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The Effects of Technical Science on Learner Performance and possible Technical Vocational Career Choices

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Technical vocational education and training (TVET) colleges offer technical vocational professions through a more vocational than academic curriculum. The addition of mathematics and physical science to the technical school curriculum led to a high failure rate and an increase in dropout rates because many students failed these two subjects. The department of basic education (DBE) established technical mathematics and technical science as alternatives to mathematics and physical science in these schools in an effort to address these issues. This study explored the effect of technical science on the technical high school pass rates following its implementation. Qualitative data methods was used to analyse physical science and technical content documents as well as pass rates descriptively. Findings for this study showed that technical science had less weight in the exam and less challenging content than physical science. After the advent of technical science, the pass rates for physical science rose considerably, though they were also inconsistent. Additionally, several schools stopped teaching technical science even after their students excelled in it. The study recommends that more investigation be done into the effects of technical science on learners' readiness for technical vocational careers and reasons for some schools to drop technical science.

Keywords: learner performance, pass rates, physical science technical science, TVET colleges, vocational careers

INTRODUCTION

Technical vocational jobs are viewed as crucial since they prepare students for the job market and help nations' economies. Prior to the establishment of the democratic government in South Africa, the country responded to the rapidly expanding demands of the country's mining industry, railways, and other emerging industries by offering technical vocational careers at technical colleges that trained artisans through a curriculum that was more vocational than academic (CDE, 2012). According to Nzonzo (2017), a vocational education can help students enter the workforce and increase their prospects of pursuing rewarding careers. Although these institutions contributed a lot to the provision of skills needed for the increasing industry, opportunities offered at these colleges were largely reserved for white South Africans. Following the establishment of

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a democratic government, there were adjustments made to the curriculum and institutions that provided artisan skills. Giving management of technical colleges to provincial education departments was one of the developments that took place at the time, and this change paved the way for the creation of technical schools. Before enrolling in college, high school students can learn about a particular job through a technical high school's curriculum (NEIT Edge, 2020). Prior to 2005, many parents considered these programmes to be unsuitable because they did not believe the subjects offered at these schools were academically rigorous enough to allow students to pursue academic careers, even though they produced a national senior certificate (matriculation) with a vocational component (Field et al., 2014).Additional adjustments were made in technical high schools, where physical science and mathematics were made required topics for the stream of subjects that were technologically oriented (DBE, 2014 & DBE, 2016 a). According to the CDE (2012), the presence of mathematics and physical science in technical subject streams was general or academic, rendering the stream unfit and unnecessary for learners' academic pursuits. They also mentioned how frequently students failed these two subjects. Changes made to the technical school curricula in South Africa did not result in the workforce that the country's economy needed to grow (Motshekga, 2015).

Multiple obstacles suggests that certain modifications were not well considered, supporting the claim made by Berestova et al. (2020) that it is difficult to change and improve educational practises and determine how educational policy affects students. The emphasis placed on academic pathways in education resulted in high rates of failure, drop-out, and repetition, and too many students were pressured to enrol in universities (Gina, 2018). According to Shew et al. (2019), receiving subpar marks depletes students' drive and self-confidence, which may be why students from technical high schools have less interest in vocational jobs. Technical and vocational jobs are in high demand because they give students the knowledge and skills they need to meet today's economic challenges (Lara-Prieto et al., 2023).). Berestova et al. (2020) argue that general education and vocational education are inseparably associated, and add that high school is a starting point for further education and training of young people. If technical high school learners do not pass matric, this reduces the number of uptake of technical vocational careers candidates.

The introduction of technical science and technical mathematics as alternatives to mathematics and physical science in technical school was one of the additional reforms carried out at technical schools (DBE, 2017a). Technical science aims to strengthen or support learners in technical subject combinations so they can integrate scientific knowledge into their subject offerings in technology in a more informed way (DBE, 2014). It also aims to demonstrate the relevance of physical sciences within the technology fields (DBE, 2016 a). Similar to technical disciplines, technical science assessments have a practical assessment task (PAT) component where students are required to create a project that serves as a mock-up of a real thing. The PAT component comprises project-based learning and challenge-based learning, which involve students in finding solutions to specific challenges and involving them in real-world problems (Lara-Prieto et al., 2023). This enables students to function at a higher mental level, allowing them to learn and update their knowledge and abilities in order to be competent in this constantly changing world (Chakrabarti et al., 2021).

At matric, a minimum of seven (7) subjects are offered, and a candidate must pass six (6) of those subjects in order to receive a matric certificate (DBE, 2021a). This indicates that students in technical high schools who failed physical science as a sixth subject (other than mathematics) would fail grade 12 and be ineligible to enrol in a TVET college to continue even a technical vocational job because they only had one subject stream.

It was anticipated that, in the fifth year after its implementation in matric, there would be some research or reports for the DBE to determine whether or not technical science has contributed to the pass rates at technical high schools since the introduction of technical science was an attempt to lower the high failure and dropout rate caused by failure of mathematics and physical science.

I conducted this conceptual study to find out how technical science has affected the pass rates of students who retained physical science (assuming that these were students who were competent to pass the subject) and technical science (assuming that the alternative subjects offered these students an opportunity). This was motivated by the fact that I have not come across studies on the effect technical science has on the pass rates at technical high schools. This study is anticipated to advance knowledge about learner performance at technical high schools and provide new research. This study responded to the question:

How has the introduction of technical science affected students' potential access to technical vocational occupations as well as their pass rates in technical schools?

Theoretical Framework and Literature Review

This study examined whether adding technical science to technical high schools helped learners to pass the matric and continue their education at technical vocational education and training (TVET) colleges by applying the social cognitive career theory (SCCT) of Lent, Brown, and Hackett (1994). The SCCT theory incorporates several concepts (such as interests, abilities, values, and environmental circumstances) that have been shown in earlier career theories to have an impact on career development. For students attending technical emphasis schools, offering a less academically rigorous course (technical science) in place of a more academically demanding subject (physical science) was expected to open up prospects for the progression of technical vocational career choice. The SCCT has a wide range of applications in career education and gives a comprehensive framework for outlining and predicting career progression, according to Lent and Brown (2019). Learners who graduate from high schools with a technical focus can pursue technical vocational careers that produce graduates who are proficient in their subjects and ready for employment (Hariyanto et al. 2023). While other learners who are less academically inclined may choose to pursue technical vocational occupations, certain students at technical high schools who are more academically oriented may seek professional engineering degrees. The three "building blocks" of SCCT—self-efficacy beliefs, result expectations, and objectives—are intricately intertwined together in this theory. Self-efficacy is a person's perception of his or her own capacity to engage in particular behaviours or courses of action. Views regarding the effects or outcomes of a particular behaviour are known as outcome expectations. As they become aware of their crucial role in economic advancement, learners with a technical concentration can perform better as a result of options for addressing the skills shortages faced by artisans in South Africa. Personal objectives can be summed up as one's plans to partake in a specific activity. If students who failed physical science succeed in technical science and pursue technical vocational occupations, they can help build the skills and knowledge necessary to keep up with the fast-paced changes in the labour market (Nkwanyane et al., 2020).

Technical vocational careers in South Africa

Technical vocational careers are a part of Vocational Education and Training programmes that deal with managing teaching and training to help students and participants become prepared for their jobs (Wannapiroon et al., 2022). They offer entrepreneurial opportunities in addition to the development of skills for a certain spectrum of employment. Technical vocational careers are designed to offer vocational or mid-level skills education to school dropouts who are unable to get into universities due to low matriculation scores, those who failed matric or left in Grades 10 or 11, and those who went straight from grade 9 to a TVET college (Field et al., 2014). According to Branson (2018), the acquisition of skills in a vocational career is a significant alternative to attending college. He adds that completing any post-secondary education significantly improves one's chances of finding work, hence any nation looking to grow its labour force must increase access to the institutions that will make this happen. Numerous curriculum revisions in South African schools, however, had an impact on this possibility. Changes in the technical vocational schools since 1994, and the reforms have resulted in significant developments (Terblanche 2018). The country changed from being manufacturing and resource-based to service sector which hinder its further development (OECD, 2017). The results were increased unemployment rate.

According to the QLFS survey from 2022, the unemployment rate in South Africa was 33.9% (8.0 million) in the second quarter. Motshekga (2015), indicated that the closing of technical institutions in an effort to provide equal access to high-quality education for all was a decision that hurt rather than helped the nation, as it was the main cause of unemployment in South Africa. She continued by saying that one more factor in the current high unemployment rate is the skill mismatch between some graduates and what is needed. The mismatch of graduates happens when job seekers lack the abilities or credentials required for open opportunities (Balwanz & Ngcwangu, 2016). In order to increase the employment rate, it is necessary to produce graduates and school leavers who are employable, who are most likely to pursue professions in STEM fields. According to (Loc et al., 2022; Nakhleh & Hanini, 2022), there needs to be tight collaboration between businesses and academic institutions in order to create academic plans and learning innovations that will help young professionals get ready for the demands of the digital transformation. Lara-Prieto et al. (2023), posit that graduates must be equipped with the skills and information necessary to meet today's difficulties in the workforce.

Technical vocational occupations generate technicians who can supply the skills needed to increase the country's economy, in the same way that colleges may provide professional skills that can lower unemployment. According to Lewis (2023), technicians are people working in positions requiring 'intermediate-level' expertise in science, technology, engineering, and/or mathematics. To resolve real-world issues that arise in research and development and manufacturing, they draw on their understanding of those disciplines and related practical abilities.

According to The IOL (2016), STEM skills can stimulate economies and workforce readiness. However, Pols (2019) suggests that matric students now graduating and entering the market are not adequately literate in STEM to take on available opportunities in these industries, therefore South Africa does not fully profit from this. However, due to the government's ambitions to address the skills gap in the engineering sector, there is a heavy focus on engineering and artisan training in the technical vocational education and training (TVET) landscape (Payne, 2019). Field et al. (2014), indicate that South Africa needs to guarantee that the correct range of skills are available for the labour market while simultaneously increasing its need for skills, particularly artisan skills. The technical vocational school's curriculum was modified from being mostly vocational to academic. White collar employment, as opposed to artisan careers, were more appealing to young people as a result of the focus placed on education. The emphasis placed on academic pathways in education resulted in high rates of failure, drop-out, and repetition, and too many students were pressured to enrol in institutions (Gina, 2018).

Contributions that technical schools can provide to increase interest in technical occupations

South Africa had 110 technical high schools as of 2019 (Gouws 2019).The researcher was unable to locate the update of this number in 2022. There were 50 TVET colleges in the same year that were funded and supported by the government and offered a range of training programmes (DHET, 2020).Technical high schools provide academic streams that give students the option of pursuing professional engineering or technical vocations or technical vocational careers. The view of people about vocational occupations seems to have done a lot of damage in the attitudes of learners towards these careers, despite efforts by the ministry of education and higher education to encourage learners to undertake vocational training. According to Motshekga (2015), students who perform poorly in school are stigmatised and are discouraged from choosing a career in the technical field because it is viewed as a less desirable option. Although the entry requirements for technical vocational careers are less stringent than those for other tertiary institutions, many post-secondary students do not choose these programmes because, as the South African education system transitioned to a knowledge-based model, artisan skills were seen as inferior to university degrees (Branson, 2018).

By creating an adequate number of graduates with the necessary skills for technical/artisan careers, the number of technical high schools and TVET colleges in the nation is sufficient to address the skills gap. A practical assessment activity is included in technical topics and technical sciences, and it has the potential to incorporate experiential learning into the classroom. Students' curiosity is piqued and they quickly pick up skills like critical thinking, teamwork, sophisticated reasoning, and problem-solving thanks to experiential learning. When students participate in PAT, they create prototypes of devices where they gain knowledge outside of the classroom, collaborate with others, engage in experiential learning, actively tackle difficulties related to the engineering discipline, and are motivated and engaged (La Piarto et al., 2022). The South African government has acknowledged the value of TVET colleges and set a target of enrolling 2.5 million students in these schools by the year 2020 (Businesstech, 2019).

METHOD

This study used a qualitative research methodology by analysing data gathered from public documents. Document analysis is a technique that involves examining various text-containing document, books, news articles, scholarly journal articles, and institutional reports are possible sources for qualitative analysis (Patton, 2015). According to Denzin (2017), a variety of approaches might be utilised to investigate the same issue in a document analysis study. The curriculum assessment policy statements (CAPS) for technical and physical science as well as national test results were the sources of information used in this study. For each subject, the CAPS include subjects and summative assessment tasks that have been organised into related knowledge areas. Reports on national exams include information on the number of matriculating students as well as any accessible information on pass rates at the national, provincial, and district levels. For technical science, the data was organised from 2018 to 2022, and for physical science, it was organised from 2016 to 2022, allowing the researcher to observe changes in enrolment and pass rates. The national pass rates of three technical focused subjects combined with physical and technical science were analysed to validate the causes of the changes in learner performance because this study aims to determine whether the introduction of technical science had any impact on the pass rates of learners.

Descriptive data analysis was utilised to describe the trends in the content and learner performance for the subjects sampled because the study's data was previously available in public publications. Data analysed from the physical and technical science CAPS was used to evaluate the two subjects’ levels of difficulty and identify overlaps and discrepancies in their curricula and summative assessment activities. Data analysed from exam reports was utilised to determine if changes in learners' overall performance in technical schools were only attributable to technical science. The data on technical subjects had limitations in that, while it was possible to compare national pass rates, it was not possible to do so for these subjects across schools in a sampled district, because students chose various technical subjects, and the subject performance reports for technical subjects did not include information on these subjects' pass rates at school level. Table 1 below shows the inclusion criterion of documents analysed for the study.

Table 1
Documents analysed

Document used	Contents used for the study	Institutions samples	Year published
Physical Science CAPS (grade 10-12)	Examinable topics in grade 12 Summative assessment weighting	N/A	2011
Technical Science CAPS (grade 10-12)	Examinable topics in grade 12 Summative assessment weighting	N/A	2014
Examination School subject report (Physical Science) (grade 12)	Learner enrolment (national data only) Pass rates in the subject	National data One Education district Schools in one education district	2016-2022
Examination School subject report (Technical Science) (grade 12)	Learner enrolment (national data only) Pass rates in the subject Distribution curve of pass rates	National data One Education district Schools in one education district	2018-2022
Examination School subject report (Technology subjects) (grade 12)	Pass rates in the subject	National data One Education district Schools in one education district	2018-2022

FINDINGS

The physical science and technical science curricula

The CAPS curriculum categories that are taught in matric physical science and technical science are listed in table 2 below (DBE, 2011; 2014 and 2016a).

Table 2
Physical and Technical Science content subject grouping and knowledge areas

Content covered in Physical and Technical science	
Knowledge areas offered at matric in Physical science	Knowledge areas offered at matric in Technical Science
Physical science: Before amendments Paper 1 (physics) • Mechanics • Matter and Materials: Optical phenomena and properties of materials • Electricity and Magnetism • Waves, Sound and Light Paper 2 (Chemistry) • Matter and materials • Chemical Change	Technical Science Before amendments Paper 1 • Mechanics • Matter and Materials: Electronic Properties of Matter • Electricity and Magnetism • Waves, Sound and Light Paper 2 • Matter and Materials: Organic molecules • Chemical Change
Matric Summative Assessment tasks	
Physical science 25 % SBA + 75 % Exam	Technical science: 25 % SBA + 25 % PAT + 50 % Exam

Both technical and physical science offer the same number of topics in grade 12, according to Table 2. However, although school-based assessments (SBA) make up 25% of the components used for advancement in physical science and exams make up 75% of it, technical science progression components are made up of 25% SBA tasks, 25% PAT tasks, and 50% exams (DBE, 2011 and 2014). In technological science, the examination weighting (a theoretical assessment) is diminished and made up for with a PAT. Because of this, technological science is advantageous for students who need less weight in a theoretical assessment activity.

The information covered in each technical scientific knowledge area is listed in Table 3 below. The following is how codes are inserted next to the content: Not done in physical science (NDPS), done in physical science (DPS), and then a grade where the technical science subject is taught in physical science, such as Grade 10 (DPS-gr10).

Table 3
Grade 12 Technical Science content

Knowledge area	Content covered
• Mechanics	• Newton's laws of motion (DPS-gr 11) • Momentum (DPS-gr 12) • Work energy and Power (DPS-gr 12) • Elasticity (NDPS) • Viscosity (NDPS) • Hydraulics (NDPS)
• Electricity and Magnetism	• Electrostatics: Capacitors (NDPS) • Electromagnetism (DPS-gr 11) • Electric circuits (DPS-gr 11)
• Matter and Materials	• Electronic Properties of Matter Capacitors (NDPS) • Organic chemistry (DPS-gr 12)
• Waves, Sound and Light	• Light (DPS-gr 10) • Electromagnetic radiation (DPS-gr 10)
• Chemical Change	• Electrochemical cells (DPS-gr 12) • Alternate Energies (NDPS)

Only four (4) of the fifteen (15) examinable topics in technical science for grade 12 share a subject with physical science in terms of content. Six (6) comprises material that is not addressed in physical science, while two (2) and three (3) are comparable to the grade 10 and 11 physical science curriculum respectively. The concept of content progressions, which explains how the material and context of each grade demonstrate a progression from simple to sophisticated, is one of the guiding principles of the physical science CAPS (DBE, 2011). The similarity between the technical science material for grades 10 and 11 and the physical science content for grades 12 suggests that the technical science content is less difficult.

Technical science and physical science learner performance

The nationwide enrollment and pass rates for technical and physical sciences are shown in Table 4. All schools in the country that offer physical sciences are included in the national data that is being presented, however the technical science data only includes technical high schools (DBE, 2016b, 2017b, 2018a, 2019a, 2020a, 2021b & 2022a).

Table 4
National matric pass rates for physical science and technical science (DBE, 2022)

Year	Physical science wrote	Physical science Pass %	Technical science wrote	Technical science Pass %
2016	192 618	62.0		
2017	179 561	65,1		
2018	172,319	74.4	10 503	87,6
2019	164,478	75.5	10 062	86,5
2020	174,310	65,8	11 655	80.4
2021	196,968	69	14 642	87,1
2022	209,004	74,6	10 503	89,9

The pass rates are obtained by using the formula: $\frac{number\ of learners\ \ passed}{number\ of\ learners\ wrote}\ x\ 100$

Between 2016 and 2019, there were fewer students who studied physical science, and between 2022 and 2022, there were more. Pass rates in these disciplines rose while learner enrolment fell between 2016 and 2019. The pass rates decreased in 2020 as the number of physical science students increased once more, but they began to rise again in 2021–2022. Table 4 only displays the overall student achievement across both disciplines at the national level. Since there were no published reports with data specifically for students in technical high schools, the data covers students from those institutions. However, at the national level, technical science students are included in cohorts of matriculants, hence the data assumes that the number of students enrolled in technical science had an impact on the national pass rates of both subjects.

The number of technical science matric candidates has been fluctuating from 2018 with reference to learner enrolment and performance in technical science since. The pass rate fell between 2018 and 2020 and rose between 2021 and 2022. The technical science subject received pass rates of 80% and above in its last five years in the South African curriculum. Table 4 shows that when students took technical science for the first time in matriculation in 2018, fewer students enrolled in physical science, but the pass rate rose and the technical science pass rate was high. Additionally, even if the pass rates for physical science declined in 2020 and 2021, they did not fall below the lowest mark during the previous five years. Despite the difficulties brought on by the COVID-19 epidemic, enrolments of both subjects rose in 2020, but the pass rates for technical science and physical science plummeted by 6,1% and 9,3% respectively.

The physical science and technical science pass rates for one educational district's technical focus schools are shown in Table 5 (DBE, 2016b, 2017b, 2018a;b, 2019a;b, 2020a, 2021b;c & 2022a;b).

Codes: PS-physical science, TS-technical science, TFS-technical focus school

Table 5
Pass rates of physical science and technical science of technical focus schools in a sampled education district

Schools	P S 2016	P S 2017	P S 2018	T S 2018	P S 2019	T S 2019	P S 2020	T S 2020	P S 2021	T S 2021	P S 2022	T S 2022
TFS 1	26.0	65.0	97.5	96.52	100	89.1	91.2	84.0	88,9	98,1	82,2	98,2
TFS 2	17.0	64.0	68.8	100	78.6	84.2	68.8	72.7	64,7	95,8	72,9	96,3
TFS 3	97.0	96.0	98.4	100	98	100	96.2	100	93,6	100	100	100
TFS 4	86.0	68.0	100	75	100	88.2	76	81.8	74,2	100	97	De-registered
TFS 5	79.0	59.0	93.9	57.14	85	De-registered						
TFS 6	89.0	93.0	91.7	75	100	88.9	94.7	62.5	91,1	100	94,3	93,8
TFS 7	98.0	97.0	99.3	100	93.1	100	94.2	63.2	De-registered			
TFS 8	30	80	87.5	73.08	100	100	50	100	50	69,7	44,4	91,7
TFS 9	42	54	72.2	100	83.9	71.4	50	62.9	De-registered			
TFS 10	73	54	87.5	100	75.4	95.7	77.6	85.2	80	86,7	83,3	85,3
TFS 11	63	57	75.0	87.50	94.3	84.69	48.6	94.7	64,4	94,3	67,5	95

In the sampled district, there were seven (7) technical science schools in 2022 as opposed to eleven (11) in 2019. This investigation was unable to identify the reason technical science was deregistered. Since technical science had pass rates of more than 80% at three of the four institutions that deregistered it, the cause could not have been due to subpar performance in the course. Just one school dropped out at 50%.

The pass rates for physical science increased from 2016 to 2017, where there were no schools with a pass rate below 50%. 4 schools with less than 50% pass rates improved. In 2016 and 2017, four schools received scores in physical science of 80% or higher. The number of technical high schools that received 80% or higher in both subjects increased to 8 and 9 respectively. The pass rates for technical science and physical science are shown in Tables 6 and 7 for the schools that still offered technical science in the sampled district in 2022.

Table 6
Physical science pass rates for schools that still offered technical science in 2022

Schools	P S 2016	P S 2017	P S 2018	P S 2019	P S 2020	P S 2021	P S 2022
TFS 1	26.0	65.0	97.5	100	91.2	88,9	82,2
TFS 2	17.0	64.0	68.8	78.6	68.8	64,7	72,9
TFS 3	97.0	96.0	98.4	98	96.2	93,6	100
TFS 6	89.0	93.0	91.7	100	94.7	91,1	94,3
TFS 8	30	80	87.5	100	50	50	44,4
TFS 10	73	54	87.5	75.4	77.6	80	83,3
TFS 11	63	57	75.0	94.3	48.6	64,4	67,5

Table 7
Technical science pass rates for schools that still offered it in 2022

Schools	TS 2018	T S 2019	T S 2020	T S 2021	T S 2022
TFS 1	96.52	89.1	84.0	98,1	98,2
TFS 2	100	84.2	72.7	95,8	96,3
TFS 3	100	100	100	100	100
TFS 6	75	88.9	62.5	100	93,8
TFS 8	73.08	100	100	69,7	91,7
TFS 10	100	95.7	85.2	86,7	85,3
TFS 11	87.50	84.6	94.7	94,3	95

Improvements have been made in the schools that have continued teaching the two subjects, though inconsistently, with the exception of a sharp decline in 2020 for TFS 8 and 11. Despite the fact that TFS11 appears to be improving, TFS8 does not for reasons that cannot be confirmed in this investigation. Comparing Tables 6 and 7, three schools (TFS 1, TFS 3, and TFS 6) have achieved pass rates in both technical and physical science of more than 80% since 2018. Although before 2018, the physical science pass rates for TFS 2 and 3 were still very high.

Quality of pass rates in technical science

The graphs below show the national performance distribution curves of technical science pass rates.

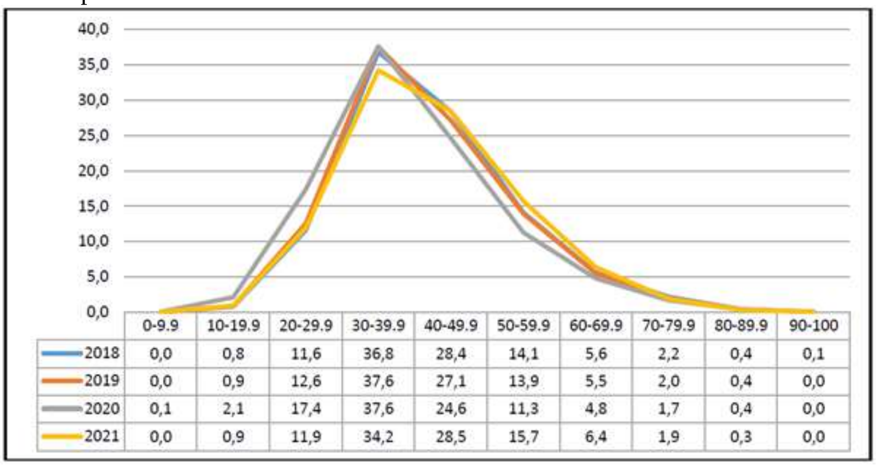

Figure 1
Distribution curves of national technical science pass rates (obtained from subject performance report of 2021c)

The performance trends of technical science students from 2018 to 2021 are depicted in Figure 1. Although the subject's pass rates indicate that more students are passing technical science, the graph above demonstrates that a significant portion of students pass technological science with 30-49%. Fewer students achieve 50% and above, notably from 80% and up.

Pass rates of technical subjects

Students from technical high schools must pass technical subjects in order to pass matric or gain admission to any tertiary institution. Table 8 displays the technical subject pass rates for the previous four years (DBE, 2019b, 2020b, 2021c, and 2022b).

Codes: CS-civil services, Cons-construction, WW-wood work, DE-digital electronics, RE-Rates in electronics, PS-Power systems, Auto-Automotive, FM-Fitting and Machining, Welding and metal work.

Table 8
Learner performance in Technical subjects

Year	Civil Technology			Electrical Technology			Mechanical Technology		
	CS	Cons	WW	DE	RE	PS	Auto	FM	WM
2018	93,0	98,6	98,8	93,1	91,9	91,9	94,2	95,4	94,6
2019	97,3	98,5	99,0	96,0	97,7	95,6	95,4	97,7	92,3
2020	99,0	99,0	96,7	96,9	96,9	94,9	94,1	96,8	88,8
2021	97,0	98,5	97,0	94,6	91,0	94,4	95,2	97,1	90,6

All of the technical subject pass percentages are more than 80%, which suggests that most students do not struggle with these subjects.

DISCUSSIONS

Technical science was introduced at schools with a technical focus, and it offers a scientific curriculum that is less rigorous academically in grade 12 than physical science. Some of the technical science topics covered in grade 12 are similar to those covered in grades 10 and 11 in physical science. Physical science material from grades 10 and 11 accounts for 27% (4/15) of the technical science grade 12 examinable content, for grade 12 content it is (5/15) 33% and from technical subjects it is (6/15) 40%. The theoretical components of technical science assessments are also given less weight than those of physical science (Table 3). Given the subject for technical science in grade 12, it can be assumed that technical science is not as challenging as physical science, allowing students who would struggle to pass physical science to succeed in technical science. This explains the introduction of technical science in technical schools as a substitute easier science subject for learners who find it difficult to cope with physical science. As stated in the technical science CAPS, this subject is only meant to support' and ‘strengthen' the subject combination in technology subject streams. Additionally, because technical science courses are less academically focused than other courses, students who take them may be qualified for technical vocational vocations provided by TVET colleges.

An alternate course in place of physical science would give the majority of students in technical schools an opportunity to pass matric, according to the improved pass rates in both technical science and physical science for the majority of institutions that offer both subjects. Nevertheless, the report notes that there may be difficulties, such as the case of schools that registered for technical science in 2018 but discontinued it even while their students were performing well. Since technical science was introduced as an alternative to physical science based on the CDE (2012) study on the causes of underperformance in technical emphasis schools, it is unclear why the number of students choosing the subject has decreased both nationally and at the district level. It is implied that more students who take technical science pass it at the matric level because the technical science pass rates for schools in a sampling district are relatively better than those of physical science.

There are instances that are inexplicable, such as when TFS5's pass rate was lower than physical science's in 2018, despite the fact that the technical science curriculum appeared to be easier than physical sciences, or when physical science pass rates drastically dropped in TFS8 and TFS11 after rising up to 2019. The years when they had a sharp decline in physical science, however, both of these schools produced good pass rates in technical science.

The positive results in technical science in 2021–2022 attest to the fact that the content of technical science is less challenging than that of physical science. According to Tatar et al. (2016), there may be additional factors influencing the pass rates at these schools, confirming that sources personal to students or teachers might have an impact on their academic performance. Given that they are not failing technical subjects, more students are passing matric in technical schools, as evidenced by the consistently high pass rate in technical science at the national and district levels (Table 8).The poor pass rates at technical emphasis schools may be due to subpar performance in mathematics and physical science since Table 8 demonstrates high performance in technical subjects and the national reports have not noted poor performance in language courses, life orientation, or EGD. The distribution curve for technical science in figure 1.1 demonstrates that while most students pass technical science, most of them do not achieve a high percentage that may allow them to gain admission to a university (if they are allowed to). As a result, the majority of them pass with just enough proficiency to earn a certificate or diploma.

To pursue NC (V) qualifications or a diploma, TVET colleges provide technical vocational certificates or diplomas. According to Report 191 (DHET, 2020), learners are simply need to have a matriculation certificate for these qualifications. Physical science and mathematics are the only areas that have historically had performance issues (CDE, 2012). Students who chose technical science over physical science can still pass six subjects and graduate from high school even if they struggle in maths or technical maths. The SCCT theory employed in this study demonstrates how technical science can facilitate learners' ability to get tertiary degrees that are appropriate for their level of proficiency. Given the enrolment in these subjects, Tables 4 and 5 may not be a fair comparison of the pass rates in the two subjects, but one can argue that the introduction of technical science contributed to the improvement in physical science pass rates because if these students had not taken technical science, they would likely have failed physical science. Since there is no alternate path for the technical subject stream, more students in technical focus schools chose physical science in 2022 rather than technical science, however those who are taking physical science had an increase in their pass rate of 5,6% from 2021 to 2022.

CONCLUSIONS AND RECOMMENDATIONS

Technical science has offered a physical science option with a curriculum that is less challenging, but it may not have addressed other issues that affect teaching and learning in some technical high schools. The technical science curriculum's objectives characterise it as an enabler topic that enables technical subject learners to comprehend the science in these subjects, not as a separate discipline from physical science. Due to the scarcity of these schools, there are many fewer students studying technical science than physical science. Nevertheless, without the advent of technical science, the majority of students at technical high schools could take physical science, but the majority would not pass it, as indicated by the distribution curve (Fig. 1) that shows the majority of students pass at lower levels. The majority of matriculants in technical emphasis schools have a better probability of passing and obtaining admittance for technical vocational occupations that require a matric diploma, regardless of whether they choose technical science or take physical science and don't receive the grades needed for university entrance. Through the development of their talents, instructors can provide students an alternative career path to attending college (Branson, 2018). As a result, learners may have more options to pursue technical or vocational occupations than they otherwise wouldn’t have if they had failed the matriculation exam. This study argues that the introduction of technical science led to higher pass rates in physical science and lower high failure rates in technical high schools.

However, the number of schools that abandoned the subject is concerning. One can only hope that the perception of artisan skills as second-class credentials or the stigmatisation of technical vocational career paths as inferior (Motshekga, 2015) are not the root causes. This study suggests that additional empirical research be conducted in technical high schools to identify curriculum-related issues that have an impact on teaching, learning, and pass rates there. Since the researcher is unaware of any university programme where preservice teachers can specialise in technical science in South African universities, study should also be done to determine who the instructors are. Another empirical study might be conducted to find out what teachers and students think about how the introduction of technical science has affected these schools' pass rates and the reasons why certain schools have dropped the subject. If schools and other educational institutions collaborate to find solutions, the current obstacles of scientific education reform can be overcome (Aldahmash et al., 2019). Collaboration between technical emphasis schools, TVET universities, and industry could help South Africa fill its skills gap.

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