Resource inadequacy as a barrier to effective curriculum implementation by life sciences teachers in South Africa

Dayce Makakole Chuene [iD] **and Florah Moleko Teane** [iD]
Department of Adult Community and Continuing Education, Faculty of Education, University of South Africa, Muckleneuk, South Africa
chuendm@unisa.ac.za

South African teachers experience challenges with the implementation of the national school curriculum – the *Curriculum and Assessment Policy Statement* (CAPS). In this regard, teachers may not feel empowered to effectively deal with the demands of the current educational policy. Concerns have been expressed about learners' poor performance in schools and the school infrastructure coupled with educational capacity emerged to be a possible contributing factor. In the study reported on here we focused on the challenges experienced by South African life sciences teachers in the implementation of CAPS caused by limited resources. The context of the study was secondary schools in 1 sub-district in the Northwest province that offered life sciences (LS) in Grades 10 to 12. A qualitative research approach was followed and 10 teachers from rural public schools who taught LS in Grades 10 to 12 during the period of this study were purposefully selected. For data generation, we used audio recordings from individual and focus-group interviews. The findings indicate that teachers' needs in terms of resources to effectively implement CAPS are often not catered for. It is recommended that adequate teaching and learning resources for effective implementation of CAPS should be provided. The Department of Education's prioritisation of teachers' needs will engender effective curriculum implementation.

Keywords: curriculum; educational assets; educational needs; learners; learner performance; life sciences; National Curriculum and Assessment Policy Statement; professional development; teachers

Introduction and Conceptual Background

Radical curriculum transformation and the introduction of the CAPS with the change in subject content of some subjects have bred implementation-related challenges in South Africa over recent years (Maharajh, Nkosi & Mkhize, 2016; Nunalall, 2012; Taole, 2015). With this study we aimed to add insight regarding the educational resource-based barriers that hampered the effective implementation of CAPS experienced by life sciences (LS) teachers teaching LS in the Further Education and Training (FET) Band (Grades 10–12).

Within the South African context, LS at Grade 10 to 12 level was one of the subjects that underwent significant changes after 1994 with the inclusion of new topics and the removal of others from the curriculum structure (Johnson, Dempster & Hugo, 2015). Following these changes to the curriculum, the national Department of Basic Education (DBE) (LS subject advisors) facilitated a 3-day workshop to train teachers on the implementation of the revised LS curriculum. Despite this training opportunity, many teachers believed they had not received adequate support in the form of resources and empowerment on new content to meet the demands of the new curriculum. In addition to Mbatha's (2016) study, which confirms that the training received by teachers was limited, our study pinpoints school infrastructure (resources and facilities) coupled with minimal teacher support on the new content knowledge to have had an impact on the implementation of the revised curriculum. Siregar and Aziza (2021) affirm that the availability of school infrastructure creates a conducive teaching and learning environment.

Several studies have been undertaken that focus on teachers' concerns regarding curriculum implementation and the challenges they may experience (Furiwai & Singh-Pillay, 2020; Hall, 2015; Mamabolo, 2021; Sebaeng, 2022). LS teachers often report frustration and feelings of neglect as a result of the challenges, complexities and anxieties they face during the process of adopting and adapting to a new curriculum (Singh-Pillay & Samuel, 2017). Nevenglosky (2018) indicates that such challenges can be mitigated by understanding the beliefs, concerns and perceptions of LS teachers as well as the characteristics that they possess that may be used when implementing the curriculum. Despite the findings mentioned above, limited research has been undertaken that specifically relates to teachers' concerns about limitations in terms of the resources required for effective implementation of the LS curriculum. Against this background, we attempted to address this gap in the existing body of knowledge by exploring teachers' experiences regarding resource-related challenges that may affect the implementation of the CAPS.

The research findings may assist stakeholders in education and/or government officials by strengthening awareness and recognition of the importance of teacher support in the form of resources and knowledge and skills to facilitate a positive impact on the scholastic performance of learners. In this way the findings of our research may inform existing work on the maintenance of teacher confidence by reducing anxiety bred by the challenges associated with curriculum implementation (Margolis, Durbin & Doring, 2017).

In undertaking this research, we were guided by the following research question: How does resource inadequacy hinder the successful implementation of the life sciences curriculum among teachers in South Africa?

To address this question, we aimed to gain insight into (i) the experiences of the teacher-participants by exploring the resource-related barriers that had an effect on the implementation of CAPS, (ii) the resources they regarded as necessary for the effective implementation of the LS curriculum, and (iii) possible intervention strategies that may be employed to mitigate the identified barriers.

Theoretical Framework
The theoretical framework that informed our study was the attribution theory, originally introduced by Heider (1958) and refined and further developed by Weiner (2004). According to Weiner (2004), the attribution theory of achievement motivation explains how individuals think about and analyse the causes of their own behaviour. The theory asserts that people are motivated to understand the causes of events and tend to attach causes to those events, whether positive or negative (Weiner, 1972). Accordingly, the consequences of contributory attribution are related to an individual's responsibility or an external event (Martinko & Mackey, 2019).

Attribution theory is based on the principle that people are constantly searching for reasons to explain why events turned out the way they did (Schmitt, 2015). In this regard, Weiner's (2004) theory describes the basic dimensions that people may use to understand their successes and failures, with these relating to an internal or external locus of control, stability over time, and controllability (Martinko & Mackey, 2019). Based on the initial work of Heider and that of Weiner (2004), the theory proposes that both successes and failures can be understood by individuals, with the steadiness of any cause being regarded as part of the explanation of the consequences caused by the successes and failures. Based on this theory, we assumed that the teachers who participated in this study would be able to ascribe obstacles that may impede the successful implementation of the curriculum to specific issues, most notably resource deficiency, regarding these as possible causes for poor learner performance.

Based on the aim to understand LS teachers' experiences of inadequate resources that may affect their curriculum implementation, the attribution theory was regarderd as suitable to underpin this study. We thus assumed that teachers as curriculum implementers would be able to explain the reasons for their success or failure based on internal or external, as well as controllable or uncontrollable dimensions (Thoron & Bunch, 2017).

Literature Review
Resource-related barriers that impede curriculum implementation
At its core, curriculum implementation entails the process during which teachers impart official course content to learners, in terms of stipulated, required knowledge, attitudes and skills that are put into practice (Oviawe, 2017). Curriculum implementation involves teachers' comprehension of how to deliver instruction, how to conduct assessments within a specific subject area, and how to use the specified resources outlined in the curriculum (Nevenglosky, Cale & Aguilar, 2019). It follows that teachers can be regarded as the main role players in the achievement or failure of curriculum implementation at schools (Alsubaie, 2016), with a successfully implemented curriculum generally leading to better learner performance (Mashekwa, 2019). Curriculum implementation is often coupled with some educational barriers (Kuzmicheva & Afonkina, 2020; Radovan, 2012). Radovan (2012:92) defines educational barriers as restraining conditions that make it more difficult or impossible to engage in the educational programme.

Published literature indicates that school infrastructure (computers, laboratories and classroom space) contributes towards the effective implementation of educational policy (Ion & Hamburda, 2020; Kompri, 2015; Siregar & Aziza, 2021; Turner, Coolican & Bafadal, 2022). In addition, Fernández, Correal, D'Ayala and Medaglia's (2023) study indicates that school infrastructure affects the quality of education and learner performance. To that effect they recommend that national governments should take decisions towards availing such resources.

Curriculum implementation in South Africa faces numerous challenges such as a lack of appropriate and adequate teaching and learning resources, technical resources, a shortage of qualified teachers in certain subjects such as LS, and a lack of or poor school infrastructure, particularly in rural areas (Bernstein, Drayton, McKenney & Schunn, 2016). Bernstein et al. (2016) further suggest that developers of the new curriculum should pay attention to the wide range of human and material resources that are required for the effective implementation of such curriculum. However, it became evident that certain challenges may be systemic in nature and beyond teachers' control (Mashekwa, 2019). These systemic barriers may relate to inadequate training, limited resources and facilities, or inadequate monitoring and support (Karakuş, 2021; Nevenglosky, 2018; Vashisth, Wadhwa & Chandra, 2021). Furthermore, Maarman and Lamont-Mbawuli (2017) found that policy changes in South Africa affected the content, structure and teaching approach of several subjects, including LS, which was challenging for teachers as they were not effectively trained (Singh-Pillay & Samuel, 2017).

Resources needed for effective curriculum implementation
Subsequent to the changing content structure and teaching approaches for LS in particular, there is a

growing need for human resource development in the form of training to equip teachers with the necessary knowledge and skills to enhance their teaching performance (Nguyen, Pham, Nguyen, Nguyen, An & Do, 2021). Furiwai and Singh-Pillay (2020) reiterate that teachers, especially in rural schools, may lack the requisite knowledge and skills to perform experiments even if they have laboratories, resulting in them having lower self-confidence to teach the subject. This warrants the need to develop the human resource by emphasising the important role of professional development initiatives in improving teachers' pedagogical content knowledge (Hall, 2015).

Despite the importance of this possible avenue to empowerment, several professional development efforts of teachers in South Africa have failed in the past due to these not being informed by an understanding of the knowledge that teachers require (Gumbo, 2020). Mamabolo (2021) discovered that teachers' training were found ineffective due to uninformed facilitators and limited time for training. However, Mamabolo (2021) suggests that teachers, as qualified professionals, can read independently and increase their curriculum delivery efficiency.

Teacher qualification could also affect curriculum implementation (Lin & Magnuson, 2018; Manning, Garvis, Fleming & Wong, 2017). A study by Lin and Magnuson (2018) indicates positive results emanating from allowing teachers with high qualifications to teach learners. Conversely, in a study by Manning et al. (2017) it was found that high teacher qualifications may predict high classroom teaching quality. In the same way, the quality of classroom teaching by teachers with low qualifications will be low compared to teachers with higher qualifications (Manning et al., 2017). In addition, teachers as human resources may lack the required technological literacy that is crucial in today's education (Batumalai & Maat, 2020; Blau, Shamir-Inbal & Avdiel, 2020; Fedynich, 2013; Kastner, 2019). Safingudin (2020) indicates that teachers often lack the knowledge and skills to teach certain content. Based on findings such as these, the importance of teacher empowerment in terms of the necessary knowledge and skills seems evident, especially when teaching the practical part of a subject by doing experiments, for example (Darling-Hammond, Flook, Cook-Harvey, Barron & Osher, 2020). Grounded on the above literature, inadequately qualified and less trained teachers could hamper the effective implementation of the LS curriculum.

Within the South African context, many rural schools lack the necessary resources, facilities and proper infrastructure (Du Plessis & Mestry, 2019). More specifically, these schools may experience challenges in terms of resources such as laboratories, libraries, computer labs, computers, apparatus, chemicals and textbooks, which will inevitably affect curriculum implementation (Mashekwa, 2019). Laboratory facilities are critical components of experiential learning in LS as they augment the theoretical part of the curriculum (Smith & Brown, 2019). Smith and Brown (2019) discovered that a lack of proper laboratory equipment impedes hands-on learning experiences, hindering students' understanding of practical topics. The same applies to school libraries as important resources to provide reference material for both teachers and the learners (Siregar & Aziza, 2021).

Additionally, with rapid technological innovation, teachers are increasingly using technological devices such as smartphones and computers to enhance pedagogical methods and expand learning experiences (Bernacki, Greene & Crompton, 2020). Engbrecht (2018) argues that the incorporation of technology has transformed curriculum delivery in schools.

Above all these physical and human resources, time is also a resource that is needed for effective curriculum implementation.

Methodology

In this section we present the methodological approach followed in the study.

Research Approach and Design

In undertaking this study, we used the interpretivist paradigm (Rehman & Alharthi, 2016) based on the belief that reality involves people's personal experiences of the external world. Within the context of the study, we specifically aimed to gain an understanding of and interpret the experiences of LS teachers in the implementation of the CAPS. We followed a qualitative research approach (Jensen & Laurie, 2016) based on the belief that the views and experiences of the participants could be best known through dialogue. We adopted the phenomenology design (Maree, 2019) to unfold the meaning of the lived experiences of Grade 10 to 12 LS teachers during policy implementation.

Participants and Research Sites

The target population was 30 LS teachers in one sub-district in the Northwest province of South Africa. Purposeful sampling (Jensen & Laurie, 2016) was used to select 10 participants whom we believed would be able to provide information-rich data due to them having experienced challenges in implementing the CAPS. The selection criterium was a focus on participants who were teaching LS in Grades 10 to 12 at the time of data generation. The 10 teachers were all teaching Grade 12 LS at the time. However, in addition to teaching Grade 12, four teachers also taught Grades 10 and 11 and two teachers also taught Grade 11.

The participants taught at 10 different public schools in rural areas, all of which were

under-performing schools in LS during 2020. All participants had completed biology or LS as one of their Grade 12 subjects or as part of their teacher training programmes. Table 1 reflects the parfticipants' profile.

Table 1 Participants in the study

Sample size	Gender	Nationality	Age	Qualifications	Teaching experience
10 Teacher (T) 6, 9 taught Grade 12 only. T1, 4, 5, 10 taught Grades 11, 12. T2, 3, 7, 8 taught Grades 10, 11, 12.	Male = 3 Female = 7	Black South African	45 to 55 = 5 (T3, 4, 5, 7, 9)	Teaching diploma with specialisation in biology/life sciences = 5 (T3, 4, 5, 7, 9)	20 to 30 years = 5 (T3, 4, 5, 7, 9)
			35 to 40 = 2 (T2, 10)	Bachelor of Education degree with specialisation in life sciences = 3 (T2, 6, 8)	10 to 15 years = 2 (T2, 8)
			25 to 30 = 3 (T1, 6, 8)	Bachelor of Arts degree not specialised in life sciences but with biology as Matric subject = 2 (T1, 10)	5 to 10 years = 3 (T1, 6, 10)

Data Generation and Documentation
We conducted one-on-one interviews and two focus groups of 45 minutes each with five participants (male and female) in each focus group. Purposive sampling was used to select the individual participants. The interviews and discussions were conducted face-to-face at schools and district offices and were audio-recorded and transcribed verbatim for the purpose of data analysis.

The individual interviews were guided by a semi-structured interview guide, which provided some direction to the discussions yet allowed room for probing questions to obtain more in-depth information (Hoets, 2012; Jensen & Laurie, 2016). The following questions were put to all interviewees:

- What are your general experiences of implementing the CAPS?
- Which barriers can be associated with the teaching of the subject LS?
- According to you, which resources are required to teach LS?
- Which strategies have supported you in mitigating the challenges associated with the implementation of the CAPS curriculum?
- How have these strategies affected your confidence in implementing the CAPS?

Before starting with the fieldwork, we obtained ethical clearance from the Ethics Committee of the College of Education at the University of South Africa. We also obtained permission to conduct research in schools from the DBE in the specific sub-district and participants completed and signed consent forms. Throughout, we were guided by the ethical principles of informed consent, voluntary participation, privacy, confidentiality and anonymity (Denzin & Lincoln, 2013). Participants' right to information and anonymity was preserved by using pseudonyms to protect the participants' identifying information (Denzin & Lincoln, 2013).

In the study, credibility was enhanced by including participants' verbatim quotes to mitigate potential researcher bias. This approach aimed to accurately represent the perspectives shared by the participants.

Data Analysis
We conducted thematic data analysis guided by the steps proposed by Braun and Clarke (2021). This enabled us to sort the data and categorise what emerged in terms of broad themes and related sub-themes (Nowell, Norris, White & Moules, 2017). According to Maguire and Delahunt (2017), this method of data analysis allows researchers to identify the broad themes in recorded data and then confirm, verify and expand these themes. In addition, the process of identification and verification may be repeated to determine additional themes that relate to the research questions.

Findings
The findings were generated from the individual semi-structured and the focus-group interviews. Themes that capture the resource-related challenges experienced by Grade 10 to 12 LS teachers regarding the implementation of the CAPS were identified. Guided by the research questions, three themes emerged from the data. We present the participants' verbatim responses for each theme. Additional responses are also provided where emphasis is needed. The three themes are: the resource-related barriers that had an effect on the implementation of CAPS; resources needed for the effective implementation of the LS curriculum, and the strategies to mitigate the barriers to effective curriculum implementation.

Theme 1: The Resource-related Barriers that had an Effect on the Implementation of CAPS
When asked about their general experiences in implementing the LS CAPS, the participants shared their frustrations regarding the barriers that impeded effective curriculum implementation. The teachers complained about subject advisors not offering sufficient professional development.

> *We seldom have content-gap workshops to empower us on new topics. I remember very well when CAPS was introduced, we attended a 3-day workshop, and we did not gain anything from such meetings as the subject advisor seemed to lack some knowledge.* (T3, 2, 5, 6, 8 and 9 during the focus-group discussion)

In terms of teacher training, older participants seemed to experience more distinct challenges than younger colleagues when implementing the LS CAPS due to their training not being aligned to modern trends. More specifically, T3, 4, 5, 7, 9 aged between 45 and 55 years and having been teaching between 20 and 30 years, lamented that the CAPS consists of content that they were not familiar with, for example, evolution.

T7 explained: "*There are several new topics in CAPS that I was not taught about at the college, such as evolution. Teaching such topics is a problem because I do not understand them*" (T7, focus-group discussion).

Another barrier was allocating teachers who did not have LS as one of the major subjects during teacher training. Such teachers had serious content knowledge gaps. These participants felt that they were expected to teach topics that they had not been trained in, as is evident in the following contribution by T5:

> *I have a BA* [Bachelor of Arts] *degree, but my major subject is geography, I only did biology in Grade 12 some 25 years ago. I was asked to teach the subject because our school is a small school and teachers are few.*

The participants also mentioned school infrastructure as contributory factor towards ineffective curriculum implementation. To them, LS is a science subject that needs scientific material and consumables to do experiments and some of the schools lacked such resources. T5 said: "*Teaching life sciences experiments need laboratories, apparatus and chemicals and my school do not have such resources. My students do not perform well in questions related to experiments because I do not engage them through practical work.*"

Furthermore, the participants mentioned that schools had inadequate technological devices. T1 explained: "*Nowadays we should use technology to teach the learners, but unfortunately my school does not have enough laptops and overhead projectors. We only have one laptop and one overhead projector which is shared by 21 teachers.*" In one focus group T5, 3, 8 and 9 said that they usually used their own laptops as the schools had limited resources.

Theme 2: Resources Needed for the Effective Implementation of the LS Curriculum

Participants indicated that learners would be able to understand LS better if they were taught through means of technology. According to them, technological skills to operate computers, laptops, smartphones, and projectors are essential in teaching modern-day learners. Some of the teachers, especially those who were approaching 60 years of age, were unable to use WhatsApp, which could have played a critical role during the COVID-19 pandemic. This was supported by T9 in a one-on-one interview: "*I don't know how to operate a computer or a smartphone and therefore I don't have one.*"

However, most of the teachers were familiar with using gadgets. T6 said: "*The local university team empowered us on technological skills and I can now apply technology, for an example, data projector when teaching some of the topics and learners are beginning to like my teaching.*"

Most of the participants indicated the importance of having smart phones in order to use WhatsApp to communicate with learners: "*I have realised that learners like using technology, when I send them work to do via WhatsApp they all do the work. But some teachers do not know how to use Whats App*" (T3).

T10 added: "*We got electronic material from the university team that offered professional development, unlike the hard copies we used to get the electronic material is handy and we use WhatsApp to share with learners and teachers from other districts.*"

In as far as human resources is concerned, participants indicated that they needed subject advisors that were well informed to provide continuous in-service training. This was confirmed by T5:

> *subject advisers need to have more knowledge to support us in the new topics. The 3 days training is not enough – we need continuous professional development to be able to master the life science content knowledge and skills to do experiments.*

In addition to the need for training (implying a need for human resources), the participants identified several resources that they required to be able to implement the curriculum effectively. They referred to the importance of laboratories, apparatus, enough classroom space with a limited number of learners, consumables (e.g. chemicals) and sufficient time as resources that would enable them to implement the curriculum more effectively. The following contributions attest to these views:

- "*My school has a laboratory, but it is empty. There are no apparatus and chemicals*" (T8, focus-group discussion; T1, 2, 3, 4, 5, 6, 7, 9 and 10 mentioned that their schools did not have laboratories).
- "*Sometimes even if we can be given apparatus, we don't know how to perform the experiments. I perform such experiments in overcrowded classrooms and it is dangerous for the learners – there is not sufficient space*" (T6, focus-group discussion).
- "*Performing these experiments need time and that is a resource we lack. We have double period once per week and it is not enough to do practical work*" (T4, one-on-one interview, supported by all the participants in the focus-group discussion).

Theme 3: The Strategies to Mitigate the Barriers to Effective Curriculum Implementation

When participants were asked about the strategies that LS teachers had relied on to mitigate the challenges they faced, the participants referred to a partnership between the DBE and a South African university. T1, 2, 4, 5, 6, 7, 8, 9, 10 (focus-group discussion) reported that this partnership had narrowed some content gaps and resulted in them being empowered to effectively implement the curriculum.

"The university team calls us regularly through TEAMS and sometimes face to face. When we meet, we collaborate and share a lot of things among us that ease our stress" (T4, focus-group discussion). The same sentiment was shared by (T3, 5, 6, 8, 9 in the focus-group discussion) who were 40 years and above. Participant 8 remarked: *"through the training by the university team I was able to develop an email* [electronic mail] *address which I used to exchange LS content material and previous question papers with other teachers."*

It appeared that the school's partnership with a South African university was not sufficient to solve the school's infrastructure problems but provided teacher training on doing experiments. T3 commented: *"I asked my principal to buy some chemicals and apparatus and applied the knowledge and skills gained from the training to perform some experiments."*

In addition, the participants indicated how they shared the electronic life science material with other colleagues from different districts and this enhanced collaboration among teachers. T6 attested to this: *"we have created a WhatsApp group with life sciences teachers where we share information including teaching strategies of some difficult topics."*

Discussion

In this article, we foreground some concerns and resource-related barriers that may prevent effective curriculum implementation by LS teachers. These concerns cover the various sectors of the education system, namely the macro-level (national Education Department), meso-level (provincial Education Department) and micro-level (district-based support system). According to the attribution theory (Weiner, 1972), individuals tend to attribute their successes or failures to internal or external factors, and in this context, the participants attributed their challenges to systemic resource-related barriers.

On the macro-level, participants recognised a lack of human resources, particularly understaffing and insufficient training, as a serious concern that can result in teachers having to teach subjects that they were not qualified for and for which they did not have the relevant training, which affects curriculum delivery and learner performance. This finding supports the work of Manning et al. (2017) who indicates that teachers' qualification levels impact on curriculum delivery. In this study qualification as a barrier may have affected curriculum implementation in two ways. Firstly, 50% of the participants aged 45 to 55, held only a diploma in education and were thus not competent to teach the new topics such as evolution, as these were not part of their syllabi during teacher training (T7). Secondly, participants like T5 held a degree but did not specialise in LS – such participants were equally not competent to teach the subject. The finding is supported by Safingudin (2020) who indicates that teachers lack the requisite knowledge and skills. Qualification as a systemic barrier at the macro level highlights the inefficiency of the department of education in making good staffing choices. The situation is exacerbated by a lack of or insufficient in-service training to prepare teachers for changes brought about by the introduction of new policies. The above possibilities require further investigation before coming to conclusions.

On the meso-level, inadequate support of human resources was identified as a barrier, underlining the significance of subject advisor support for addressing problematic topics through in-service training and not merely through topics selected by the subject advisers. Like in Weiner's (2004) attribution theory, participants blamed the lack of support by subject advisors as one reason for their failures. To some extent, this attribution is supported by Hall (2015) who emphasises the important role of professional development initiatives in improving teachers' pedagogical content knowledge. The findings indicate that even after 3-day workshops by subject advisors the teachers had not gained any knowledge or skills as the subject advisors did not do a proper needs analysis prior to the training. The importance of a needs analysis seems clear when it comes to teacher development for effective curriculum implementation. This recommendation aligns with the work of Nevenglosky (2018) who states that teacher interventions not informed by teachers' needs will fail to prepare teachers for effective curriculum implementation. Participants also alluded to the fact that the subject advisers lacked the expertise in LS content knowledge and skills – their support did not scratch the surface of teachers' challenges (Mamabolo, 2021).

The participants also identified time as a critical resource constraint, affecting both teacher training and implementation – especially for practical activities. Some of the participants indicated that the school timetable did not allow them to do experiments. The reported limitation of time also applies to the training of teachers which was often limited, once-off events. According to the participants, such training cannot equip teachers efficiently. This finding resonates with existing literature (Cancedda, Farmer, Kyamanywa,

Riviello, Rhatigan, Wagner, Ngabo, Anatole, Drobac, Mpunga, Nutt, Cameron, Kakoma, Mukherjee, Cortas, Condo, Ntaganda, Bukhman & Binagwaho, 2014; Darling-Hammond et al., 2020; Parker, Osei-Himah, Asare & Ackah, 2018) that similarly proposes that subject advisers should prioritise teacher development and allow more time for the development of teachers to bridge the content and skills gaps (Karakuş, 2021; Mbatha, 2016; Sifuna & Obonyo, 2019).

At the micro level, all the participants highlighted resource shortages, including inadequately equipped laboratories, apparatus, and chemicals. At this level, poor school infrastructure ranked high on the list of barriers caused by resource inadequacy (Ion & Hamburda, 2020; Kompri, 2015; Siregar & Aziza, 2021; Turner et al., 2022). The challenges of storing available chemicals in cupboards or doing experiments in overcrowded classrooms imply distinct risks that the DBE should take heed of. As proposed by the attribution theory, participants attribute challenges to external circumstances, highlighting the DBE's responsibility. At school level, participants emphasised the need for support from school management teams and school governing bodies as important for teachers, e.g., providing the necessary resources such as laptops or data.

In terms of possible ways of mitigating the challenges they faced, the participants highlighted the value of a partnership between schools and a university with the latter potentially assisting teachers to bridge content gaps, adopt suitable teaching methodologies and acquire technological skills. To the participants, the collaboration between teachers and university staff members as well as among teachers themselves can be of great importance, as is confirmed by Mitchell, Keese, Banerjee, Huston and Kwok (2021) who describe this as a mentor-mentee collaboration, illustrating the attribution theory by attributing success to external collaborative efforts. The participants' acknowledgment of how the partnership handled human resource development and technology skills was consistent with the theory, attributing success to external support. Participants reported that guidance on how the use of technology could enhance collaboration and encourage them to implement it at the school level to improve learner performance (Guirguis & Pankowski, 2017).

Conclusion and Recommendations
The findings of the study indicate that Grade 10 to 12 LS teachers experienced a range of challenges with the implementation of CAPS. The challenges included time constraints for training and executing practical work, inadequate resources, insufficient facilities, unqualified and inexperienced staff members teaching LS, limited professional development and training, insufficient content knowledge, and inadequate support for teachers.

The findings of this research contribute to the knowledge base on curriculum implementation – more specifically the lifes sciences CAPS. The findings may assist higher education institutions in planning training opportunities for teachers. In addition, the DBE may be guided to offer additional training or refresher courses to address content gaps and keep teachers informed about all topics covered in the LS curriculum. Furthermore, it is recommended that continuing support and constant monitoring from the Department of Education, school management teams (SMTs) school governing bodies (SGBs) and parents for LS teachers in the implementation of the LS curriculum is essential as the needs and challenges of the teachers will be identified and addressed. This multidimensional strategy seeks to overcome resource gaps, increase teacher training, and improve overall curriculum delivery to improve learner performance. This is to say that there should be adequate teaching and learning resources and support materials for efficient teaching so that learners do not lack practical application of the theory. Equally important is that the DBE should ensure that schools have well-equipped laboratories with apparatus and chemicals for experiments.

Authors' Contributions
DMC and FMT did the data collection. FMT conducted the one-on-one interviews. DMC wrote the first draft of the article; FMT did the literature review. DMC analysed and interpreted the data while FMT finalised it. DMC and FMT worked separately to address the reviewers' comments and met virtually on TEAMS to tighten any loose ends. Both authors reviewed the final manuscript.

Notes

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