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THE QUALITY OF TEACHING AND LEARNING OF SCIENCES IN SOUTH AFRICAN PUBLIC AND PRIVATE SCHOOLS: A COMPARATIVE STUDY IN THE JOHANNESBURG NORTH DISTRICT.

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TITLE: THE QUALITY OF TEACHING AND LEARNING OF SCIENCES IN SOUTH AFRICAN PUBLIC AND PRIVATE SCHOOLS: A COMPARATIVE STUDY IN THE JOHANNESBURG NORTH DISTRICT.

ABSTRACT

This study investigates the quality of science teaching and learning in South African public and private schools through a comparative analysis. Given the disparities in educational resources, teaching methodologies, and overall learning environments, the study examines how these factors influence student outcomes in the Life Sciences, Physical Sciences, and Natural Sciences. A qualitative research approach was employed, utilising anonymous digital questionnaires and semi-structured interviews to gather insights from science teachers in selected public and private schools in Johannesburg North. A total of 11 questionnaires and 3 interviews were completed. Data analysis focused on key indicators such as the use of practical investigations, technology integration, class sizes, curriculum delivery, and the broader culture of Science Education. Findings revealed a perceived higher quality of Science Education in private schools across most categories, with public and private schools demonstrating similar levels of technology use and Science culture. This disparity suggests a potential disadvantage for learners in public schools, potentially impacting their future academic and real-world Science success. In this study, the gaps in Science Education quality are highlighted, contributing to a deeper understanding of educational inequality in South Africa. Addressing these disparities is crucial to promoting equity in Science Education and mitigating broader societal inequalities.

OPSOMMING

Hierdie studie ondersoek die gehalte van Wetenskaponderrig en leer in Suid-Afrikaanse publieke en privaatskole deur middel van 'n vergelykende analise. Gegewe die verskille in opvoedkundige hulpbronne, onderrigmetodologieë en algehele leeromgewings, ondersoek die studie hoe hierdie faktore student uitkomste in die Lewenswetenskappe, Fisiese Wetenskappe en Natuurwetenskappe beïnvloed. 'n Kwalitatiewe navorsingsbenadering is gebruik, met behulp van anonieme digitale vraelyste en semi-gestruktureerde onderhoude om insigte van Wetenskaponderwysers in geselekteerde openbare en privaatskole in Johannesburg-Noord in te samel. 'n Totaal van 11 vraelyste en 3 onderhoude is voltooi. Data-analise het gefokus op sleutelaanwysers soos die gebruik van praktiese ondersoeke, tegnologie-integrasie, klasgroottes, kurrikulumlewering en die breër kultuur van Wetenskaponderwys. Bevindinge het 'n waargenome hoër gehalte van Wetenskaponderwys in privaatskole oor die meeste kategorieë getoon, met openbare en privaatskole wat soortgelyke vlakke van tegnologiegebruik en Wetenskapkultuur toon. Hierdie verskil dui op 'n potensiële nadeel vir leerders in publieke skole, wat moontlik hul toekomstige akademiese en werklike wetenskapsukses kan beïnvloed. In hierdie studie word die gapings in die gehalte van Wetenskaponderwys uitgelig, wat bydra tot 'n dieper begrip van opvoedkundige ongelykheid in Suid-Afrika. Die aanspreek van hierdie ongelykhede is van kritieke belang om billikheid in Wetenskaponderwys te bevorder en breër maatskaplike ongelykhede te verminder.

APPENDIX

Lists of Tables, Figures, and Acronyms

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List of Acronyms

TSPCK: Topic Specific Pedagogical Content Knowledge

FET: Further Education and Training

CAPS: Curriculum Assessment Policy Statement

IEB: Independent Education Board

NSC: National Senior Certificate

NOS: Nature of Science

TQ: Teaching Quality

EQ: Education Quality

DBE: Department of Basic Education

CPD: Continuous Professional Development

NGOs: Non-Governmental Officials

STUDENT

DECLARATION OF ORIGINALITY

I, Henning Blignaut, declare that this research report, entitled “The quality of teaching and learning of Sciences in South African public and private schools: A comparative study in the Johannesburg North District.”, is my own original work and has not been submitted for any other academic degree or examination at any other university or institution. Except where explicitly acknowledged, all ideas, data, and information presented are my own, and all sources used have been fully referenced and cited according to APA referencing style.

I understand that any form of plagiarism or academic dishonesty is a serious offense and will result in disciplinary action.

Signature: 

Date: 2025/03/14

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CHAPTER 1: INTRODUCTION

Background Information

Education has been recognised as a crucial tool for sustainable development in Sub-Saharan Africa (Barry, 2009). It was only in the 1980s that governments in this region recognised the limitations of public education, leading to the adoption of private education as an alternative (Barry, 2009). In South Africa, significant disparities exist in the quality of teaching and learning across different school types and geographical locations. Public and private schools make up the majority of the country's education system (Swart, Pottas, & Maree, 2021). Public schools can be further categorised into former Model C schools, which receive substantial financial support from parents and alumni, and previously disadvantaged schools that rely entirely on government funding (Swart, Pottas, & Maree, 2021). Historically, academic performance has been higher in former Model C schools compared to other public schools (Swart, Pottas, & Maree, 2021). In contrast, private schools are often associated with superior educational facilities, higher teaching standards, and better academic outcomes, although they come with significantly higher tuition fees (Swart, Pottas, & Maree, 2021).

Underperforming public schools, particularly in rural and economically disadvantaged areas, face numerous challenges. These include insufficient funding, inadequate government oversight of resources, a shortage of qualified teachers, outdated or inadequate classroom equipment, high teacher absenteeism, and overall poor educational standards (Swart, Pottas, & Maree, 2021). As a result, students in these schools experience lower academic achievement, reduced graduation rates, and limited career opportunities. Many rural schools also lack essential infrastructure such as electricity, running water, toilets, textbooks, learning materials, and support staff (Swart, Pottas, & Maree, 2021). These deficiencies negatively impact the quality of teaching and learning, perpetuating cycles of poverty and hindering rural development. In response, South Africa has seen the establishment of both low-fee private schools (Horn, McKay, & Mafanya, 2018) and high-fee private schools accredited by the International Examination Board (IEB). While these institutions provide an alternative for parents seeking quality education, they also contribute to a dual-tiered education system, where students from privileged backgrounds have access to superior resources compared to their less affluent peers. However, it is important to acknowledge that not all public schools face these challenges—those in urban and wealthier areas often have better access to resources, further exacerbating educational inequality.

Educational disparities have long been a concern in South Africa, and they continue to persist. Science subjects, particularly Life Sciences (LS) and Physical Sciences (PS), have historically recorded some of the lowest National Senior Certificate (NSC) pass rates. In the 2023 final examinations, LS and PS had 75.6% and 76.2%, pass rates respectively, compared to the overall NSC pass rate of 82.9% (Department of Basic Education, 2024). Furthermore, while 897,775 candidates sat for the NSC examination in 2023, only 15,180 students took the IEB examination (Department of Basic Education, 2024). The IEB pass rate was significantly higher at 98.46%, underscoring the advantage of private education in preparing students for academic success (Department of Basic Education, 2024). The stark difference in candidate numbers reflects the limited accessibility of privately funded education and its direct influence on overall pass rates. This suggests that IEB-accredited schools are better equipped to deliver quality education, thereby ensuring improved academic outcomes.

STEM subjects, including PS and LS, are critical for university admission into fields such as Medicine, Physiotherapy, Dietetics, and Engineering. Despite differences in secondary school preparation, students across South Africa enrol in these fields, often facing challenges due to varying educational backgrounds. Although the NSC and IEB set national standards for Grade 12 assessments, performance disparities persist, affecting students' success at the tertiary level and ultimately influencing their ability to complete their studies. This underscores the urgent need for more equitable access to high-quality secondary and tertiary education in South Africa.

Beyond academic success, Science Education plays a vital role in fostering critical thinking, problem-solving skills, creativity, innovations and essential competencies in today’s job market. A strong Science curriculum and effective teaching methodologies are crucial for developing scientifically literate students who understand the nature of Science (NOS) and inquiry-based learning (Namakula & Akerson, 2024). Strengthening these aspects is key to enhancing the overall quality of Science Education in South Africa and ensuring that students are well-equipped for future challenges.

Problem Statement

Despite South Africa’s commitment to equitable education, stark disparities persist between public and private schools, particularly in science education. Public schools, especially those relying solely on government support, often struggle with overcrowded classrooms, limited laboratory facilities, inadequate access to technology, and underqualified teachers. These challenges undermine inquiry-based learning and contribute to persistently low pass rates in Physical Sciences compared to the National Senior Certificate averages. Conversely, private schools, supported by higher tuition fees, benefit from smaller class sizes, advanced resources, and the International Examinations Board (IEB) curriculum, which is widely regarded as more effective in preparing learners for tertiary STEM studies. These systemic differences perpetuate socio-economic inequalities, limiting access to science-related careers for learners from disadvantaged backgrounds. Although existing studies highlight general inequalities between public and private education, there is insufficient research focusing specifically on science education in the South African context from the perspective of educators. Without targeted evidence, policies risk failing to

address the structural and cultural factors shaping the quality of science education. This gap underscores the need for a comparative investigation into how resources, curriculum design, and school culture influence the effectiveness of science education in both sectors.

Focus of the study

This study explores differences in the quality of science instruction between public and private schools in Johannesburg North, particularly focusing on LS, PS, and Natural Sciences. The research evaluates key aspects such as the availability of resources, technological integration, and the effectiveness of teaching strategies. Additionally, the study examined how these factors influence student performance and overall educational outcomes. By exploring the perspectives of science teachers in sampled schools, this study aims to provide insights into the broader implications of educational inequality in South Africa's Science Education system. Science teachers' perspectives on teaching and learning practices were explored based on their experiences in sampled schools.

Based on this study, the research question and aim, and list of objectives were developed.

Research Question, Aim and Objectives of the Study

Research Question:

What are the significant disparities in the quality of Science teaching and learning between public and private schools, and what are the implications for student achievement?

Aim:

To investigate and compare the quality of science teaching and learning, including the use of technology, availability of resources, and effectiveness of teaching methods, between public and private schools, including:

Objectives:

1. To examine and compare the quality of science teaching and learning among science teachers, highlighting the challenges and constraints hindering educational quality, and teaching quality.
    - Teacher qualifications and experience
    - Teacher professional development opportunities
2. To investigate the availability and utilisation of resources for Science Education in both public and private schools, including:
    - Laboratory equipment and materials
    - Technology integration (e.g. computers, internet access, interactive smartboards)
    - School infrastructure (e.g. Science laboratories, classrooms)
3. To examine the impact of teaching and learning quality on student outcomes in Life Sciences, Physical Sciences, and Natural Sciences, considering factors such as:
    - Student academic performance (e.g. examination results, grades)

4. To explore the perspectives of Science teachers in public and private schools regarding:

    - The availability and utilisation of resources
    - The impact of school environment on teaching and learning

5. To identify and analyse the key factors contributing to disparities in the quality of Science Education between public and private schools in the Johannesburg North district.

Keywords

Teaching refers to the impartation of skills and/or knowledge to another person (Rajogopalan, 2019). In the school environment it can also be defined as “an interactive process, primarily involving classroom talk which takes place between teacher and pupil and occurs during certain definable activities” by Amidon in 1967 (Rajogopalan, 2019).

The general definition for **learning** is a “relatively permanent change in behaviour, knowledge and thinking skills as a result of experience” (Jorg, Davis, & Nickmans, 2007). In the school context, learning can be generally considered as an outcome or an objective suggesting some change in a student (Jorg, Davis, & Nickmans, 2007). It is a quite a broad term with many implications and aspects.

Life Sciences (LS) and **Physical Sciences (PS)** are National Senior Certificate (NSC) subjects which are presented in South African schools in the FET Phase (Further Education and Training phase), which is from grade 10-12. **LS** is the study of all living entities and includes topics such as Zoology, Botany, Microbiology, Genetics, Biology, and Biochemistry among others. **PS** is the study of chemistry and physics. **Natural Sciences (NS)** is presented at the senior phase level (Grades 7 to 9) and serves as an introduction to LS and PS as it includes introductory concepts and topics of both of these subjects.

Teaching quality (TQ) can be briefly defined as teachers' behaviour and the resulting teacher-student interactions in the classroom. TQ is affected by many aspects of the school environment as well as teacher attributes such as teacher training.

Education quality (EQ) can be defined as the overall effectiveness of teaching and learning taking place.

Independent Education Board (IEB) refers to the curriculum which most privately funded South African schools implement. The IEB is a non-profit, private assessment body, often used by independent (private) schools, and is accredited by Umalusi, the South African quality assurance council.

Curriculum Assessment Policy Statements (CAPS) is the curriculum which is implemented by South African schools, which are partly or wholly funded by the Government.

National Senior Certificate (NSC) is the national matric certificate (independently regulated by UMALUSI), which is obtained by matriculants writing the final IEB and CAPS curriculum examinations in South Africa.

Nature Of Science (NOS) is a fundamental concept in Science Education that involves the underlying assumptions, principles, and methods that guide scientific inquiry. In essence, NOS refers to the epistemology of Science, Science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge (Lederman, 1992).

Science Education refers to the formal as well as informal instruction and acquisition of scientific knowledge across various educational levels and platforms (Taber, 2017).

CHAPTER 2: LITERATURE REVIEW

This section reviews studies that have been conducted on quality in the teaching and learning of Science in public and private schools. This section provides valuable insights into the quality of Science Education in both public and private schools, offering recommendations on how to improve teaching and learning in any educational setting. In the literature, factors such as the availability of resources, curriculum design, teacher qualifications, and student outcomes among different types of schools have been discussed as factors that influence the quality of teaching and learning in the Sciences.

Numerous studies have examined the differences in TQ and EQ between public and private schools worldwide. However, there is a lack of research specifically comparing TQ and EQ in Science Education in these schools, particularly in South Africa. It is also imperative to recognise that public and private schools differ significantly in their funding structures globally. Beyond funding, schools vary in several other ways, resulting in a diverse range of school types. These variations extend to curricula and teaching methods, which differ widely across countries. Additionally, this study distinguishes itself from others in the broader field by focusing on the teacher's perspective. As key influencers of the learning environment, teachers play a crucial role in shaping educational experiences. Effective teachers can significantly impact student progress (Fauth et al., 2019). Teaching quality (TQ) is a crucial factor in the quality of the learning taking place (Singh & Sarkar, 2015) and is directly influenced by various teacher factors. It is therefore valuable to use Science teachers as a source of information on the EQ and TQ of Science Education taking place in their schools.

Before looking at global studies in this field, it is important to note the value of Science Education. Science Education's goal is for learners to achieve scientific literacy and to understand the nature of Science (NOS). It also provides students with knowledge and skills, increase students' awareness of Science, technology, and engineering, and engage them in efforts towards sustainable development (Howell & Brossard, 2021; Knekta, 2022; Kyle, 2020). Science Education is also essential for developing critical thinking skills, promoting a spirit of inquiry, and enhancing conceptual understanding (Faize, Husain, & Nisar, 2017). Scientifically literate individuals can understand and use scientific concepts, facts, and theories and can apply the Science process skills to carry out a scientific inquiry (Metin Peten, 2022). They can also comprehend how Science functions and how knowledge and evidence are validated and justified.

It is relevant to mention some global studies that do not necessarily focus on Science Education. This situates the study as relevant and shows the gap in research. A study by Bedi & Garg (2000) analysed the effectiveness of private versus public schools in Indonesia. In this study, labour market earnings were used as a measure of school effectiveness. This refers to the earnings of graduates that leave school. Privately funded schools were found to be of higher quality and more cost-effective, meaning that learners received good value in relation to the fees paid. In another similar Indonesian study, Newhouse & Beegle (2006), the effect of school type on academic achievement was studied and analysed. Contrary to the other study by Bedi & Garg (2000), public schools were found to have better academic results than private schools at junior secondary school level. There were more textbooks available and a higher teacher-to-student ratio was evident. The study used test scores of junior secondary school students as a measure of the level or quality of education.

In a recent Turkish study conducted by Cansiz, Ozbaylanli, & Colakoglu (2019), the impact of school type on student academic achievement was studied and analysed. The study was conducted in Turkish secondary schools from 2014-2016. Cansiz, Ozbaylanli, & Colakoglu (2019) defined student achievement in terms of an overall measure named the Basis for

Admission Score (BAS), which was a weighted score reflecting both the grades obtained from courses in each school and the points obtained in the nation-wide centralised exams. This included private and public schools. Private school students obtained an average of 29.6% higher marks for the nationwide BAS score.

An older, but very relevant study by Barry (2009) involved doing a comparative analysis of private and public education in Africa, South of the Sahara. According to Barry (2009), school quality is, for the most part, measured either in terms of educational inputs or educational outputs. Tsang (2002) defined educational inputs as human and other material resources that are factored into the production function of schools, while outputs are the performance of students on achievement tests or the number and type of graduates coming out of the educational system. In terms of external outcomes, researchers assess the relative performance of public and private schools based on the quality of graduates and their earning potential. Findings are that private school students appear to be better equipped to find employment after graduation from secondary schools, although there is virtually no difference in the earnings received by graduates of the two types of schools.

A study conducted in the Dominican Republic by Jimenez, Lockheed, Lunsa, & Paqueo (1991) took school effects and costs for private and public schools into consideration. The study focused on 76 schools in the Dominican Republic. A standardised mathematics test was given to 2472 students nationally in three types of schools (public, elite private and low-fee private) and both types of private schools outperformed public schools. According to Jimenez, Lockheed, Lunsa, & Paqueo (1991), more learning took place in private schools, but at a higher cost. This study used academic achievement as a measure of learning and overall quality of education. The study also made mention of the effect of teacher characteristics: teacher education, teacher experience and teaching practices. Teaching practices included things such as time in lessons used for administration and time used for getting learners' attention. Classroom aspects were also considered: time of mathematics lessons and the number of learners with textbooks. Additionally, other peer group aspects were also considered.

Lee (2007) examined student achievement in private versus public schools in the USA. Lee (2007) reviewed two published reports in the USA on this topic. While one of the studies' results was inconclusive, the other report stated that graduates from private schools perform better than those from public schools in various fields such as reading, math, Science, social studies, educational attainment, civic-mindedness, and students' job satisfaction eight years after high school.

A Pakistani study by Ashraf (2012) studied the parental perceptions of the varying quality of private and public schools. According to Ashraf (2012) the public school system in Pakistan was seen to be crumbling. In this study, both parents who had enrolled their children in public and private schools were given a survey to complete. The survey included the critical aspects of schools such as the learning environment, the academic credibility of the school, the experience of teachers, school discipline and school facilities. In summary, parents considered student learning outcomes, academic performance and the learners' personal development. In another Pakistani study by de Talance (2020), it was found that parents frequently chose private schools over public schools due to the perception of low quality education in public schools.

In an older study by Cox & Jimenez (1991) public and private schools in Colombia and Tanzania were compared. Student aptitude and school factors mainly determined the school quality. Student aptitude included learner test scores (math and verbal) of standardised tests and whether learners repeated a secondary grade. School inputs or characteristics included

teacher salaries and the teacher to student ratio. This study aimed to generate interest in the quality and standards of teaching and learning in both public and private schools, and to draw conclusions about these standards. The goal was to identify differences in these standards and suggest ways to standardise the quality of education in both sectors. When examining the literature, it became evident that private schools worldwide were often perceived to be offering a higher quality education.

The ultimate objective of the Education System is to ensure that all South African students have equal access to high quality education. Given the research gap in Science Education in South Africa, this study aims to highlight significant disparities in Science Education.

Theoretical framework

This study will be guided by the following theoretical frameworks:

Quality education and equity theory.

Quality education: posits that quality education, including Science Education, is crucial for developing a skilled workforce and driving innovation. This framework will help understand the potential economic implications of disparities in Science Education quality between public and private schools.

Equity Theory developed by John Stacey Adams in the 1960s: This theory focuses on individuals' perceptions of fairness and justice in social and economic exchanges. In the context of education, it suggests that students should have equitable access to quality education regardless of their socioeconomic background or the type of school they attend. This framework will guide the investigation of disparities in access to resources and opportunities between public and private schools and their potential impact on student outcomes.

Sociocultural Theory, developed by Lev Vygotsky in the early 20th century: This theory emphasises the role of social and cultural contexts in shaping learning and development. It highlights the importance of social interaction, cultural beliefs, and shared knowledge in the learning process. This framework will help understand how the social and cultural contexts of public and private schools may influence teaching and learning practices and student outcomes in Science.

Technology Integration Theory, which was developed in the early 20th century (Rogers, Singhal, & Quinlan, 2014). This theory explores the effective integration of technology into teaching and learning. It emphasises the need for meaningful and purposeful use of technology to enhance student learning and engagement. This framework will guide the investigation of the role of technology in Science Education, including its availability, utilisation, and impact on student outcomes.

This theoretical framework will provide a foundation for the study by guiding the research questions, data collection methods, and analysis of findings. It will help to understand the complex interplay of factors that influence the quality of Science teaching and learning in public and private schools and to identify potential solutions to address the observed disparities.

This study generated data based on teachers’ experiences and perspectives of the quality of teaching and learning in public and private schools and to draw some conclusions about these standards. Eventually, the study aims to determine how these standards differ and to find possible solutions to ensure teaching and learning quality can be more standardised at public and private schools in South Africa.

Review of literature as a rationale for selecting TQ and EQ factors

Several methods or factors have been identified in the literature as contributing to the assessment of EQ and TQ in Science. The literature provided insight into the potential benefits of using TQ and EQ factors for scientific decision-making. The literature provided guidance for the development of effective tools and measures for assessing TQ and EQ. In addition, literature indicated the importance of considering other factors, such as students' motivation, commitment, and engagement in Science Education. Based on literature, TQ and EQ assessment tools should be tailored to the needs of all learners, regardless of the type of school or context (Singh & Sarkar, 2015).

Also, more importantly, one should consider how these factors could then be applied to Science Education specifically. Four main factors were found to be ways in which private and public schools were assessed in almost all relevant studies, irrespective of the subject(s). They are learner academic performance, teacher factors, school factors and earnings/employability of graduates.

Learner academic performance

Based on literature, the most important determining factor of TQ and EQ is learner academic performance, as this is a direct way to determine educational output. This could be standardised or aptitude test results (Cansiz, Ozbaylanli, & Colakoglu, 2019), grades or overall academic performance.

Teacher factors

This includes the teacher-to-student ratio, teacher experience/education and, more importantly, teaching practices. Teaching practices include teaching methods, time spent on administrative tasks and how lessons are structured.

School factors

Factors associated with schools include the educational environment, academic credibility, and school discipline (Ashraf, 2012). In addition, textbooks and electronic devices may also be considered as related school factors. Moreover, the size of the classrooms for students and the culture of the school are also considered part of the school's learning environment.

Market earnings or employability of student teachers after tertiary education

Among the factors that Bedi & Garg (2020) considered when evaluating graduates leaving school was their total earnings. As a direct educational outcome, this factor was closely related to the quality, and type of graduates coming out of the educational system (Barry, 2009). Educational quality played a crucial role in enhancing the employability of graduates. High-quality education equipped students with relevant skills, knowledge, and competencies that were in demand in the job market. As a result, graduates from institutions with a strong educational reputation were found to be more likely to secure well-paying jobs and succeed in their careers.

Educational Quality and Teaching Quality Assessment Factors

The above-mentioned factors from the literature review provided guidelines for creating a customised set of factors from which a research methodology could be designed. The assessment factors were also included in the study as an additional factor affecting EQ and TQ. Curriculum development, classroom management, and teacher professional development were all included in this process. Additionally, factors such as student

engagement, learning outcomes, and technology use in the classroom were taken into account.

The questionnaire and interview questions in this study incorporated the following five main assessment factors (see addendum A and B):

- **(1) Use of practical investigations** (Section C in questionnaire)
- **(2) Availability and use of technology in the classroom** (Section D in questionnaire)
- **(3) Class sizes and marks** (Section E in questionnaire)
- **(4) Curriculum and perceptions thereof** (Section F in questionnaire)
- **(5) Culture of Science Education** (Section G in questionnaire)

(1) Use of practical investigations

In Science Education, practical investigations are an integral part of the curriculum. It is through these investigations that learners can better comprehend concepts, since they promote scientific inquiry and facilitate the acquisition of scientific skills (Namakula & Akerson, 2022). As part of the Science curriculum, students are required to conduct practical investigations and laboratory work, and the main knowledge areas also require practical investigations and laboratory work (Department of Basic Education, 2011). In Natural Sciences, these topics are introduced in the Grade 8 and 9 curricula and require practical investigations and laboratory work. Both the IEB and CAPS curricula require practical investigations. Even though these practical investigations are required, some teachers and/or schools do not incorporate them into their teaching practices.

(2) Availability and use of technology in the classroom

The use of technology in the classroom is another factor that may benefit Science Education, and this is both a teacher factor and a school factor. Certain types of technology are preferred by some teachers for the purpose of teaching. These may include presenting via projectors, using digital notes and textbooks, using gamification (e.g. quizzes such as Kahoot, Quizlet or Padlet), or utilising online classrooms such as Microsoft Teams and Google Classroom. Technology may also include the use of learner tablets or laptops in the classroom, smartboards, or teaching/learning apps. All topics in Science can benefit from this approach and can aid the learner in understanding concepts. It is also important to note that the use of technology will prepare students for the technologically rich world of various scientific professions.

(3) Class sizes and marks

One of the most critical factors among these factors is the size of the class and the grade level or marks. The size of the class can have a significant impact on the learning process. Historically, learners in smaller classes have received more individual attention from their teachers, and the reverse is also true. As a result, this is an educational input that has the potential to directly influence the main educational output, which is a student's performance. Performance of learners provides the most direct and realistic indicator of whether EQ and TQ are being addressed in a school, and this research study supports this notion.

(4) Curriculum and perceptions

Due to the use of the IEB curriculum in private schools and the CAPS curriculum in public schools, the curriculum (referring to the specific content covered in a certain learning area)

differs between public and private schools. In this regard, learners are subject to specific requirements of a curriculum, which may affect their performance at the school level and beyond. The ability of learners to acquire scientific skills depends to a certain extent on the specific curriculum they are enrolled in. However, it is also the teachers who deliver the curriculum who are best qualified to evaluate and critique the effectiveness of the curriculum they are responsible for delivering. Moreover, the structure of the curriculum impacts how learners and teachers perceive it, as it also dictates the content and structure of assessments.

(5) Culture of Science Education

A final factor considered in this study is the school's culture of Science Education. It discusses learners' attitudes towards selecting Science subjects in the FET phase as well as how they feel about assessments and practical tasks. It also includes participation in co-curricular activities such as Science Olympiads, expos. Science fairs, etc. These factors reflect the educational inputs (teaching methods and other school factors) and will directly affect the performance of learners. A question on school discipline was included in the questionnaire, as well as its implementation, which is essential to effective teaching and learning.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

(i) Research methodology

This study employed a qualitative research approach to explore participants' experiences and perceptions of teaching and learning in public and private schools. Qualitative research gathers participants' experiences, perceptions, and behaviour ((Tenny, Brannan, & Brannan, 2022). It explains the hows and whys instead of how many or how much (Tenny, Brannan, & Brannan, 2022). This methodology provided valuable insights by allowing participants to share relevant and meaningful information about their school environments. The researcher drew on personal experience as an educator having worked in both private and public school settings to enhance the study's depth. Data was collected through anonymous digital questionnaires and semi-structured interviews with participants from diverse backgrounds. The responses and interview transcripts were analysed to identify disparities in Science Education, with the goal of highlighting areas for improvement and developing strategies to address these gaps. Based on this information, targeted interventions can be developed for improving Science Education and learning to meet quality standards.

(ii) Population and sampling

Study population

A specific focus of this study was to identify a population group with similar characteristics and interests, in this case, Science teachers. Population groups are organised to explore a specific set of issues such as people's views and experiences of common interest or the same subject (Barker & Rich, 1992). The study identified Science teachers as a means of gathering information and gaining insight into disparities in the quality of Science Education.

Sample group

Teachers in the Life Sciences, Physical Sciences, and Natural Sciences departments of the Johannesburg North district were targeted for the study. A specific list of schools was selected for sampling, and the sampling method was as follows: The larger and more prominent public schools ("Ex-model-C schools") were selected, as they would be a fair comparison to the bigger and more prominent private schools in the area. Due to the limited number of public schools in the area, most of the public schools and the larger private schools were selected. Only the most prominent public and private schools in the area with at least 300 students were selected for the study. Due to time constraints, not all schools could be contacted. This was done to have a similar number of public and private schools for the research. Some schools were therefore left out due to not meeting the above-mentioned criteria. Using this sampling method, a total of 8 public schools and 12 private schools in the area were selected and contacted. The numbers of each school type differed; however, the number of actual responses would be of more significance. From each school, Science teachers were contacted through the Heads of Departments (HODs). Before being able to contact teachers, principals first had to provide permission to adhere to ethical standards. Through a sample group, the researcher could explore a topic in greater depth, as participants share perspectives and experiences while the researcher identifies potential solutions and strategies.

iii) Data collection tools and techniques

After obtaining an ethics certificate for conducting research, data collection commenced. Two methods of obtaining data were used: *digital questionnaires* and *interviews*. In the study by Ashraf (2012), parents were given questionnaires to complete for investigation of parental

perceptions of quality. Similarly, teacher perceptions were studied in this report. The questionnaires had a total of 38 multiple choice questions with rating scales (0 – 10) and various options for each question. Questionnaires were sent out to all the teachers at the schools where permission had been granted. A total of 11 questionnaires were completed. Three responses were received from public schools and eight from private schools. Even though the researcher followed up with teachers, likely due to time constraints many teachers did not respond. The names of teachers and schools were kept anonymous. In a few cases, more than one teacher from a single school provided information. The questionnaires were made available electronically for all participants. Semi-structured interviews are commonly used in the social Sciences for qualitative research to gather in-depth data. These interviews are characterised by a prepared set of guiding questions and a clearly defined interview method. They allow for open-ended, exploratory questions and enable interviewers to ask follow-up questions for deeper insights into the interviewee's thoughts and emotions. While semi-structured interviews follow a pre-designed guide or protocol, they also provide flexibility for further exploration as the conversation evolves. In this study, an interpretive paradigm was adopted, and data was collected using semi-structured interviews and questionnaires. Permission to conduct interviews and administer questionnaires was granted by the principal and the Head of the Science Department. The interviews were recorded and transcribed for analysis. The researcher conducted semi-structured interviews, and they were recorded and transcribed to text (Magaldi & Berler, 2020).

Along with questionnaires, one experienced teacher from each school was invited for an interview. Interviews are a valuable tool in qualitative studies such as this. The interview questions were similar to those of the questionnaires, but allowed for more descriptive answers, as the interview allowed for verbal discussion. A total of three interviews were conducted. All three interviews were with teachers who had more than 20 years of teaching experience, were HODs and have taught in both public and private schools. These interviews were each around 15 minutes long and were recorded, and excerpts were referred to during data analysis. Interviews were done at the schools where the participating teachers work.

The interviews and questionnaires were based on the main 5 categories of assessment (as explained in next section) and were focussed on the experiences of these teachers at the schools where they currently teach.

(iv) Data analysis and interpretation

(v) Data analysis procedure

The qualitative analysis was conducted based on predefined categories. The questionnaire included a combination of yes/no questions, multiple-choice questions, a biographical section for teachers, and rating scale questions (ranging from 1 to 10). Each response was analysed individually, considering all collected data. Rating scale responses were averaged to provide quantitative insights, and the summarised results are presented in Table 2 of the results section.

For the interviews, the transcribed responses were examined for each assessment factor to highlight differences between public and private schools. Key points from the interviews were summarised in Table 3. However, since all three interviewed teachers currently work in private schools and no public-school teachers were available to be interviewed, the qualitative interview data served as supplementary information to the questionnaire findings.

The following chapter presents the collected data, focusing on factors that influence education and teaching quality in Science Education. The study's findings aim to provide insight into key determinants of effective Science Education, ultimately supporting efforts to create equitable and high-quality learning experiences across different educational settings.

CHAPTER 4: RESULTS AND DATA ANALYSIS

The results of the study exploring TQ and EQ in public and private schools are presented in this chapter. In the next chapter, the results are analysed, interpreted, and discussed in relation to teachers' perceptions regarding TQ and EQ. The data collected for this chapter was obtained using a questionnaire and interviews with Science teachers. Qualitative methods provided a thorough understanding of participants' experiences and perceptions of the research topic. Table 1 provides a brief biographical profile of the teachers, along with their consent to participate in the study, followed by tables 2 and 3 showing the results of the questionnaire and interviews, respectively.

TABLE 1: TEACHERS' BIOGRAPHICAL INFORMATION AND CONSENT

Items	**Private**	**Public**
Q1 – 9 Teacher Consent Form (see Addendum A) All teachers provided consent for taking part in an interview and/or questionnaire.	Consent provided.	Consent provided.
Q10 - What is the name of the school you are currently teaching at?	Anonymous	Anonymous
Q11 - Is this a public or private school?	8 teachers	3 teachers
Q12 - Is the school making use of the IEB or CAPS curriculum?	7 teachers using IEB 2 using both CAPS and IEB	2 teachers using CAPS 2 teachers using both CAPS and IEB
Q13 - How many years have you been teaching? This refers to the total number of years teaching any subject, and not necessarily the number of years teaching Life/Physical/Natural Sciences. e.g. 7	Average: 18.4 years teaching experience	Average: 16 years teaching experience
Q14 - Which grade(s) are you currently teaching?	All Grades represented (Grade 8 – 12)	All Grade represented (Grade 8 – 12), Except for Gr. 10 – 11 LS
Q15 - Which subject(s) are you currently teaching?	NS, PS and LS covered	NS, PS and LS covered
Q16 - Are you currently a Head of Department (HOD) of the subject(s) you are teaching?	5 of 8 teachers were HODs	3 of 3 teachers HODs
Q17 - What is your highest education level? Choose the option below which best describes your highest education level.	1 Master's 5 Honors 1 Bachelor in Teaching 1 Higher Diploma/Certificate	1 Honors 1 Bachelor in Another Field (not teaching) 1 Higher Diploma/Certificate

TABLE 2: PRESENTATION OF RESULTS FROM QUESTIONNAIRE

1. Use of practical investigations (Section C)		
Items	**Private**	**Public**
Q18 – Useable laboratories.	All.	All.
Q19 – Number of laboratories.	All more than 2 laboratories. Some schools 5+	All more than 2 laboratories. Some schools 5+
Q20 – Laboratory equipment.	Average rating: 8.5 /10	Average rating: 7.7 /10
Q21 – Incorporation of practical investigations into syllabus.	Average rating: 8.6 /10	Average rating: 5.7 /10
Q22 – Time for practical investigations in syllabus.	Average rating: 6.8 /10	Average rating: 4 /10
Q23 – Access to lab assistant.	3 out of 4 private schools have lab assistants.	1 out of 3 public schools have lab assistant.
2. Availability and use of technology in the classroom (Section D)		
	Private	**Public**
Q24 – Use of technology	Projector - All PowerPoint presentations - All Digital notes/textbooks – All Gamification – 1 of 4 schools Other multimedia - All Learner tablets/laptops – 2 of 4 schools Online teaching classrooms - All Smartboards – 2 of 4 schools Teaching/learning apps – 2 of 4 schools	Projector - All PowerPoint presentations - All Digital notes/textbooks - All Gamification - None Other multimedia - All Learner tablets/laptops - None Online teaching classrooms – 2 of 3 schools Smartboards – 1 of 3 schools Teaching/learning apps - None
Q25 – Use of technology in teaching and learning.	Average rating: 7.3 /10	Average rating: 8.7 /10
Q26 – Technology training for teachers at school.	Average rating: 6.8 /10	Average rating: 7.3 /10
Q27 – Work laptops received from school.	All	All
3. Class sizes and marks (Section E)		
	Private	**Public**
Q28 – Class sizes	7 × (16 – 20) learners /class 1 × (21 - 25) learners /class Average: 18.6 learners/class	2 × (26 – 30) learners /class 1 × (21 – 25) learners /class Average: 26.3 learners/class
Q29 – Average class marks (for all Science subjects, from Gr. 8 to 12) (%)	6 × (66 – 70%) 2 × (71 – 75%) Average: 69.25%	2 × (61 – 65%) 1 × (51 – 55%) Average: 59.7%
4. Curriculum and perceptions thereof (Section F)		
Q30 – Teacher attitude towards IEB curriculum	Average rating: 8.5 /10	
Q31 – Ability of IEB to prepare learners for career Science	Average rating: 8 /10	
Q32 - Teacher attitude towards CAPS curriculum		Average rating: 6.7 /10
Q33 - Ability of CAPS to prepare learners for career Science		Average rating: 6.7 /10

5. Culture of Science Education (Section G)		
Q34 - Overall school discipline	Average rating: 7.3 /10	Average rating: 9 /10
Q35 – Culture of Science Education	Average rating: 8.25 /10	Average rating: 8.3 /10
Q36 – Physical Sciences Olympiad participation	None.	1 of 3 schools take part in Physical Sciences Olympiads
Q37 - Life Sciences Olympiad participation	None.	1 of 3 schools take part in Life Sciences Olympiads
Q38 – School participation in Science expo's, excursions or other external events	Average rating: 5.9 /10	Average rating: 6 /10

INTERVIEW RESULTS

Transcripts of the interviews are available to view in Addendum C.
Teacher 1 – Life Sciences teacher at a private school (teaching experience at private and public schools)
Teacher 2 – Physical Sciences teacher at a private school (teaching experience at private and public schools)
Teacher 3 – Life Sciences teacher at a private school (teaching experience at private and public schools)
Teacher 1 and *Teacher 2* are at the same private school.

TABLE 3: SUMMARISED RESULTS FROM INTERVIEWS

Question 1: *Elaborate on the use of laboratories at your school for practical investigations. Your answer might include reference to laboratory resources, and the level at which your school makes use of these resources.*	
Teacher 1 + 2:	Everything needed is available in lab. One lab assistant sets up practicals. No limit to what can be obtained – anything that is needed is bought or borrowed from sister school.
Teacher 3:	Everything that is needed. Lab has enough microscopes, glassware, chemical supplies, anything that is needed. Two lab assistants at the school.
Question 2: *Explain your integration of practical investigations in teaching of Life and/or Physical Sciences at your school.*	
Teacher 1:	Practical exams from Grade 10 to 12. Lots of dissections.
Teacher 2:	Heavy integration of practicals as demonstrations in physics and chemistry. Not in exams. Brings subject to life.
Teacher 3:	Dense integration of practicals in the form of tasks, cycle tests and exams from Grade 8 to 12. Grade 8 practical final exams implemented from previous year. School does more practical exams in Life Sciences than Physical Sciences.
Question 3: *Discuss the use of technology in the teaching of Science at your school. Mention where your school might lack and where your school might excel in this field. (Additional to details given in questionnaire.)*	
Teacher 1:	Heavy use of technology. School is an MIE school. Heavy use of PowerPoint via a projector. Many YouTube videos. Have Smartboard.
Teacher 2:	Use of PowerPoint notes and all learner notes uploaded on Microsoft Teams. All teacher notes uploaded to OneNote to keep track of progress with each class. Use of PhET simulations for demonstrations in class.

Teacher 3:	Use all listed technologies from questionnaire. Gamification more traditional – e.g. Pictionary.
Question 4: *What are your perceptions of the IEB/CAPS curriculum for Physical or Life Sciences? This includes the value of this curriculum in preparing learners for real life (career) Science. This might include inclusion of more than just theoretical content, but also of practical skills.*	
Teacher 1:	Up to Grade 11, IEB is quite open with regards to content. No specific requirements. CAPS is prescriptive from Grade 8 to 12. IEB has paper 3 (practical skills), which is not a requirement in CAPS. IEB prepares learners better for university and real-life Science due to the focus on scientific skills such as setting up experiments, understanding variables, etc.
Teacher 2:	Content in IEB and CAPS is slightly different. The IEB content is less dense with regards to content in comparison to the CAPS curriculum. Also, the IEB tests more rigorously and at a higher level. Both do practical work.
Teacher 3:	The IEB has excellent assessments. Students obtain a higher quality of skills and therefore may receive better results at university. The IEB Life Sciences curriculum is very broad, making it more challenging, and thus prepares learners better for further studies.
Question 5: *Elaborate on the culture of Science teaching and learning at your school. Your answer might refer to teacher experience, attitude of learners towards scientific material and scientific practices.*	
Teacher 1:	The school has a very positive culture. There are very experienced teachers at the school, resulting in a lot of students taking the subject. Many students choose the subject due to career choices such as Medicine or Engineering but end up enjoying the subject.
Teacher 2:	Learners take Science very seriously at the school. Both Life and Physical Sciences are seen as prestigious subjects, making the subjects very popular. This may also be due to these subject teachers being very qualified.
Teacher 3:	Due to parental perceptions, the Sciences are subjects of choice for learners. Life Sciences is not as highly regarded as Physical Sciences.
Question 6*: In what ways do you engage learners in lessons?*	
Teacher 1:	I encourage learners to do it themselves, especially in the practicals. I therefore do not adopt a teacher-centred approach.
Teacher 2:	Assessments contain a lot of probing questions and scenarios are used to try to make the content more relatable for learners. Students are exposed to a lot of learner exercises and learners check answers from the board during class time.
Teacher 3:	We make use of learner-focused translational tasks such as thinking maps for content-heavy topics. Learners are not just provided with answers – they must figure it out themselves. There are lots of class demonstrations.
Question 7: *If available, provide average class marks for your classes in the last year or the last term. How does this compare to your school's overall historical Science marks?*	
Teacher 1:	Very good year – 75% average for Gr. 12 classes. Historically remarkably high marks – ranging from 72% - 77% in Gr. 12. School's Life Science average is always 5 – 7% higher than IEB average.
Teacher 2:	Average mark for Gr. 12 prelim exam high this year: +70%. Usually one or two +90% marks, but this year more. Historically high Physical Science marks at the school.
Teacher 3:	Marks historically above IEB average. Learners do well in Grade 10. Marks then drop in Grade 11 and pick up in Grade 12.
Question 8: *Provide an overall rating of the level at which your school is performing in providing effective teaching and learning in the field of Science (Physical and/or Life Sciences).*	
Teacher 1:	Learners do well because the teachers prepare them well.
Teacher 2:	The school's Physical Science is at an elevated level. We have top students who work hard and do well.
Teacher 3:	There are fewer students taking Life Science than there are Physical Science. However, the school manages to keep students in Life Science, and they do well. In Physical Science learners frequently drop out.

Question 9: What, according to you, are the aspects a researcher should look at when assessing the quality of Science Education?	
Teacher 1:	To see how students do at tertiary level. Many past students have done very well at tertiary level and career-wise - many doctors. Many state that it is because of what they have learnt in Life Sciences at this school.
Teacher 2:	Learner grades and their attitude towards Science.
Teacher 3:	Assessment of how a school lets learners explore Science concepts for themselves.
Question 10: When comparing the quality of Science Education at private versus public schools in JHB North, what do you think the results will be?	
Teacher 1:	Difficult to compare, as CAPS focuses on theory and IEB more on practical aspects. However, IEB graduates will be better adapted for after school studies.
Teacher 2:	IEB gives learners an advantage for after school studies. CAPS papers at school level are predictable, so past papers can be studied and can give good marks based on that. IEB is not like that, it is more like tertiary studies.
Teacher 3:	IEB gives learners an advantage for after school studies due to scientific thinking skills acquired.

DATA ANALYSIS

Interpretation of results and discussion

1. Use of practical investigations

Practical investigations directly relate with learners' sociocultural context and environment, pointing back to Vygotsky's theory. Practical investigations in the Physical Sciences and Life Sciences classes have a social aspect, as social interaction is required. Due to economic and other factors, the sociocultural context might look different in private and public schools in South Africa, possibly affecting the effectivity and the way these investigations are done.

The teachers' responses to the questionnaire and interview regarding the use of practical investigations revealed several key insights. Teacher 2, from a private school, emphasised that practical demonstrations "bring a subject to life" and highlighted the importance of analysing why and how schools excel or fall short in this area. All participating schools, both public and private, had usable laboratories. However, due to the smaller size of private schools in terms of the number of learners compared to public schools, the learner-to-laboratory ratio in private schools was much smaller. Teachers at public schools rated the equipment of the facilities slightly lower than those at private schools.

Teacher 3, also from a private school, mentioned that the budget provided adequate supplies, allowing teachers to do almost anything they wished. Public schools, primarily funded by the Department of Basic Education, often lacked sufficient funds for such facilities, whereas well-run private schools could generate enough funds. The analysis indicated that private school teachers rated the incorporation of practical investigations into the syllabus significantly higher than public school teachers, along with the time allocated for practical investigations. This could be related to the use of IEB policies rather than content from the CAPS document. According to one teacher, the IEB is more open, allowing for greater flexibility in grades 10 and 11, although grade 12 follows the SAGS. This openness facilitates the incorporation of practicals.

While CAPS includes some suggested practicals in their prescribed textbooks, the presence of laboratory assistants in private schools and their absence in public schools played a crucial role. Laboratory assistants in private schools helped teachers set up practicals, purchase necessary equipment, and maintain the laboratories. In contrast, public school teachers had to manage all these tasks themselves, in addition to their teaching and extramural duties, making it difficult to incorporate practical work effectively into their Science curricula. Other factors such as school management, mismanagement of funds or facilities, incorrect timetable allocation, and lack of experienced teachers also contributed to the lack of practical task incorporation into Science classrooms.

2. Availability and use of technology in the classroom

This related directly to the technology integration theory. According to this technology has the potential to enhance Science Education. Technology integration can cause learners to be intellectually stimulated in more ways, leading possibly to better Science Education outcomes.

Findings indicated that both public and private schools demonstrated similar levels of access to various types of technology, with a few exceptions. It was noted that while half of the private schools had access to student laptops or tablets, none of the public schools reported having access to this resource. A similar trend was observed in the use of additional teaching and learning applications, which were available in some private schools but not in public schools. Additionally, private schools reported a greater use of smartboards compared to public schools.

All private school teachers stated that they utilised online teaching platforms such as Microsoft Teams or Google Classroom, whereas nearly all public schools also made use of these platforms. Interestingly, public school teachers rated both their training in technology and their use of technology in the classroom significantly higher than their private school counterparts. However, it was emphasised that these ratings were subjective and could be influenced by teachers' prior experiences at other schools, as well as their personal perceptions of high technology use. It was suggested that private school teachers might generally have higher expectations regarding the integration of technology in their schools.

Overall, findings highlighted that the use of technology was largely similar between public and private schools, apart from a few differences. This was considered noteworthy, as it indicated that despite public schools relying on government funding, sufficient resources were allocated for technology integration. Consequently, it was concluded that both private and public schools were equally committed to leveraging technology for effective teaching and learning. The equity theory (chapter 2) provides a framework by which equitable education needs to be understood. Learners need to have access to the same learning environment (including resources) to have equitable education. Technology (access to and use thereof) in the classroom is equitably the same for both schools, but a slight lower implementation of this was seen in public schools. This shows a slight inequality towards public schools.

3. Class sizes and grading/marks

Class sizes could affect the type of social interactions experienced by learners, pointing back to the relevance of Vygotsky's sociocultural theory. Smaller classes would allow for different interactions than larger classes. Smaller classes tend to have more individualised attention

between teachers and learners, and among learners, possibly affecting EQ and TQ more positively. This was more apparent due to smaller classes in private schools. The study revealed a significant difference in class sizes between public and private schools. Teachers provided a range of numbers representing the average class sizes for the various classes they taught (as referenced in Q28 of Addendum A). Based on these responses, an overall average class size was calculated for both public and private schools. It was noted that in public schools, the standard learner-teacher ratio was typically 1:32. However, the survey indicated that the actual average class size in public schools was 26.3 learners per class. In contrast, private schools reported an average class size of 18.6 learners per class.

It was further observed that public schools in South Africa have historically experienced overcrowding due to the insufficient construction of new schools, particularly in recent years. As a result, high numbers of learners per class remain a challenge, with most public-school Science teachers in the study reporting class sizes ranging between 26 and 30 learners. On the other hand, private schools, which are not government-funded and charge significantly higher fees, were found to have smaller class sizes. This difference in class size contributed to a significantly lower teacher-to-student ratio in private schools, making individualised attention more accessible to learners in these institutions. Consequently, this disparity was noted to have a direct impact on educational outcomes, including student grades and preparedness for tertiary education.

Regarding learner marks and grading, Teacher 2 emphasised that student performance was one of the most crucial indicators of the quality of teaching and learning at a school. The teacher stated that academic results were an objective measure, highlighting that higher marks reflected successful teaching and learning.

In the questionnaire, teachers selected a marks range based on the average Science class performance across their taught grades (as referenced in Q29 of Addendum A). From these responses, an overall average percentage was calculated for public and private schools. The findings indicated that private schools had a higher average learner percentage (69.25%) compared to 59.7% in public schools. It was noted that various educational inputs, including those assessed in categories 1, 2, 4, and 5, influenced this average performance.

Although no public-school teachers were interviewed, all three private school interviewees reported achieving results above the Independent Examinations Board (IEB) National Average. One of the interviewees, Teacher 1, indicated that their Grade 12 learners typically achieved marks ranging between 72% and 77% at the private school where they currently taught. Additionally, it was observed that all three interviewed teachers demonstrated exceptionally high educational inputs in other assessed categories, which suggested a strong presence of both high teaching quality (TQ) and emotional intelligence (EQ) in their instructional approaches.

4. Curriculum and perceptions thereof

The study found that teachers generally held a more positive attitude toward the Independent Examinations Board (IEB) curriculum compared to the Curriculum and Assessment Policy Statement (CAPS). Teachers who taught Science under the IEB curriculum rated their experience highly, with an average score of 8.5 out of 10. In contrast, public school teachers rated the CAPS Science curriculum lower, with an average score of 6.7 out of 10. A similar trend was observed when assessing the curriculum's ability to

prepare learners for real-world scientific applications. Teachers rated the IEB curriculum at 8 out of 10 in this regard, whereas CAPS received an average rating of 6.7 out of 10.

During interviews, all three teachers highlighted the advantages of teaching the IEB curriculum, particularly its effectiveness in preparing students for further studies in the Sciences. They collectively emphasised that the practical component of the IEB curriculum was its key distinguishing feature from CAPS. It was noted that all three teachers had experience teaching both curricula.

One teacher (Teacher 1) pointed out that a significant benefit of the IEB Life Sciences curriculum was the inclusion of Paper 3, which helped students develop essential experimental skills. The teacher explained that this component ensured students entering scientific fields were already familiar with designing experiments, identifying variables, and understanding practical scientific applications. The teacher further suggested that learners from CAPS schools, which did not incorporate similar experimental components, might lack this advantage.

Another teacher (Teacher 2) reinforced this viewpoint by stating that the IEB curriculum effectively prepared students for university. The teacher attributed this to the rigor of the IEB's assessment methods and the higher standard at which students were examined. It was emphasised that learners developed strong problem-solving skills in Science, which was considered a crucial advantage.

A third teacher (Teacher 3) described the IEB Life Sciences curriculum as a strong foundation for future scientific studies. The teacher acknowledged that some students questioned the relevance of certain topics, particularly those aspiring to careers in Medicine, but stressed the importance of a broad scientific skill set. The teacher also praised the various forms of assessment within the IEB curriculum, stating that students who completed Life Sciences under IEB were likely to perform better at university due to their well-developed skill sets.

The study further noted that the level of assessment and the acquisition of skills were key strengths of the IEB curriculum in the Sciences. It was highlighted that, unlike CAPS, the Life Sciences curriculum under IEB was less prescriptive before Grade 12, allowing teachers some flexibility in adjusting content delivery.

However, the IEB provided a Subject Assessment Guidelines (SAGS) document to ensure alignment across learning areas. In contrast, CAPS was described as highly prescriptive, with the Department of Basic Education (DBE) conducting regular school check-ins to ensure strict adherence to the required topics, assessments, and standards. While this level of regulation was deemed necessary given the significantly larger number of learners and schools following the CAPS curriculum, it was noted that discrepancies often existed between the intended and the actual implemented curriculum. Due to resource limitations or time constraints, many schools were unable to complete all prescribed practical tasks and demonstrations.

5. Culture of Science Education

The study assessed the culture of Science Education in both public and private schools, particularly on school discipline, external Science or co-curricular participation, and overall attitudes toward Science subjects.

Regarding school discipline, public schools received a higher average rating of 9 out of 10, compared to 7.3 out of 10 in private schools. It was noted that public schools tended to implement more prescriptive disciplinary measures, likely due to their larger class sizes and, in some cases, behavioural challenges linked to socio-economic conditions. This structured approach to discipline was considered a positive factor in maintaining order in public school Science classrooms.

Both school types received similar ratings of approximately 6 out of 10 for external Science participation, such as Science expos or excursions. Only one of the three participating public schools reported involvement in both the Life Sciences and Physical Sciences national Olympiads, whereas none of the private schools took part in these competitions.
When evaluating the overall culture of Science Education, both public and private schools scored highly, with public schools receiving an average rating of 8.3 out of 10 and private schools scoring 8.25 out of 10. All three interviewed teachers reported a positive Science culture at their schools, with two of the teachers (Teacher 1 and Teacher 2), who taught at the same school, attributing this to the high qualifications and experience of Science teachers. Additionally, they suggested that Science subjects were perceived as "prestigious" at their school.

Teacher 1 observed that many students at their school chose to study Life Sciences and Physical Sciences due to aspirations for careers in the medical field. The teacher noted that from Grade 10 onwards, students demonstrated a strong commitment to these subjects and achieved good results.

In contrast, Teacher 3, who also taught Life Sciences, highlighted a perception that Life Sciences was not valued as highly as Physical Sciences. The teacher remarked that Life Sciences was often seen as a secondary subject rather than an equal counterpart to Physical Sciences, despite both disciplines sharing fundamental scientific principles and methodologies.

Teacher 2 commented on students' dedication to Science subjects, explaining that learners would prioritise attending Science lessons over other subjects if necessary. The teacher stated that students had a profound respect for their Science teachers and recognised their extensive experience. Additionally, it was noted that Science subjects were held in high regard within the school.

Although no public-school teachers were interviewed, the high rating of 8.3 out of 10 indicated that the Sciences were well respected in the participating public schools. The study suggested that Science subjects maintained a strong reputation at the secondary school level, largely due to their association with prestigious career paths and their perceived difficulty. It was noted that students and teachers alike acknowledged the intelligence and dedication required to excel in these subjects.

All 5 factors discussed have a theoretical framework in the quality education theory. All 5 of these factors showed differences in public versus private schools, pointing to possible differences in the outcomes of learners. The quality education theory points to how these differences can affect the future workforce and can therefore have economic impacts. A higher perceived EQ and TQ in all 5 of these categories shows how private schools might have learners who have better career readiness, possibly affecting their future earnings.

CHAPTER 5: CONCLUSION

Public and private schools were perceived to differ in quality when it came to Science Education. This study provided valuable insights into this distinction. Consistent with global trends, findings of this small-scale study suggest that private schools were generally regarded as offering a higher standard of education. Despite the study limitations, the findings indicated that teachers perceived private schools as having a superior standard of education, particularly in the Sciences. These perceptions underscored the need for public schools to enhance their Science Education quality to bridge the gap with private institutions.

While concluding the findings of the study, one must evaluate the theoretical framework which underpins this research. The quality of education theory, the equity theory, the technology integration theory, and the sociocultural theory collectively provide a foundation for understanding the theoretical significance of the findings.

Firstly, the quality of education theory forms the backbone of this study. When considering that the quality of Science Education directly affects the future workforce of South Africa and the economic implications thereof, the differences in public and private school Science Education quality are both tangible and consequential. The perceived higher quality of Science Education in private schools could therefore advantage these learners economically and, in contrast, disadvantage learners from public schools.

One of the key advantages of private schools lay in their greater emphasis on practical and experimental Science, facilitated by the IEB curriculum. This approach enhanced learners' scientific skills, better preparing them for tertiary education and careers in the Sciences. While both public and private schools reported having laboratories, public school laboratories were often underutilised due to resource constraints. Private schools were therefore, according to teacher perceptions, able to achieve higher TQ and EQ levels because of their greater focus on practical Science. Additionally, private schools benefited from smaller class sizes, allowing for greater individualised attention, which correlated with significantly higher learner performance in science subjects. Although both school types incorporated technology in their classrooms, private schools appeared to utilise these resources more effectively, further contributing to improved academic outcomes. The technology integration theory (Rogers, Singhal, & Quinlan, 2014), with its emphasis on improving quality student engagement, was evident in this study. Perceived lower integration of technology in teaching (not access in this case) led to teachers perceiving that EQ and TQ were higher in private schools. According to the teachers, the public schools in the study had sufficient access to technology in the classroom but did not utilise it as effectively.

Nevertheless, the study found that Science subjects were highly regarded in both public and private schools, with teachers in both sectors expressing a strong commitment to fostering a positive Science culture. While both public and private schools valued Science Education, private schools tended to provide a more effective learning environment, leading to better academic outcomes in Science subjects.

The study further highlighted broader systemic challenges, particularly concerning educational inequality in South Africa. While private schools were perceived to offer a more effective learning environment, leading to better academic outcomes, both public and private schools in South Africa highly valued Science Education. However, systemic challenges such as educational inequality persist, with private schools often having better resources and

infrastructure. The adoption of IEB-aligned curricula in some public schools and the growth of cost-effective private school branches were seen as promising steps towards addressing these disparities. The equity theory of John Stacey Adams, when related to education, states that there needs to be equitable access to quality education, regardless of socioeconomic status or background. The findings of this small-scale study therefore show that equitable access to quality Science Education might not be possible for all learners. Private school fees are much higher and are not accessible in all parts of the country, thereby excluding some learners from its perceived benefits. This, in turn, also points us back to Vygotsky's sociocultural theory. In theory, the sociocultural background and environment of learners affect their learning. Due to differing sociocultural interactions at public versus private schools, there might be differences in Science Education outcomes.

While public school Science Education in the Johannesburg North district remained strong, areas for improvement persist. Teachers identified resource limitations, particularly the absence of officially employed laboratory assistants, as a significant barrier to conducting practical lessons. Due to high teacher workloads, these constraints hindered the full implementation of Science curricula.

Improving Science Education in South Africa requires addressing educational inequality and resource limitations. As a result of these challenges, the Department of Basic Education (DBE) needs to pursue targeted interventions, including increased funding, enhanced teacher training, and improved access to essential resources in public schools. Although the DBE has made significant progress in improving Science Education outcomes, continued efforts are necessary to eliminate disparities between public and private schools. DBE and key stakeholders must work collaboratively to ensure that every learner, regardless of school type, receives a high-quality Science Education that will prepare them for academic and career success in the future.

The findings of this study can be better understood when interpreted through the interaction of the four guiding theoretical frameworks. Each framework provides a distinct yet complementary lens that helps explain the mechanisms underlying the observed disparities between public and private schools. Together, they reveal the complex, multi-dimensional nature of Science Education inequality in South Africa.

The "Quality Education Theory" forms the foundational layer for interpreting the study's results. It asserts that sustained investment in educational inputs such as teacher qualifications, infrastructure, and pedagogical resources, directly influences educational outputs and, ultimately, the development of a skilled and innovative workforce. In this study, the higher perceived quality of Science Education in private schools aligns with this theoretical premise. Smaller class sizes, adequate laboratory support, and a stronger emphasis on practical investigations collectively strengthen both teaching quality (TQ) and educational quality (EQ), thereby contributing to improved learner outcomes and career readiness.

The "Equity Theory" complements this by emphasising fairness and justice in the distribution of educational opportunities. Inequitable access to teaching resources, technology, and professional development among public school teachers hinders their ability to deliver effective Science Education, creating a cycle of disadvantage that affects learner performance. These inequities are not merely structural but also psychological. Teachers

and learners in under-resourced settings may perceive their contexts as inherently limiting, which can reduce motivation and engagement, further influencing educational outcomes.

The “Sociocultural Theory”, developed by Vygotsky, provides insight into ‘how’ these inequities manifest within the learning process. It highlights that learning is mediated through social and cultural contexts that shape the kinds of interactions possible within classrooms. In this study, larger class sizes, resource constraints, and high teacher workloads in public schools reduce opportunities for collaborative, inquiry-based learning. Such contexts inhibit the kind of dialogic and experiential learning that is essential for deep conceptual understanding in the Sciences, thereby constraining both TQ and EQ despite teachers’ best intentions.

The “Technology Integration Theory” operates as a bridging mechanism between the structural and sociocultural layers of analysis. While both public and private schools reported similar access to technological tools, their utilisation differed significantly. In private schools, the presence of smaller classes, structured teacher support, and digital literacy training created the conditions necessary for meaningful technology integration. Conversely, in public schools, inequitable sociocultural contexts marked by limited time, heavy workloads, and insufficient institutional support, constrained the pedagogical use of technology. This demonstrates how sociocultural and equity-related factors mediate the effectiveness of technological interventions, directly impacting the quality of teaching and learning.

Considered together, these four frameworks form an integrated explanatory model for understanding disparities in Science Education. The Quality Education Theory explains structural inequalities in inputs and outputs; the Equity Theory exposes the distributive and motivational dimensions of fairness; the Sociocultural Theory reveals how context mediates the enactment of learning; and the Technology Integration Theory illustrates how these disparities interact in modern classrooms. Their intersection underscores that Science Education quality is not determined by resources alone, but by the dynamic interplay of material, social, and cultural systems. Addressing inequality in Science Education therefore requires interventions that operate across all these layers (structural, pedagogical, and sociocultural) to achieve genuine equity and excellence within the South African educational landscape.

Limitations of the study

As with all qualitative research, this study was subject to several limitations that may have influenced the interpretation and generalisability of its findings. Firstly, the study relied exclusively on teacher perceptions, which constitute self-reported data. While these perspectives offer valuable insights into lived experiences, they are inherently subjective and may not fully capture actual classroom practices. The absence of classroom observations limited the ability to triangulate these perceptions with observed teaching behaviours or learner outcomes, which would have provided a more comprehensive understanding of Science Education quality.

Secondly, the sample size was small and geographically restricted to the Johannesburg North district. Moreover, there was an imbalance in data collection between public and private schools, with no interviews conducted with public-school teachers. Despite repeated invitations, many public-school teachers cited time constraints and heavy workloads as barriers to participation. The study therefore relied on private-school teachers who had prior experience teaching in public schools, as well as responses from public school questionnaires, to obtain comparative data. While this approach offered some insight into both contexts, the absence of direct public school interviews limits the representativeness of the findings.

Thirdly, as a perception-based qualitative study, the findings cannot be generalised to all schools in South Africa. Educational contexts vary considerably between provinces, and factors such as community support, school leadership, and resource allocation may influence Science Education outcomes differently across regions. A larger and more diverse sample would therefore be needed to confirm the broader applicability of these findings.

Nevertheless, despite these constraints, the study succeeded in highlighting key trends and contextual factors influencing Science Education quality in both public and private schools. The insights gained contribute meaningfully to understanding how disparities in resources, pedagogy, and sociocultural environments shape teacher perceptions and educational experiences within South African schools.

Although this study provides meaningful insights into the perceived disparities in the quality of Science Education between public and private schools, its limited sample size and reliance on teacher perceptions constrain the generalisability of the findings. Future research should build upon these theoretical foundations by employing broader and more representative samples across diverse geographical contexts, complemented by classroom observations and learner performance data to substantiate self-reported perspectives. The adoption of a mixed-methods design would further enhance the explanatory strength of the theoretical framework, enabling a more comprehensive analysis of how sociocultural, equity, and technology integration dynamics interact in shaping Science Education outcomes. Such investigations would not only test the robustness of the current study’s theoretical propositions but also contribute to refining these models for greater relevance within the South African educational context.

Recommendations

Strengthen resource equity through targeted funding by allocating specific funds for Science Education in under-resourced public schools. Prioritise laboratory refurbishments, modern apparatus procurement, and maintenance plans. Collaborate with local industries, universities, and Non-Governmental Organisations (NGOs) to enhance resources through sharing agreements or school-lab adoption programmes.

Introduce shared resource hubs in districts with multiple public schools, such as regional facilities equipped with experiment kits, data loggers, and safety materials. These hubs, managed by district science coordinators, can serve schools rotationally, ensuring consistent access to practical learning.

Reform the CAPS curriculum to emphasize inquiry-based learning, integrating structured opportunities for practical investigations and project-based learning. Assessment rubrics should value process skills like hypothesis formulation, data interpretation, and experimentation over rote memorization. Appoint laboratory technicians in public schools or shared resource hubs to support these efforts.

Establish continuous professional development (CPD) programs for science educators, focusing on effective use of limited resources, digital pedagogy, and inquiry-based teaching strategies. Training should be practice-oriented, allowing teachers to demonstrate competencies with mentoring support.

Promote cross-sector collaboration between public and private schools through co-curricular science projects, Olympiads, and shared professional development. Private schools can host science expos or mentorship programs for public school learners, fostering inclusivity and scientific curiosity.

Leverage technology to bridge resource gaps by adopting digital science simulations and virtual labs in public schools. Collaborate with EdTech developers to ensure offline accessibility, enabling equitable participation in low-connectivity areas.

Foster a strong science culture through extracurricular activities by institutionalizing participation in science Olympiads, expos, and innovation fairs. Integrate these into annual school improvement plans, supported by district offices through transport subsidies or mentorship from university students.

Enhance monitoring and evaluation of science education quality by developing indicators that assess practical work frequency, technology integration, learner engagement, and teacher competence. Use this data to guide targeted interventions.

Encourage parental and community involvement in science learning through school governing bodies (SGBs). Host science open days and local career talks by STEM professionals to reinforce the socio-cultural dimensions of science education.

Establish public–private–university partnerships to support teachers and research. Universities can adopt local clusters of public schools, providing mentorship, pre-service teacher placements, and collaborative research to align academic knowledge with classroom realities.

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ADDENDUMS

ADDENDUM A

Questionnaire:

Section A: Ethical consent (9 questions)

1.The research study was explained to me. I understand what this study is about.

2. I understand that I can volunteer to take part in the study.

3. I agree to be interviewed in the study.

4. I agree that the interview will be audio recorded. Answer no if you are not participating in an interview.

5. I agree to complete a questionnaire.

6. I agree that direct quotations from my interview and or questionnaire may be used by the researcher in the research report.

7. I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in the research report).

8. I agree that other researchers' participants in the study may use the information I provide in my interview/questionnaire (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on.

9.To provide consent, please provide an electronic signature with your full name and e-signature in the space below.

Section B: Teacher Biographical Information (8 questions)

10. What is the name of the school you are currently teaching at?

11. Is this a public or private school?

12. Is the school making use of the IEB or CAPS curriculum?

13. How many years have you been teaching? This refers to the total number of years teaching any subject, and not necessarily the number of years teaching Life/Physical/Natural Sciences.

14. Which grade(s) are you currently teaching?

15. Which subject(s) are you currently teaching?

16. Are you currently a Head of Department (HOD) of the subject(s) you are teaching?

17. What is your highest education level? Choose the option below which best describes your highest education level.

Section C: Use of practical investigations

18. Does your school have useable laboratories available for use in the subjects of Physical/Life/Natural Sciences?

19. How many useable laboratories do you have at your school?

20. By using a rating scale of 1-10, rate your lab with regards to lab equipment and useability for practical work.

A value of 1 relates to "poor"
A value of 5 relates to "adequate"
A value of 10 relates to "excellent"

21. By using a rating scale of 1-10, rate the level at which your Physical and/or Life Sciences Department(s) integrates practical investigations/experiments or practical activities into the teaching of the syllabus.

A value of 1 relates to "no integration"
A value of 5 relates to "to some extent integrated"
A value of 10 relates to "very highly integrated"

22. By using a rating scale of 1-10, rate the amount of time available in your timetable and/or content planning for practical laboratory work.
A value of 1 relates to "none"
A value of 5 relates to "some time available"
A value of 10 relates to "more than sufficient time available"

23. Do you currently have laboratory assistant(s) employed at your school?

Section D: Availability and use of technology in the classroom

24. Of which of the following types of technology do you make use of in the teaching of your subject(s)?

A projector
PowerPoint presentations
Digital notes/textbooks
Gamification (e.g. quizzes such as Kahoot, Quizlet or Padlet)
Other multimedia e.g. videos
Use of learner tablets/laptops in the classroom
Use of online teaching classrooms (e.g. Google Classroom or Microsoft Teams)
Smartboards
Teaching/learning apps

25. By using a rating scale of 1-10, rate the overall level at which the Physical and/or Life Sciences Department(s) at your school uses technology in the teaching and learning of the curriculum. This does not refer to planned teaching, but rather the actual teaching and learning taking place.

A rating of 1 relates to "no use of technology"
A rating of 5 relates to "moderate use of technology"
A rating of 10 relates to "full use of various types of technologies"

26. By using a rating scale of 1-10, rate the level at which teachers are trained by your school (or sent for training externally) to better utilize technology in the classroom. e.g. Microsoft Innovative Educator Expert (MIEE)

27.Did you receive a laptop from the school to use for work?

Section E: Class sizes and marks

28. What is the average number of learners in your classes? This is an estimated value based on the average learners in all the classes you teach. Choose a range in the options below.

29. Please refer to your marksheets (if available) for the answering of this question. What was the average term mark for your classes in 2024 so far? You can use the average mark for all the classes you teach. This question only refers to your Physical, Life and Natural Sciences classes. If marksheets are not available, please make an estimation. Choose one of the percentage ranges below.

Section F: Curriculum and perceptions thereof

30. Answer this question if you make use of the IEB curriculum. Ignore the question if you don't. What is your overall attitude towards teaching the IEB curriculum in your subject (Life/Physical/Natural Science)? Make use of a rating scale of 1 - 10.

A rating of 1 relates to "negative"
A rating of 5 relates to "neutral"
A rating of 10 relates to "positive"

31. Answer this question if you make use of the IEB curriculum. Ignore the question if you don't. What is your perception of the effectiveness of the IEB curriculum in your subject in preparing learners for real world Science? Make use of a rating scale of 1 - 10.

A rating of 1 relates to "completely ineffective"
A rating of 5 relates to "moderate"
A rating of 10 relates to "highly effective"

32. Answer this question if you make use of the CAPS curriculum. Ignore the question if you don't. What is your overall attitude towards teaching the CAPS curriculum in your subject (Life/Physical/Natural Science)? Make use of a rating scale of 1 - 10.

A rating of 1 relates to "negative"
A rating of 5 relates to "neutral"
A rating of 10 relates to "positive"

33. Answer this question if you make use of the CAPS curriculum. Ignore the question if you don't. What is your perception of the effectiveness of the CAPS curriculum in your subject in preparing learners for real world Science? Make use of a rating scale of 1 - 10.

A rating of 1 relates to "completely ineffective"
A rating of 5 relates to "moderate"
A rating of 10 relates to "highly effective"

Section G: Culture of Science Education

34. By making use of a rating scale (1-10), what is your perception of the overall level of discipline at your school? This includes the implementation of the school's code of conduct, and the attitude of the learners towards all teaching and learning.

A rating of 1 relates to "non-existent"
A rating of 5 relates to "somewhat present"
A rating of 10 relates to "discipline very effective"

35. By making use of a rating scale (1-10), rate the culture of Science Education at your school. This relates to the eagerness of learners to choose Life Sciences and/or Physical Sciences as subjects for FET phase, and the overall attitude towards assessments and practical tasks or experiments, etc.

A rating of 1 relates to "negative"
A rating of 5 relates to "neutral"
A rating of 10 relates to "positive"

36. Does your school take part in the national Physical Sciences Olympiad?

37. Does your school take part in the national Life Sciences Olympiad?

38. By making use of a rating scale (1-10), how would you rate your school's participation in Science expo's (internal or external), excursions to laboratories or expos at universities, or any other external events where scientific interest is gained.
A rating of 1 relates to "no participation"
A rating of 5 relates to "moderate participation"
A rating of 10 relates to "exemplary participation"

ADDENDUM B

Interview Questions:

1. Elaborate on the use of laboratories at your school for practical investigations. Your answer might include reference to laboratory resources, and the level at which your school makes use of these resources.

2. Explain your integration of practical investigations in teaching of Life and/or Physical Sciences at your school.

3. Discuss the use of technology in the teaching of Science at your school. Mention where your school might lack and where your school might excel in this field.

4. What are your perceptions of the IEB/CAPS curriculum for Physical or Life Sciences? This includes the value of this curriculum in preparing learners for real life (career) Science. This might include inclusion of more than just theoretical content, but also of practical skills.

5. Elaborate on the culture of Science teaching and learning at your school. Your answer might refer to teacher experience, attitude of learners towards scientific material and scientific practices.

6. In what ways do you engage learners in lessons?

7. If available, provide average class marks for your classes in the last year or the last term. How does this compare to your school's overall historical Science marks.

8. Provide an overall rating of the level at which your school is performing in providing effective teaching and learning in the field of Science (physical and/or life Sciences).

9. What, according to you, are the aspects a researcher should look at when assessing the quality of Science Education?

10. When comparing the quality of Science Education at private versus public schools in JHB North, what do you think the results will be?

ADDENDUM C

INTERVIEW RESPONSES

Question 1:

Teacher 2:

"Oh, we do use it often as much as possible. And we have plenty of resources. Whatever we don't have, we make a plan.

Yeah, because like last year, I did a grade 12 portfolio on electricity, and I didn't have enough real steps, so we ordered it. We got it in time. It's not a problem.

Whatever I need. I didn't have enough circuit boards. We ordered it.

It didn't come in time. So we borrowed from *anonymous*. So we have a sister school, which is able to help us.

And so a driver fetched things. We used it and we dropped it back. Oh, lovely.

And everything went smoothly. So we are very fortunate that we have a sister school as well. And we can be in contact with."

Teacher 1:

"Obviously, I'm using the life science one. It's a very well-equipped lab. If there's anything that needs, I ask for it and I work through the lab assistant.

We try and use it as much as possible because the kids enjoy the practical. If the labs are sometimes too small to do metric or other practicals, we actually use the wall, but then the lab assistant will set everything up in our well-equipped lab. Fantastic."

Teacher 3:

"When I arrived here, there was probably, sort of, one a year in the life sciences, and then I know physical sciences was very much demonstration. We've been very conscious in terms of upping our practical. So, with the IEB curriculum, having that practical exam, we actually do three in a year during the term, and then both exams.

So, they do five, perhaps, in a year. From grade 10 to 12. 11 and 12.

And then, for our grade 8s, we are now into our second year of having practical exams in July and November. In grade 8? In grade 8 and grade 9, and all individually. Wow.

We also, because we get a cycle test, which is an hour and 10 minutes, and we also sometimes will use a 40-minute period for the theory and the hour lesson for prac. So, it really is something we are driving in the life sciences. And also, I don't know if you consider simulations and that type of thing.

I do that quite often in class. I know physical sciences, speaking on their behalf, they've also now started practicals within, I think they do twice a term, but only with grade 12s. So, they're slowly starting to build their scientific.

Up to the, okay. Yeah, but they don't have the same portfolio requirement, because their prac is quite minimized in comparison to the life sciences. That's true."

Researcher: "That's very impressive, actually. That's amazing. And, okay."

QUESTION 2

Teacher 3:

"Yeah, we've got enough microscopes for 30 kids.

Yeah, yeah. So, we set that up. A chemical supply, we've got lots of glassware, so I don't feel limited.

Yeah, you've got anything you need. Yeah, we've got, at the moment, we've got two lab assistants, because we also ran a Cambridge program. So, that upscaled a lot of our prac work.

Yeah, so, as I say, with regards to our equipment, our budget is very sufficient for the supplies. For all of that, yeah. So, I can't really complain.

Yeah, you can do anything. Pretty much, yeah. That's awesome, thanks.

Okay, the second question, explain your integration of, okay, but that's similar to what we already mentioned, integration of practical investigations in your teaching. So, does it happen at specific times in lessons, or do you schedule it in the timetable, or do you? Yeah, so, as I say, with regards to the full exam, those are afternoons and then the exams. I did a population example with jelly babies, and that's part of a lesson, etc.

As I say, those typical little demonstration kind of things, we try and build in at least one per section of work."

Researcher: “Okay, that's fantastic, fantastic. Okay, cool.”

Teacher 1:

“Okay, so where possible we try to include the practicals. We very much focus in grade 10, 11, and 12 on exercising the scientific method.

Grade 10 and 11, for wherever we can, we do organ practicals like the eye, the kidney, and we also do the heart, grade 10. We also try and do, although they don't do so many organ practicals, I always feel you can try and incorporate practicals whenever possible. I'm actually quite happy in the way we use our labs for practical.”

Teacher 2:

“So it's very important for the students to do it practically, especially in physical science, because then they are able to see what they are learning is actually real. Yeah. Yeah.

So like, for example, we just done organic chemistry and we've done the saturation test of alkanes and alkenes so they can see from the back, physically, that actually with alkanes, nothing happens. But with alkenes, it changes, like the rays of color changes. So the physical thing of actually seeing it they will never forget that.

Yeah. Yeah. But they could forget the theory, but they won't forget the prep.

Yeah. And the smell and the color and, you know, the excitement around the prep as well. Yeah.

So it brings a subject to life. That's true. Yeah.

And so even for physics now, like all physics prep, they are able to see electricity or forces or momentum. Whatever prep we do, they are able to see the content and relate to it in real life. Researcher: “Oh, wonderful.”

QUESTION 3

Teacher 2:

“So things like just using a PowerPoint presentation, for example, using a projector, using maybe online resources such as Teams or gamification, like maybe good or you know, anything like that. So I think there's always room for improvement on that, you know. But currently what we're doing or what I'm doing is I use Microsoft OneNote.

So I upload all my notes there and then it's good because I stop at different portions in different classes so I'm able to see where I stop. The work I've done using Teams, we record the lessons, especially for the students who are not coming to school and that's so often at Big Tree Park. What else? So assessments and all that are posted on Teams, files are posted on Teams.

Life science, we're doing PowerPoints. And the PowerPoints are very interactive because it's got lovely videos and just something that they can really relate to. Yeah, but we use simulations in physics, like your FET simulations and the simulation bucket is called as well.

So that's quite nice to see the animations and, you know, especially for electricity or electrostatics, to see charges moving, that kind of thing. Yeah. Awesome.”

Teacher 1:

“Okay, so technology, we are a MIE school.

I've got a smart board in my class and a data projector. I try and incorporate as much as possible using YouTube videos in my lessons. Obviously, being a more senior teacher, I can probably learn more using technology.

All our lessons are PowerPoint based. I would like to maybe use some quizzes that my colleague uses, but there you can train me how to do that."

Teacher 3:

"With regards to use of presentations, with regards maybe to use of, you know, in class, maybe you saw on the questionnaire, things like your, maybe gamification, like iPads, or goods, you know, quizzes and those types of things.

So, we all have projectors, and yeah, we use that. There are some classes where we have write on laptops, that as you're walking around, you can project with that. I personally don't like the gamification online.

I do the gamification in the traditional way. So, to get them to do your terminology, I'll do a Pictionary, and or 30 seconds, I don't use the Puhuts too much. I do use, when I do project, there's a lot of simulations, there's a lot of interactive activities, that they will bring a device into class, or given homework with that.

I hear you, okay. Thank you for that. That's interesting, the Pictionary, I haven't thought about that.

I'm going to try that. It's a very good learning tool for them to translate. Yeah, and they join something, and that's interesting, thanks."

QUESTION 4

Teacher 3:

"So, IEB. Yeah, so with the IEB, I love the fact that a controlled test is exactly the same as a practical, obviously in the portfolio, not in the big exam, and I think that is one of the strengths of the IAB curriculum. I think that the life sciences IEB curriculum is really a foundation.

So, I know some people say, well, I want to be a doctor, you know, why am I not just covering anatomy and physiology? And I like to emphasize that we're all going to have experiences with our aim three, that societal one. And yeah, I love that. I love the forms of assessments, because I definitely think a high school kid that has life sciences will fare much, much better in university, because our skill set is so broad.

It's broad. It's very broad, but it's difficult to maximize, because we have such a broad one. So, a lot of the kids say, well, I'd rather get an easy 90 than an 80 in life sciences with that.

Good point as well, because I know the life sciences, because of that, it is more difficult. I say, tracking, I've got a couple of kids in the top 1%. And so far in my career, every single kid, it's their lowest mark, but they're in the top 1% in life sciences.

So, I think we do maybe do a disadvantage, but going forward, their skill set, no matter which faculty they go and try. Absolutely, yeah. And it's going to be interesting when I get to CAPS as well, to see the difference."

Teacher 1:

"I really enjoy the IEB.

I've been many years ago. We did do CAPS. I think what's nice about the IEB is they've got that paper three that is a practical paper where they're actually going to test the scientific skills.

I also think what is quite nice about the IEB is it's very much open. Grade 10 and 11, it's very open. You can do what you want to do.

You're not prescribed. Although grade 12 has got the sacks. But I think the big benefit currently in life science for the IAB is that paper three that really prepares the kids that goes into sciences, that they already know how to conduct an experiment, how to design experiments, what is all the variables.

Maybe I'm talking out of correction that CAPS schools that don't do it won't have that advantage. You feel the practical understanding of variables and those types of things. That's a big bonus in the IEB.

Definitely a big bonus in the IEB, the paper three."

Teacher 2:

"OK, yeah, no, it is.

It definitely is. I do feel like there are certain sections that, for example, gases was taken out of the Gartner School. The CAPS has it, but the IEB doesn't.

And that's that basis of chemistry. They need to understand that. It was part of our syllabus out.

We have the apparatus to not even using it. But otherwise, the IEB prepares the student for varsity for sure, in that the rigour is being tested, the standard and the level at which it's been examined at. So they have skills of problem solving definitely in science, which is very, very good.

And the topics, yeah, definitely will help them in engineering and other science-related fields, for sure. Oh, fantastic, fantastic. Small things like organic chemistry, where they don't do certain functional groups, where the Gartner School does, they do all the functional groups.

But we don't do... We are three short. And I think that's a disadvantage for those who are going to do chemistry, but it's not something major, they can learn it at a varsity level. So there's a few content differences.

Content is different. So our content is a little bit lighter, I would say, than CAPS. However, tested more rigorously and at a higher level.

And more practical application possibly, or not really? Both, both practical and non-practical. I just think that us, we just test it more at a higher level. Oh, I see, I see."

QUESTION 5

Teacher 2:

"So science is taken very seriously at this school. Yeah.

Students will actually miss other subjects, especially for science. So if we tell our students, you must be here, they will be here. They take it very, very seriously.

Actually, more than lab science, which is a bit obscene. They absolutely respect and adore the teachers, both the teachers and physical science. And I think the same with biology, because they understand that teachers have a lot of experience and the school has a very high, what's the word? They view science at a very high level.

And they respect it. So the culture is a Mr. Prestige type of thing. It is.

So it's taken like that at the school, that if you take science, you are one of those very intelligent students. So it is an unspoken thing. Yeah, it really is, you're right."

Teacher 1:

"I think the advantage we've got at our school is that all our science and life science teachers are very well qualified. We get a lot of kids taking it.

Obviously in our school, a lot of kids take life science and physical science because they want to go into the medical fields. What else do you want me to discuss? That says it very well. The kids have got a very positive attitude especially from grade 10 going up.

They have now decided to take the subject and we actually get very good results. I think especially because you said that many kids take the subject. That means a lot.

They take the subjects because they want to go into natural sciences and actually into medicine. Do you think that's the only reason the fact that for career benefit? Do you think it's because they enjoy the subject at school itself? What do you think? I think it's a bit of both. A lot of them initially take it because they want to go into the medical fields and then they actually start enjoying the subject.

Fantastic, that makes sense. In what ways do you engage learners in lessons? What is your way in your science or life science lessons that you use? Obviously in the practical, you actually leave it to the kids to do the practical on their own. You're just really there to assist them.

In the lessons also, try and be very much more interactive. Not just to dictate, but when you actually see someone has lost a little bit of focus, you ask them, how do you feel? Do you agree with this? That makes sense. I agree with that.

That's wonderful. Especially when the learners can do it themselves. It's not necessarily a teacher-centric approach, but more the learners are doing a lot of it themselves and learning for themselves.

Yeah, and I think also we give them already books, so we don't really work out of textbooks. And in the books are questions at the end where you actually let the kids try the questions and then you show them what the correct answer says. Absolutely, thanks for that."

Teacher 3:

"So, the overall culture and attitude. So, very much, and I think it's the parental generation, physical sciences is the go to. And a lot of people still think life sciences is the traditional biology, learn the 50 facts, etc.

So, very much trying to work that there are other skill sets with that. So, the perception is that life sciences, I don't know how to phrase it, but it's the second cousin to the physical sciences instead of an equal. And I think, maybe I'm talking because I have a chip on my shoulder.

But definitely within the kids, it's not rated very highly as a science. Which is actually a strange perception. It's a very strange perception.

Because the type of scientific skills. The scientific method is common across. And the microscopes work and all that.

But as I say, the kids definitely say, oh, the physical sciences, the real science and life sciences is kind of dabbling in science. Which is weird, because I would also prefer that."

QUESTION 6

Teacher 3:

"I very much have a sort of question answer. I'm very, very focused on teaching them how to study, particularly the content heavy. So, I've structured that they have a textbook.

But particularly with my PowerPoints, I'm quite conscientious in terms of introducing thinking maps, those translational tasks. So, like I said, with the Pictionary, okay, here's a term, draw it so that you understand. So, with that gamification kind of idea.

And then I really do like the idea we did something with regards to bone density. And we got ghost pops and we built it into different one and they actually like we're hammering to see if the density and whatever. So, stuff like that with hands on exploration.

Yeah. And they discover it for themselves. And they discover it for themselves.

They hate me because they just want the answers. But I see far more value in them struggling to find out and figure it out on their own.

Researcher: "Thank you so much."

Teacher 1:

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Teacher 2:

“By asking probing questions, relating it to their normal life, like, you know, as much as possible, make it realistic as possible. And then obviously, like with science, there's a lot of exercises that they have to complete.

So we do the discussion, but the exercises they are completing themselves, walking around, marking their work, checking where they are wrong, you know, writing up solutions on the board.”

QUESTION 7

Teacher 2:

“Okay, so this year we had a high head and a very... So our top top are doing very well, and our weaker ones are doing better than expected.

Oh, so it's a good year. So this year's average for our prelims was in the 70s, which is quite good. So I think that's what's bringing up the average, that the top students are very good.

So like last year I would have like one or two that's in the 90s, now I've got a few. So more and more, so it's definitely going up. It's definitely going up for this year.

Wow, that's incredible. I don't know when the grade A to B comes to science, but it might come. In a few years time, yeah.

Well, two years actually, but... Yes, that's the thing, that's the scary part, that the level might drop in the school. That is possible. Possible, but we don't know how dynamics could change.”

Teacher 1:

“Actually, interesting, I have got them because I was busy doing the comments. My metrics, I'm talking out of correction, I think both of the classes have got an average of about 75.

It's a very high average. They are. The grade 11s also, their average is quite high.

In the 70s, where the grade 10s are, I think it's in the 60s. Yeah, fantastic. That's very high.

And then just part of this question also asks, how does this compare to your school's overall historical science marks? So, back in the day, maybe a few years ago. Our marks have always been around about there and also we, in all instances, always at the end of metric, we're like 5 to 6, sometimes 7% above IB average. Oh, wow.

So, it's always been like that for your school? It's always been, yeah. Metric has always been from 72 going up, sometimes up to 77. Wow.

And in some years, we really get strong groups. The average for metrics has never been lower than 70. Wow.

Yeah, the IEB average is in the high 60s. Wow. That's fantastic.”

Teacher 3:

Researcher: “So, this you did, I think, already on the questionnaire. How does this compare to your school's overall historical science marks? So, maybe in this one, you can mention with what you've experienced this year, maybe you can remember your prelim marks even, and then mention how it's been in previous years, historically.”

Teacher 1: “So, with regards to our grade eights and nine currently, because we've split recently from the natural sciences.

And agreement was that I would cover the or the life sciences would cover the scientific method. So, we are finding that the life sciences marks are actually a little bit lower than the physical sciences at the moment. Yeah.

Grade 10, 11 and 12. As I say, for a lot of the top kids, it is the lowest mark. But our IEB average has always been or our school average has always been above the IEB average.

And we tend to find grade 10 is fine, they dip incredibly in grade 11, and then pick themselves up. I don't know if that answers the question. It's exactly the same.

It's very strange. I think it's just the mentality. The mentality that, yeah.

And I think the content maybe as well throws them with that. But yeah, so that answers the question.

Researcher: “Thank you so much. Just to comment on that, it's exactly what we also have, where, like you mentioned, the top learners, they're the top learners with the other marks, but the life sciences are the lowest. Still above a 90, but it's the lowest. As I say, I mean, our master had it in the 1%, 91 was her mark, which is great. And then for maths, she's got 99%, you know. So, we regard it as a hard subject. Yeah, absolutely.”

QUESTION 8

Teacher 3:

“So, definitely, again, the pressure of the performance from the physical sciences.

Yeah. What we find is that a lot of kids will take it in grade 10, but they drop out quite quickly. With the life sciences, we get fewer kids taking it.

Yeah. But we don't have them dropping out. So, we managed to support them and keep them.

So, there is a different impression. But yeah, as I say, all our subjects are generally treated as having value and for different skill sets of learners. Absolutely.

So, I think, yeah, we don't stand above or below. Absolutely. It's a general question.”

Teacher 2:

“What's the goal? Are we effective? Yeah, so I think like for me now, this is my 8th or 9th school over my 25 years of teaching, and I feel like the level is very high. And so it's a very high level, and students who actually take physical science are very serious about it. They have a lot of attitude.

I only have like maybe two or three who are battling. The rest are like in their 60s and above. Yeah, so that is not a common thing that you find in all R&D schools.

A lot of schools, the children take science and they're really battling even at the basic level. So yeah, we're at a very high level. Yeah.

Yeah, definitely.”

Teacher 1:

“Yeah, I think we are doing exceptionally well. We're always above IB standards in both our papers, both the 1, 2, and 3. I've never had 2. I've never been called in to say, what have you done wrong, that your average is lower.

So, the kids, yeah. I think because the kids enjoy it so well, because we prepare them quite well. Fantastic.

We've got that average always higher.”

QUESTION 9

Teacher 1:

“I think in science is, obviously we more focus on school level, is to see how well our kids do on a tertiary level. Okay.

So, we've actually had quite a few of our kids that has done quite well, have been top of some science faculties. We produce quite a lot of doctors. Yeah.

I think the quality is also how we incorporate the theory and the practical. What else you think I can include? I think that's great, yeah.”

Researcher: “One thing that was interesting and maybe you can comment on this, the fact that a lot of schools or a lot of literature refers to quality of teaching, pointing to career benefits of learners.

So, for example, career earnings. For example, maybe some private schools have a tendency maybe for learners to earn more once they get to their career values. Maybe it's based on how well they do at university.

But do you think earnings can be related to quality of education?”

Earnings, like money-wise? Money-wise. Interesting concept, but I saw that a lot in literature. Yeah.

I think that's more, yeah, probably if you look at the sciences, that they actually take the sciences to get into very high-paying careers. Yeah. And they do well.

If they do it well at school, they're more likely to get into better universities and institutions. And to get that selection because obviously going into medicine you need the selection. So work for those high marks.

I mean, I've even had kids coming back to me to say that the techniques and the ways we've actually taught them has helped them so much in their studies further. And the interesting is, if I can tell a really interesting story, a girl I saw that was probably with us a couple of years ago came to me and I think she's now a physiotherapist. And she actually said to me, Can you believe it? The subject that I didn't do that well or didn't like that much, I actually went and I made it my career.

And I think things like that makes a teacher proud. Yeah. And when the kids come back to you, you actually see that some of your kids are actually well-qualified doctors, specialists.

There's someone doing high research in genetics. And they actually come back and say that they've learned so much from us. I would actually more say, using the IB system.

Oh, absolutely. The IEB system really prepares them for research. For research.

Teacher 2:

“Well, there's the tools that, I mean, marks speak for itself.

I think that is non-subjective. It's just there, you know, we're achieving those good marks. The attitude of students.

I mean, like I would say that the client is a child and how they view science, I think that could be a good one. Like, you know, an interview of students and how they view science. And yeah, the environment of the science classes, labs, that kind of thing."

Teacher 3:

"I'm definitely looking at where the trends are going. The traditional teaching of, you know, here's an experiment. These are the results you will get.

Instead of the inquiry, ask the question, because that's very much a part of our process. Let them discover it. Let them take a tangent.

Let them fail at it and analyze why. But we would need more time. But I do think that is the true science of it, instead of just being able to learn.

This is the theoretical answer. So, we should assess how our science at the school does that. Yeah.

And I would say inquiry based rather than, I don't know what the opposite is, the traditional sage on the stage, just giving the info."

"Oh, thank you. Thank you."

QUESTION 10

Teacher 3:

"I think a lot of the caps would be a very similar finding with regards to quality. I just think, as I say, we have a crack in the IAB, the kids don't. So, content wise, I think possibly similar.

But I do think that the IAB gives them the crack advantage for after school studies. Go after the scientific way of thinking. Absolutely."

Teacher 1:

"My honest opinion is, I don't know, I'm not stepping on toes. It's comparing apples with pears. Because your CAPS uses a different way.

They don't do that much application and practical, but then their papers are set to their curriculum and the way they are teaching. Where, let's say for instance, the kids have to write one standardized exam. Then I would say, maybe our kids would have an advantage.

But it all depends, because if you take the IB paper, in some other subjects the papers are very similar. But especially in life science, your CAPS papers are completely different than the IB papers. And I always say to my kids, when they want to say, should they work at CAPS paper, I say, you might even do worse in a CAPS paper, because you haven't been taught from grade 10, 11 and 12 the IB ways, the application way, the practical way.

Where in the CAPS schools, they are taught the way they are going to set the papers. But then again, like you said, later on, after school, you can see the difference. After school, I would say, especially for the life sciences, the IEB kids have got an advantage.

But yeah, probably by their second, third year, but it takes longer. I hear what you are saying. Lovely stuff.

Researcher: "So, that's the only questions I've got. Do you have anything else you wanted to maybe ask or mention with regards to my research?"

"Just good luck to you. Hard work waiting for you.

And I would love to one day just hear what your results and your findings are."

Teacher 2:

“In the IEB. In the IEB. At the IEB level, yeah, it should be higher.

I also think that even for going into varsity, the IEB students are able to cope with the heaviness of study. They are able to cope with staying in the course and completing a course because they have been at this rigor from day one. I also just feel like, you know, in terms of science papers, there's a pattern in the government.

You follow that pattern, you can see over the years, the pattern of question one, question two. And if you're able to do those past papers, it gives you definitely a better advantage. But with the IAB, there's no pattern.

There's no pattern. And it's just because of so many different examiners over the years. Which prepares them better for... Which prepares them better for unseen problems, different subjects.”

Researcher: “Thank you so much. That was so valuable. And that was our ten questions.”