. This is important because, in the latest action plan (2019–2024), the DBE cautions that although success has been limited, it is important to understand why and take remedial action. With the first research question I addressed the issue of the goals that were set out to be achieved with the strategy and to what extend the strategy was successful. The findings show that none of the five measurable objectives set were achieved. Enrolment in mathematics remains on a downward trajectory with the numbers of learners registering for mathematics in 2022 being lower than that in 2008; learners have been migrating to mathematical literacy, pass rates have stagnated, and the performance of learners from previously disadvantaged backgrounds has remained low. In fact, the latest developments in the DBE show that the director of special projects, whose role had been to monitor the DSP, has now been tasked to reverse the trend in which learners choose mathematical literacy instead of mathematics.

It is not sufficient to simply point out what the intervention failed to do but also to understand the reasons why the set targets were not achieved. With the second research question, the concern was about the competence levels of learners in the DSP project. The results show that besides the lack of competent teachers, the DSP did not have the capacity to meet the goals of the NSMSTE, given that the selection criteria were not adhered to. Similar evaluations have concluded that Dinaledi schools were just another group of randomly selected ordinary schools (CDE, 2004; Simkins, 2010).

The third research question was not only concerned with what went wrong but also to understand what should have been done. With regard to the inputs that were prioritised in implementing the NSMSTE, the results show that external resources (O-capabilities) were prioritised exclusively at the expense of internal resources (S-capabilities). Although external resources such as teachers and materials matter, according to the CA theory, these are insufficient in predicting achievements if learners' endogenous factors are ignored. Based on local evidence, the findings in this study show that the idea of prioritising learner potential is both doable and beneficial. One aspect that has received attention from intervention experts in research is how researchers try to establish the plausibility that their proposed project has practical credence. In 2006, at the time of the first 5-year strategic plan (2005–2009) a TTP was being implemented at Wits. Consistent with the CA theory, the TTP used multi-modal criteria to select academically gifted learners in Dinaledi schools from three provinces. Due to success over the years, the programme has expanded and now enrols nearly 2,300 learners from nine provinces. The impact of the TTP is exceptional given that since its inception it now has a geographic footprint all over South Africa, it has supported 3,022 learners from across the country and boasts a 94% access rate to universities. The founder and custodian of the TTP described himself as a "lobbyist" and "salesperson" for gifted learners. In one of his reflections, he said that academically gifted learners in marginalised communities have not received sufficient attention in interventions aimed at improving educational outcomes.

What is the way forward? A global expert, Spence (2023, cited in CDE, 2023), cautions that a growth strategy that is fundamentally flawed will never work. He said that no level of persuasive power will ever overcome challenges following a strategy that does not work. This suggests that stakeholders need to start with a strategy based on core principles in order for it to have a chance of success. In terms of these core principles, designing and implementing programmes for gifted and talented learners requires careful thought and planning about four key programming elements: (a) identification and placement, (b) intervention, (c) infrastructure and resources, and (d) programme and learner outcomes (Reis & Gubbins, 2017).

Conclusion

With this article I aimed to understand (a) what the goals with the NSMSTE were, (b) the extent to which these were achieved, and (c) the factors that contributed to achievement or the lack thereof. The goal with the NSMSTE was to achieve five goals but the results show that none of them were achieved due to learner migration away from pure mathematics to mathematical literacy. Exceptionally gifted youths were also not identified as stakeholders focused more on allocating external resources such as books, laptops and other learning materials. In my opinion the success of the NSMSTE depends on how the DSP functions and that S-capabilities are prioritised as they are buttressed by social arrangements or O-capabilities. Such prioritisation is not only logical in the talent development process, but it would also be consistent with a number of goals stated in the strategy. For example, given that the NSMSTE would allow exceptional learners to study intensively, the starting point should have been the identification of learners with potential. In the context of competing priorities and limited resources, it would be better to provide sufficient and adequate learning and teaching facilities to fewer schools/learners than using a business-as-usual approach where resources are wasted on schools in which no learners pass. How can Dinaledi school deliver the stars of tomorrow if no gifted learners are identified from or enrolled in these schools? The 2014 action plan states that the government should provide exceptional learners with better access through focus schools. In my view the name "Dinaledi" and not "focus schools" should be cherished, given its relevance to what the country wants to achieve – to deliver stars in science, technology, engineering, and mathematics (STEM). Simkins (2010) argues that the culture of incubating potential is most likely to start lifting South Africa from a country that falls behind to one delivering world-class STEM education. Tikly, Joubert, Barrett, Bainton, Cameron and Doyle (2018) recommend that if the NSMSTE initiative is to be scaled up or replicated elsewhere in Sub-Saharan Africa, an important lesson would be to target well-managed schools and willing teachers. I add to this recommendation by saying that if the NSMSTE initiative is to be scaled up or replicated elsewhere, it should target learners with exceptional abilities, place them in well-resourced and well-managed schools with well-trained and willing teachers.

Acknowledgements

I acknowledge the National Research Foundation (NRF) for funding the research project on mathematical giftedness. The results and views set out in this article are those of the author and not those of the NRF.

Notes

ii. DATES: Received: 8 November 2022; Revised: 24 January 2025; Accepted: 23 February 2025; Published: 31 May 2025.

References

Best J 2004. *More damned lies and statistics: How numbers confuse public issues*. Berkeley, CA: University of California Press.

Blum J, Krishnan N & Legovini A 2010. *Expanding opportunities for South African youth through math & science: The impact of the Dinaledi program*. Washington, DC: World Bank. Available at https://openknowledge.worldbank.org/server/api/core/bitstreams/c5c5d6bb-b1fd-52b1-8e55-48c5027c9501/content. Accessed 16 April 2025.

Broderick A 2018. Equality of what? The capability approach and the Right to education for Persons with Disabilities. *Social Inclusion*, 6(1):29–39 https://doi.org/10.17645/si.v6i1.1193

Centre for Development and Enterprise 2004. *From laggard to world class: Reforming maths and science education in South Africa* (Research report no 13). Johannesburg, South Africa: Author. Available at https://cde.org.za/wp-content/uploads/2019/03/From-laggard-to-world-class-full.pdf. Accessed 16 April 2025.

Centre for Development and Enterprise 2023. *Michael Spence in conversation with Ann Bernstein*.

Johannesburg, South Africa: Author. Available at https://cde.org.za/wp-content/uploads/2023/07/Michael-Spence-in-conversation-with-Ann-Bernstein.pdf. Accessed 22 April 2025.

Department of Basic Education 2022. *Mathematics, Science and Technology Strategies and Interventions (teacher training and development, teacher demand/needs, learner uptake, improved subject performance): DBE briefing with Deputy Minister*. Available at https://pmg.org.za/committee-meeting/34936/. Accessed 22 April 2025.

Finn CE, Jr. 2014. Gifted, talented, and underserved. *National Affairs*, 18:50–62. Available at https://www.nationalaffairs.com/publications/detail/gifted-talented-and-underserved. Accessed 15 April 2025.

Finn CE, Jr. 2020. *School accountability—past, present, and future: Findings and recommendations for state and district policymakers.* Stanford, CA: Hoover Institution, Stanford University. Available at https://www.hoover.org/sites/default/files/research/docs/finn_execsummary_webready.pdf. Accessed 23 April 2025.

Gagné F 2019. *Building gifts into talents: Brief overview of the DMGT 2.0*. Montréal, Canada: Author.

Gasper D 2002. Is Sen's capability approach an adequate basis for considering human development? *Review of Political Economy*, 14(4):435–461. https://doi.org/10.1080/0953825022000009898

Hanushek EA 2020. Education production functions. In S Bradley & C Green (eds). *The economics of education: A comprehensive overview* (2nd ed). London, England: Academic Press. https://doi.org/10.1016/B978-0-12-815391-8.00013-6

Kahn M 2019. Science, Technology, Engineering and Mathematics education in South Africa. In *Securing Australia's future STEM: Country comparisons*. Canberra, Australia: Australian Council of Learned Academies.

Knight P 1995. *Assessment for learning in higher education*. London, England: Kogan Page.

Motshekga A 2016. *Keynote address by the Minister of Basic Education, Mrs Angie Motshekga, MP, at the Mathematics Indaba*. 12 December, Sol Plaatje House, Pretoria, South Africa. Available at https://www.gov.za/speeches/minister-angie-motshekga-mathematics-indaba-12-dec-2016-0000. Accessed 30 May 2025.

Organisation for Economic Co-operation and Development 2020. *Education 2030: The future of education and skills*. Position paper.

Reddy V, Winnaar L, Arends F, Juan A, Harvey J, Hannan S, Namome C, Sekhejane P & Zulu N 2022. *TIMSS 2019: Highlights of South African Grade 9 results in Mathematics and Science. Building achievements bridging achievement gaps*. Pretoria, South Africa: Department of Basic Education.

Reis SM & Gubbins EJ 2017. Comprehensive program design. In RD Eckert & JH Robins (eds). *Designing services and programs for high-ability learners: A guidebook for gifted education* (2nd ed). Thousand Oaks, CA: Corwin Press.

Robeyns I 2020. The capability approach. In G Berik & E Kongar (eds). *The Routledge handbook of feminist economics*. New York, NY: Routledge.

Ruggiano N & Perry TE 2019. Conducting secondary analysis of qualitative data: Should we, can we, and how? *Qualitative Social Work*, 18(1):81–97. https://doi.org/10.1177/1473325017700701

Schield M 2007. *Teaching the social construction of statistics*. Paper presented at the joint annual meeting of the Midwest Sociological Society and the North Central Sociological Association, Chicago, IL, 4–7 April.

Sen A 2005. Human rights and capabilities. *Journal of Human Development*, 6(2):151–166. https://doi.org/10.1080/14649880500120491

Simkins C 2010. *The maths and science performance of South Africa's public schools: Some lessons from the past decade*. Johannesburg, South Africa: Centre for Development and Enterprise. Available at https://www.cde.org.za/wp-content/uploads/2018/07/The-maths-and-science-performance-of-South-Africas-public-schools-Some-lessons-from-the-past-decade-CDE-Report.pdf. Accessed 17 April 2025.

Smillie S 2013. Dinaledi revived as maths and science remain a challenge. *Star*, 19 February. Available at https://www.iol.co.za/the-star/news/dinaledi-revived-as-maths-and-science-remain-a-challenge-1472866. Accessed 11 April 2025.

Spaull N 2019. Equity: A price too high to pay. In N Spaull & JD Jansen (eds). *South African schooling: The enigma of inequality. A study of the present situation and future possibilities.* Switzerland: Springer. https://doi.org/10.1007/978-3-030-18811-5

Stabback P 2016. *What makes a quality curriculum: Current and critical issues in curriculum and learning.* Geneva, Switzerland: UNESCO International Bureau of Education. Available at https://unesdoc.unesco.org/ark:/48223/pf0000243975. Accessed 1 May 2025.

Tikly L, Joubert M, Barrett AM, Bainton D, Cameron L & Doyle H 2018. *Supporting secondary school STEM education for sustainable development in Africa* (Bristol Working Papers in Education #05/2018). Bristol, England: University of Bristol. Available at https://www.bristol.ac.uk/media-library/sites/education/documents/Supporting%20Secondary%20School%20STEM%20Education%20for%20Sustainabale%20Development%20in%20Africa.pdf. Accessed 11 April 2025.