

**SOUTH AFRICAN TEACHERS' CONCERNS AND LEVELS OF USE OF PRACTICAL WORK
IN THE PHYSICAL SCIENCES CURRICULUM AND ASSESSMENT POLICY STATEMENT**

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DECLARATION

I hereby declare that the work submitted here is the result of my own investigations and that all sources I have used or quoted have been acknowledged by means of complete references. I further declare that the work is submitted for the first time at this university towards a Master's in Education and it has never been submitted to any other university in order to obtain a degree. I hereby cede copyright of this product to the University of the Free State.

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E.N.C. Oguoma

Date

DEDICATION

To my loving husband, Ikechukwu Oguoma: for support and being there for our children, and closing the gap.

To our children Kirabo, Chidimma and Mmesomachi: for providing moral support in their own special ways. I know that this achievement has motivated you to study further.

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SUMMARY OF THE STUDY

In many countries across the world, a notable portion of the science curriculum involves learners conducting practical work. The physical sciences Curriculum and Assessment Policy Statement (CAPS) of South Africa (2011) advocates for a scientific inquiry approach where hands-on practical activities are used to develop explanations and predictions of events in the environment (Department of Basic Education, [DBE], 2011). CAPS (*ibid*) further argues that investigative skills in addition to process skills such as classifying, measuring, formulating models, hypothesising, communicating, analysing conclusions and recognising and monitoring variables should be developed in learners. One of the recommended formal assessments for the FET band (grades 10–12) is for learners to have the opportunity to perform one or more practical tasks during the course of each term.

The demand to teach practical and inquiry skills would be a tall order for most teachers under any circumstances. The South African context, as a developing country with limited classroom resources, adds a further complicating dimension in relation to the implementation of practical work in the curriculum. Furthermore, the change in the focus of the curriculum, as embodied in CAPS with its emphasis on problem-based practical activities, represents a new challenge for many teachers in South Africa who may be used to a more content and information loaded curriculum. These teachers may also have limited experience with practical work in their own teacher preparation programmes. Many teachers are therefore likely to have various concerns with the new focus on doing increased amounts of practical work in the physical sciences CAPS curriculum, even as they try their best to implement it as required by the authorities. This study used the concerns-based adoption model (CBAM) to uncover and track teachers' concerns and levels of use of the new practical requirement of the physical sciences CAPS in one district of South Africa, namely the Motheo district in the Free State.

The study used a mixed-methods research approach with questionnaires, semi-structured and focus group interviews as well as lesson observations as data sources to

understand the concerns that physical sciences teachers have regarding CAPS practical work and the level at which this component is implemented. The findings are reported in two articles that address different research questions. The first article, which is quantitative in nature, explores the concerns that physical sciences teachers in the Motheo district of South Africa have regarding practical work.

The findings suggest that teachers' concerns are inclined towards management issues by focusing on overcoming time constraints and the lengthy curriculum. Furthermore, teachers place low importance on the effects of practical work on learners' performance, with limited attempts for improvement. Respondents have management concerns that mainly constituted dealing with demanding day-to-day organisational tasks regarding CAPS practical work. Teachers have a desire to collaborate but this is not significantly evident. This suggests that despite the challenges experienced by teachers with practical work, circumstances are minimally improved.

The second article is qualitative in nature and examines the extent of implementation of CAPS practical work by physical sciences teachers. The findings uncover the level at which physical sciences teachers implement CAPS practical work according to CBAM. Findings show that teachers operate significantly at the mechanical and routine levels, while the refinement level is at a less significant degree. This revealed that while participants employ teacher-centred methods during practical work, learner engagement is limited. Learners only watch what the teachers do and no active participation was observed. Teachers do not seem to implement CAPS practical work as intended by policymakers.

Teachers are faced with a shortage of time and resources. Limited content and pedagogical content knowledge also contribute to nominal implementation of CAPS practical work. Moreover, teachers use traditional teaching strategies when carrying out practical work. This leaves them with little room for innovation with the objective of engaging learners. With the application of triangulation, the results of this investigation show that teachers' concerns affect the implementation of CAPS practical work. It was

important to triangulate the research instruments and data to ensure validity and reliability as well as compare and verify the data.

The study recommends that physical sciences teachers need to collaborate more with one another. The results presented here may facilitate improvements in the professional development of physical sciences teachers concerning experimental work. Recommendations include effective teacher collaboration, introduction of laboratory assistants, appropriate professional development and quality planning. An implication for education managers is the need for active monitoring, evaluation and support of practical work.

Keywords: teachers' concerns, practical work, physical sciences, concerns-based adoption model, curriculum implementation, levels of use

ACRONYMS

ACE	ADVANCED CERTIFICATE IN EDUCATION
CAPS	CURRICULUM AND ASSESSMENT POLICY STATEMENT
CBAM	CONCERNS-BASED ADOPTION MODEL
CTR	COMMITTEE FOR TITLE REGISTRATION
DoE	DEPARTMENT OF EDUCATION
DBE	DEPARTMENT OF BASIC EDUCATION
FET	FURTHER EDUCATION AND TRAINING
FSDoE	FREE STATE DEPARTMENT OF EDUCATION
LoU	LEVELS OF USE
NCS	NATIONAL CURRICULUM STATEMENT
PGCE	POSTGRADUATE CERTIFICATE IN EDUCATION
SoC	STAGES OF CONCERN
SoCQ	STAGES OF CONCERN QUESTIONNAIRE

SECTION 1

1.1 INTRODUCTION

This study examines the concerns and levels of use (LoU) of physical sciences teachers regarding CAPS practical work in the Motheo district of the Free State in South Africa. The purpose was to identify the concerns of 81 teachers regarding the implementation of CAPS practical work by using CBAM. The extent to which this implementation occurs was also investigated. Researchers have shown that the teachers' concerns influence the implementation of reforms in science education (Ryder & Banner, 2013; Elmas *et al.*, 2014). The objective of this study was to ascertain teacher concerns about practical work at the FET level in high schools and identify the level of implementation of this component of CAPS by using CBAM.

A central challenge for schoolteachers worldwide is to implement reforms in curricula. Successful implementation of school curricula in general is influenced by various factors, such as teachers' concerns with supplementary knowledge about the change, content knowledge, how the change will affect learners or the day-to-day management of the innovation (Hall, 2014). Feelings and perceptions that impede individuals from working effectively with the change process are referred to as concerns ¹(Fuller, 1969b). The author adds that teachers are concerned about the influence of the innovation on learners, collaboration issues with other teachers or the manner in which they can alter some areas of the reform to suit specific contexts. Studies show that the science teachers' concerns with implementing practical work successfully in science curricula include the development of scientific knowledge and skills, strengthening the concepts being taught by integrating the practical work with theory, developing technical and cognitive skills associated with experimental work and motivating learners by stimulating interest and enjoyment (Rofe *et al.*, 2015). Researchers have explored the implementation of classroom practices in schools and found that despite being supported with curriculum

¹Fullan (1969) pioneered research on teachers' concerns about curriculum innovation.

materials that encourage inquiry, teachers do not effectively use them as intended (Shim, Moon, Kil & Kim, 2014). Inquiry is scarce due to frustrations and difficult problems encountered in implementing inquiry in practical work.

In South Africa, the physical sciences CAPS (DBE, 2011) advocates for an inquiry approach to apply scientific laws, theories and models for the explanation and prediction of events in the environment. Teachers are thus expected to provide opportunities for learners to obtain investigative skills for designing investigations. According to the DBE (2011), classifying, measuring, formulating models, hypothesising, communicating, analysis of conclusions, recognising and monitoring variables as well as interpreting, comparing, inferring, reflective solving of problems and predicting are some of the observable skills expected of physical sciences learners in the FET band (grades 10 to 12). Additionally, physical sciences teachers are required to promote skills and knowledge in scientific inquiry as well as problem solving and the construction and application of scientific information. One of the recommended informal assessments is for learners to have the opportunity to perform one or more practical tasks during each term. The demands for practical and inquiry skills appear to be a tall order for some teachers nationwide (Bantwini, 2010) due to the requirement for a learner-centred laboratory method of schoolwork. The aim of this laboratory component in the curriculum is to educate learners to be competent in the knowledge of science and the skills involved in the field. Learners are therefore expected to have the ability to resolve problems and take part in science issues outside of the classroom. This is a significant shift in the South African science curriculum in the FET band, where practical work has become a priority. The pioneering research by Hord, Rutherford and Hall (1987) that relates concerns of teachers and curriculum implementation has created a fertile area of research on teachers' concerns by many scholars. The first aim of my study was to investigate the concerns that physical sciences teachers have about practical work at high school level. The studies conducted so far mainly concentrated on science education content, but they neglect to investigate the experimental aspect of this broad subject (Bartos & Lederman, 2014).

This study used the concerns-based adoption model (CBAM) to uncover and track teachers' concerns and LoU of the new practical requirements of the physical sciences CAPS in one district of South Africa. CBAM has been used in education and other disciplines to investigate the implementation of innovations by mapping out the various SoC that indicate, "a quasi-developmental path to the concerns as a change process unfolds" (Hall & Hord, 2011:74). The CBAM model also includes exploring teachers' level of use (LoU), which depicts the extent of use of the innovations.

Concerns regarding practical work in physical sciences are not new to researchers in science education. Researchers have found that teachers have concerns about innovations in the two main branches of physical sciences, namely physics and chemistry (Coenders, 2010; Stolk *et al.*, 2010; Vos *et al.*, 2010). Previous studies revealed that improving teachers' content knowledge deserves special attention in order to empower them to implement the science curriculum (Anderson, 2010). Other studies examined how experience (Boz & Boz, 2010) and training (Gokmenoglu, Clark & Kiraz, 2016) resulted in the types of teacher concerns which in turn affected implementation of science curricula. Such findings motivate my questions about the success or failure of the practical work innovations in the South African CAPS. I am curious about the concerns that South African physical sciences teachers may have about implementing the practical work component of the new curriculum.

1.2 BACKGROUND AND RATIONALE

In South Africa, a new outcomes-based curriculum (also known as Curriculum 2005) was introduced in 1998 in an attempt to address the imbalances in the education system. Formerly marginalised groups could not access laboratory opportunities equally or equitably. The new curriculum promoted a learner-centred constructivist approach. Significantly, though, Curriculum 2005 was later reviewed and changed to the National Curriculum Statement (NCS), which later gave rise to CAPS (DBE, 2011). The DoE (2003) attempted to offer a curriculum that was relevant as a way of addressing what Aikenhead (2007: 882) had identified as the key features of most science curricula in the

majority of the school systems, namely that they were “socially sterile, impersonal, frustrating, intellectually boring, and/or dismissive of learners’ life-worlds”. The inclusion of active practical work is intended to make the content more relevant to learners.

Science teachers require skills to be able to implement expected changes in the science curriculum. The training in South Africa takes the form of workshops offered by the government (Bansilal & Rosenberg, 2011; Stears, Good & James, 2012). Additionally, the government gave a firm mandate to train more teachers and to provide additional training for those already in service in order to address the shortage of qualified teachers. Teachers were trained in physical sciences and other subjects through the Advanced Certificate in Education (ACE) (Bansilal & James, 2016). The expectation from the DoE (2000) was for teachers to develop such competencies as the teaching of practical work by conducting practical sessions with laboratory kits that had been provided to schools. How successful the programme has been in helping teachers to be adept at teaching practical work in physical sciences classrooms remains an open question. The situation in South Africa, as a developing country with limited classroom resources (Makgato & Mji, 2006; Makgato, 2007), adds a further complicating dimension that should be interesting to research in relation to the implementation of practical work in the curriculum. Despite resource challenges, CAPS further recommends that practical work be integrated with theory to strengthen the concepts being taught (DBE, 2011). The CAPS document outlines numerous practical activities alongside the content, concepts and skills columns. Some practical activities form part of formal assessment while others are for informal assessment. A list of prescribed practical activities for formal and informal assessments is available in the CAPS documents and specifically in the Free State Assessment Guidelines (2013).

Table 1 below summarises the number of practical activities expected in each grade by CAPS.

Table 1: The number of practical activities per grade and per term (DBE, 2011: 14)

Grade	10	11	12
Number of practical activities			
Term 1	6	5	2
Term 2	7	5	3
Term 3	6	4	2
Term 4	2	0	
Total	21	14	7

All grade 10 and 11 practical work is up for formal assessment while only three activities in grade 12 are examinable. The skills of scientific inquiry are expected to be transferred during the stipulated period in the curriculum.

Teachers' instructional practices are expected to include problem-based practical activities and laboratory work as stipulated in the curriculum. CAPS, with its emphasis on problem-based practical activities, represents a new challenge for many teachers in South Africa who may be used to a more content and information loaded curriculum, as in the past (Bantwini, 2010). As with any change in the curriculum that requires a different form of instructional practice, some teachers are likely to struggle with how to respond to the new demands in their classrooms. For this reason, among others, it becomes important to uncover and track teachers' concerns and challenges as they implement the requirements regarding practical work in the classroom.

As an experienced physical sciences teacher, I was interested in exploring how my co-workers cope with this demand by CAPS for increased practical work, which goes against much of the teacher education that many of my colleagues in South Africa would have received as pre-service teachers. Exploring the concerns and experiences of teachers, together with their LoU of the practical components of the new curriculum, is a problem worth researching so that educational leaders and policymakers can develop support programmes that are informed by research, in order to increase the prospects of success for present and future educational innovations. I have been teaching physical sciences for more than 15 years at high school level and have attended many professional development workshops for physical sciences teachers based on the new curriculum. Without fail, at many of these workshops, the issue of practical investigations always seems to be a major concern for the majority of the teachers.

A study on physical sciences teachers' concerns and the extent of the implementation of practical investigations according to CAPS in South Africa would shed some light on the challenges faced by teachers. A set of interesting studies from Israel provide some useful insights on the success factors required for implementation of new science curricula. For example, one study revealed that the successful implementation of inquiry-based chemistry laboratories was mainly due to close collaboration between teachers, academic institutions and the Israeli Ministry of Education (Barnea, Dori & Hofstein, 2010).

In Israel, teachers were empowered through leadership workshops, action research and evidence-based professional development for the successful implementation of new content and pedagogical standards in science (Mamluk-Naaman, Katchevich & Hofstein, 2016). Al-Amoush, Markic and Eilks (2012) however presented contradictory findings that suggested the dominance of teacher-centred instruction in chemistry laboratories of Israel. The outcome of these traditional teaching beliefs was due to a focus on demonstrations of practical work. The initial steps of the inquiry process, such as observing and questioning within an activity, were implemented, but predictions and the evaluation of evidence were rarely encouraged (Hollingsworth & Vandermaas-Peeler,

2017). Teacher skills that accentuate the analysis and interpretation of data by the learners by using graphs or calculations were limited. Teachers would often provide answers to their learners. Moreover, teachers could not assist learners in learning how to use data from an experiment to test a hypothesis or draw conclusions. Peleg *et al.* (2017) consider that drama-based pedagogies and showmanship skills may support the implementation of inquiry when the EU-funded project, TEMI-Teaching Enquiry with Mysteries Incorporated, was introduced in chemistry. Time constraints, planning and a lack of materials are usually identified as challenges to the execution of effective practical work (Hollingsworth & Vandermaas-Peeler, 2017). In addition to those findings, Singh (2014) also cites large classes as barriers to the effective implementation of practical work.

This research investigates the concerns that physical sciences teachers have regarding practical work and their LoU of this part of the curriculum in their classrooms. The present study seeks to add to the field of research on the LoU of CAPS practical work and the concerns teachers may have about it. The study is timely in light of implementation of CAPS practical work, since important elements that promote acceptable science instruction include teacher views and attitudes regarding the laboratory environment. The level of use of this part of the curriculum, namely practical investigations by physical sciences teachers, has been the subject of many previous investigations (Kang, 2008; Saad & BouJaoude, 2012; Kapanadze & Eilks, 2014; Park, Martin & Chu, 2015; Harrison, 2016). The present study sought to contribute to this body of growing scholarship by exploring the issues in a South African context. The findings provided information about the specifics of the concerns that are linked to the implementation of practical work in physical sciences by FET physical sciences teachers in the Motheo district of South Africa. The research has the potential to make suggestions about the most appropriate types of support or assistance required for the successful implementation of practical work.

1.3 FRAMEWORK OF THE STUDY

Individual teachers' actions play a vital role in driving change in a classroom. The varied practices of teachers, their beliefs and working environments affect the successful implementation of an innovation. The concerns that teachers have about reform will influence their instructional practice positively or negatively. In a classic research study, Fuller (1969a) classified these concerns into three developmental stages as impact, self and task concerns. The first set of concerns highlights learner outcomes in light of the innovation, while the second set centres on the issue of teachers' efficacy. The last set of concerns deals with the daily teaching responsibilities that are influenced by factors such as class size or the availability of resources. There has been recent interest in the concept of concerns (Sun & Strobel, 2013; Brown, 2016). Researchers have examined the existence of a relationship between the level and type of concerns individuals may possess and implementation of change and reform in education (Shwartz *et al.*, 2017). Hord *et al.* (1998) describe the feelings, thoughts and reactions individuals develop to the latest programme or innovation in their job as concerns. CBAM further describes the position of mental arousal that comes from the need to handle new conditions in one's work environment as innovation concerns. When teachers' concerns contradict new curricular reforms, implementation may be unsuccessful. It is therefore vital to determine the types of concerns teachers have in order to assist them while they adopt a new innovation. Managers thus need to determine teacher concerns early on and throughout the implementation phase of an innovation (Fullan, 1999).

In support of the idea of tracking the implementation process for each teacher, Spillane (1999) argues that different teachers create their own zones of enactment during a change, which assists them in carrying out new innovations in the manner that is most appropriate for them. Therefore, the present study seeks to understand the differences in the FET physical sciences teacher efforts to implement practical work successfully in South African classrooms. When policymakers and managers understand what teachers know and believe about physical sciences and practical work, then it is possible that a

more positive reception of new ideas can be planned for and supported (Fuller, 1969a). The present study was aimed at understanding physical sciences teachers' fidelity to the curriculum with respect to practical work and, more importantly, to rectify the glaring absence of such studies that track on-going implementation concerns and actions of science teachers in South Africa and elsewhere. CBAM is an instrument used by leaders in the field of education to track and assess innovation implementation. Hord *et al.* (1998) explain that CBAM shows educational leaders, reformers and researchers how the individuals most affected by the change react to the implementation of these innovations. Three diagnostic instruments of CBAM are often used to measure the developmental processes of an innovation. These instruments are referred to as the SoC, LoU and innovation configurations (IC). The first two instruments are discussed in some detail here since they were used in this study.

According to Anderson (1997), the SoC instrument includes the feelings and emotions that teachers might have when curriculum amendments are made. It is important that the concerns of individuals who are involved in the innovation be identified so that the change can be successful. Hord *et al.* (1987) argue that change can be further sub-divided into seven developmental stages of concern that emanate from the implementation process.

Table 2 below illustrates these seven stages of concern.

Table 2: The seven stages of concern (Hord *et al.*, 1987)

Stage and description	Feelings of teacher
0- Unconcerned or awareness	A teacher is aware of the reform but his/her interest level is low.
1- Informational	A teacher's interest level increases for some information about the change.
2- Personal	A teacher wants to know how this reform will affect him/her personally.
3- Mechanical or management	A teacher is concerned about how to deal with the management of the change or innovation.
4- Consequence	A teacher wants to know how this change will affect learners.
5- Collaboration	A teacher wants to work with others in order for the innovation to become effective.
6- Refocusing	A teacher has ideas of how to refine the innovation to obtain better learner performance.

Once the researchers have managed to identify the general concerns of teachers, the concerns are categorised and teachers are supported in their adoption of the change. It is expected that teachers developmentally move to higher SoCs, especially when support has been provided.

An individual's level of use of the innovation is important in diagnosing the progress attained in implementing a change project. This is the actual work done by the teacher in relation to the innovation. Hall and Hord (2014) argue that the way in which users and non-users of the innovation conduct themselves describes at which level they are in the change process. As a teacher moves from one level of use to another, support is required and that is the major aim of investigating teachers' behaviour.

The eight LoU, according to Hall and Roussin (2013), are illustrated in the table below.

Table 3: The eight LoU according to Hall and Roussin (2013)

Level & description	Behavioural indicators of level
0 – Non-use	There is no observable behaviour of the teacher to be involved in the innovation.
I – Orientation	A teacher actively looks for information about the innovation, its workings and what is demanded from him/her.
II – Preparation	The intention to use the innovation is high, so s/he acquires the necessary materials and resources. This individual would be preparing for first-time use.
III – Mechanical use	A teacher at this level is inexperienced and experiments with different ways of using the innovation. Considerable time is taken up by making plans to get the needed materials and familiarising the learners with the programme. It is not strange for people to stay at this level for a while. If enough training is offered on how to use the innovation, progress will be observed. It is characterised by stress and uncertainty.
IVA – Routine use	The teacher would have learnt the skills to use the innovation and would be comfortable with what s/he is doing. The individual feels relieved, stable and confident regarding the reform.
IVB – Refinement	The behaviours and activities of users at this stage are focused on the needs of learners. Individuals start amending the innovation with the intention of capitalising on its impact on the learners. The teacher makes these changes according to what s/he knows about the anticipated future of the innovation.
V – Integration	If teachers are at this stage, collaboration commitments are made with other teachers with a focus of contributing information to other teachers' methods of dealing with the innovation.
VI – Renewal	A teacher at this stage would renew the innovation by adjusting some aspects of the innovation, while some teachers go to the extent of changing it completely.

The third diagnostic instrument, namely the innovation configuration (IC), deals directly with characteristics of the innovation and its meaning when the innovation is the frame of reference (as reported by Hall & Roussin, 2013). The three diagnostic instruments of CBAM may be used in a variety of ways to record the execution of a change or innovation. They may be used alone, together or in any combination as deemed necessary. In the present study, an SoQ questionnaire (SoCQ) was used to measure physical sciences teachers' concerns while interviews on LoU assessed how teachers actually perform their

instructional practices that seek to implement the practical work requirements in the physical sciences curriculum. The innovation configuration was not used in this case, as this was an exploratory study of the early implementation of the practical work requirements of CAPS.

1.4 RESEARCH QUESTIONS

The main research question for this study involved the use of CBAM to uncover and track teachers' concerns and LoU of the new practical requirements of the physical sciences CAPS in one district of South Africa. To explore this main question, the following three sub-questions were posed:

- What type of concerns do FET physical sciences teachers have about implementing the practical work component of CAPS?
- What are the differences in teachers' concerns regarding the implementation of practical work, if any, in relation to a number of demographic variables such as gender, educational level, teaching experience and exposure to professional development?
- What are the variations in the levels of implementation by FET teachers in the Motheo district of the physical sciences practical components of CAPS?

1.5 AIMS AND OBJECTIVES

The main aim of the study was to uncover and track teachers' concerns and LoU of the new practical requirements of the physical sciences CAPS in one district of South Africa by using CBAM. Three objectives were pursued, viz.:

- To identify the concerns that physical sciences teachers have in implementing practical work in the FET phase for grades 10, 11 and 12.
- To examine whether there are significant differences in teachers' concerns according to a number of demographic variables such as gender, educational

level, the length of the teaching experience and the years of their involvement in practical work.

- To investigate how physical sciences teachers in the Motheo district in the Free State, South Africa implement practical work lessons in FET classrooms.

1.6 RESEARCH METHODOLOGY

1.6.1 Research approach

Informed by the paradigm of pragmatism, the present study used quantitative and qualitative approaches to explore the stages of concern of physical sciences teachers and the levels at which they are in terms of their utilisation of the innovation. A paradigm can be defined as the way individuals view and analyse the world around them (Morgan, 2007). This frame directs the way a research project takes and in which a discipline's concerns are viewed. It is the perspective that guides the researcher about the area of specialisation of the study. It also directs the type of questions that are asked and how the answers are analysed.

1.6.2 Research design

1.6.2.1 Data collection instruments

The SoC questionnaire was used to obtain quantitative information about the implementation concerns of 81 physical sciences teachers while qualitative information was collected on the LoU via interviews and lesson observations conducted on a sample of four teachers from different schools teaching different grades (10, 11 and 12). This was to evaluate whether there are any differences (or changes) in teacher concerns and their LoU regarding practical work. A sample of 81 teachers from 52 schools was identified to include a minimum of two physical sciences teachers per school, where possible, who were responsible for grades 10–12 within the Motheo district. The participants were selected through the simple random sampling method.

The study used a modified SoCQ. Before the administration of the SoCQ, I contacted Dr Gene Hall, an educational researcher and the lead architect of the CBAM, to obtain permission and information on how to read and understand the data accurately and to use the expression “practical work” in place of “innovation”. This questionnaire can be modified to apply it to any innovation of interest. In this study, the phrase “the innovation” was replaced with “practical work” throughout the questionnaire. In 1987, Hord *et al.* established that the SoCQ has test/retest reliabilities that move from .65 to .86 and that this instrument has alpha coefficients ranging from .64 to .83 resulting in the conclusion that the SoCQ has strong internal consistency and reliability estimates.

The instrument has 35 items, categorised according to the seven SoQ that teachers rated using a 7-point Likert scale of intensity from 0 (Irrelevant), 1-2 (Not true of me now), 3-5 (Somewhat true of me now), to 6-7 (Very true of me now). Cooper and Emory (1995) report that the benefits of using the Likert scale are that:

- it is easy to construct and one spends little time doing so;
- each item meets an empirical test for discriminating ability;
- its reliability provides a large volume of data; and
- it is also treated as an interval scale.

Teachers’ affective concerns are evaluated as they go through change or an adoption process, which in this study is the implementation of practical work in physical sciences. Other studies adapted the SoCQ to investigate concerns of non-teachers. Hall *et al.* (1975) developed a concerns questionnaire for leaders who were in charge of different organisations. This was known as the change facilitator SoQ questionnaire. Bailey and Palsha (1992) together with Cheung, Hattie and Ng (2001) found that the validity of the SoCQ was high. Their finding was that the 7-stage model contained less reliability than one with five stages. Upon further analysis, the present study regarding practical work used the 5-stage questionnaire because each concern level has five statements. High numbers indicate high concerns, while low numbers indicate low concerns. Insignificant

items are indicated by 0 and are excluded from the calculation of scores. The 5-stage model was used in this study because teachers in South Africa are beyond just informational stages and implementing the change is compulsory for them (Makgato & Mji, 2006). The lowest two stages (0 and 1) were therefore eliminated in this study. To ensure reliability and validity in the South African context, the questionnaire was piloted with 12 respondents. The results of the pilot study suggested that the items in the questionnaire were representative of the possible teacher related variables that influenced concerns regarding CAPS practical work. For the current study, some items were adopted from the questionnaire to assist in establishing the relevance of the items in the study questionnaire's ability to measure teacher concerns regarding CAPS practical work. The results of the study were correlated with results from studies focusing on concerns of teachers about practical work in other curricula worldwide.

The instrument was further compared to other curriculum concern studies that focussed on practical work in science or other disciplines (Christou, Eliophotou-Menton & Philippou, 2004). The aim was to measure the criterion-related validity. Dr Hall, the originator of the SoCQ, established the content validity of the questions for the respondents. The SoCQ and semi-structured interviews, known as branched interviews, served the purpose of collecting qualitative and quantitative data. Cronbach's alpha values were used to examine the items that explore the different SoC. A demographic questionnaire contained items that related to years of experience teaching physical sciences, age, training (years of professional development), gender and education (the participants' highest degree obtained). The SAS software was used to statistically analyse the responses. The data collected from the section on teachers' demographics and the SoCQ produced frequency tables. After this, teacher profiles were constructed from the frequency tables. The tables on the item data for concerns of teachers enabled me to identify trends and patterns regarding practical work implementation in the FET phase of high school. A one-way analysis of variance (ANOVA) was conducted to test for differences in teacher concerns about the implementation of practical work.

The present research on practical work in South Africa also used the second diagnostic tool of CBAM, which is the LoU branching interview. According to Hall and Roussin (2013), assessing an individual's LoU consists of the LoU branching interview and the LoU focus interview. The general patterns of the way teachers behave towards an intervention are the focus of these particular interviews. The intervention is identified in this study as practical work in the physical sciences classroom. The innovation process contains eight LoU. Each level has its own behavioural indicators. When using innovations, different individuals show types of behaviours that are dissimilar to each other, which Hord, Rutherford and Hall (1987) also observed in groups. The behaviours were categorised as distinct states. Additionally, for researchers to categorise implementation of an innovation by people, LoU are needed. The manner in which new skills are acquired and varied can be investigated using this diagnostic tool. According to Hall *et al.* (1975), a branching interview follows a predetermined format in the form of a tree branch. The questions require "yes" or "no" responses and guide researchers through different branches according to the respondents' answers. The branching interview assists the researcher in obtaining as much information as possible in a limited time about how the user uses the innovation. The interviews in this proposed study followed the steps of a branching interview. The researcher posed questions in the semi-structured and focus group interviews that required information about the implementation of practical work according to CAPS. Lessons were also observed.

Once the data had been gathered on teachers' LoU, the interviews were transcribed and then analysed through content analysis. Hsieh and Shannon (2005) propose that qualitative content can be analysed by systematically classifying text data. This is done by first interpreting the content through coding and then identifying patterns or themes. The authors report three approaches of interpreting meaning from the context of text data: conventional content analysis, a directed approach and a summative content analysis. Researchers obtain coding categories from the text data when the first method is employed while the directed approach utilises an initial consultation of a pre-existing theory or research findings that direct the study in forming initial codes. When a

researcher counts and compares keywords or content and then interprets the underlying context, the third way of analysing data is in use. Because the objective of a directed approach to content analysis is to corroborate the data with a theoretical framework or theory, the present study will employ this method to analyse the data. The existing CBAM theory was used to focus the research questions and was used to predict the variables of interest. This assisted in determining the initial coding scheme. Mayring (2000) named this “deductive category application”. The above qualitative data was compared to the SoC data, enabling the researcher to identify physical sciences teachers’ attitudes towards practical work. The comparison of LoU and SoCQ data provided a full picture of implementation.

1.6.2.2 Data analysis

To analyse the quantitative data for the first research question, descriptive statistics namely frequency count, mean and standard deviation were employed to test the two key hypotheses, namely that:

1. physical sciences teachers in the Motheo district have significant concerns about the implementation of practical work; and
2. the teachers’ concerns are significantly related to their demographic characteristics such as gender, levels of education, years of experience teaching physical sciences and attendance of professional development opportunities.

Content analysis

To gather the data about the extent of implementation of practical work, the interviews were transcribed and later analysed using content analysis. In this study, the directed approach was employed because the CBAM theory has the potential to be directive in forming initial codes. The codes that were obtained include levels that teachers could be

performing at, namely orientation, preparation, mechanical use, routine use, refinement, integration and renewal.

Table 4: Arrangement of themes and descriptions of teachers' responses

Generated themes	Descriptors
Orientation	The teacher actively searches for information about the innovation, its workings and what is demanded from him/her.
Preparation	The intention to use the innovation is high; acquisition of the necessary materials and resources is done. Preparing for first time use.
Mechanical use	The teacher is inexperienced and experiments with different ways of using the innovation. The practical work is introduced to the learners. Characterised by stress and uncertainty.
Routine use	Skills mastery, comfortable with what s/he is doing. The individual feels relieved, stable and confident regarding the reform.
Refinement	The teacher is focused on the needs of the learners. Amendment of the innovation with the intention of capitalising on its impact on the learners takes place. The teacher makes these changes according to what s/he knows about the anticipated future of the innovation.
Integration	The teacher collaborates with other teachers with a focus on sharing and exploring ideas of how other teachers use the innovation.
Renewal	The teacher renews the innovation by adjusting some aspects of the innovation or by changing it completely.

1.6.3 Mixed methods analysis

1.6.3.1 Data analysis

The aim of data analysis is to convert data into findings. Data are the pieces of information obtained in a study. In this study, data refers to the answers of the SoCQ completed by the teachers, along with the interview transcripts. To analyse the quantitative data for this study, descriptive, correlational and exploratory processes were followed. The descriptive

statistics to test the two key hypotheses are frequency count, mean and standard deviation. These were used to gain an understanding of the key concerns of physical sciences teachers in implementing practical work in the FET phase at high school level.

1.6.3.2 Pre-analysis

The characteristics of the sample of teachers were described by employing descriptive statistics. The same method was used to test whether the variables have any violations of assumptions or missing data. Assumptions include linearity of relationships, outliers and normality. Outliers were identified and analysed. Normality and linearity of relationships were assessed using a scatter plot matrix. Elliptical shapes of scatter plots showed normality and linearity of relationships together with testing of skewness and kurtosis-statistics from SAS software. To minimise the impact of missing data, a pairwise exclusion of cases was used. Cronbach's alphas were used to check for inter-reliability consistency.

Data analysis from the two diagnostic instruments of CBAM

An exploratory factor analysis on the SoCQ was performed to ascertain the degree to which the data naturally agrees with the scale according to information from the CBAM SoCQ. Any content provided on the open-ended questions that linked to the SoCQ was organised by question so that themes and patterns were identified and placed into categories. These themes and patterns were identified via an iterative process. Categories include the five areas of concern. After the respondents documented their concerns about performance of practical work with SoCQ, the responses were grouped into one of the SoC. Each participant received a score that was based on his/her response. This was achieved by adding the teacher's ratings of the five statements under each proposed phase and stage of concern. The range from 0-35 represented the score for each phase and stage category of concern. The greater a teacher's total score for the SoCQ in a grouping, the higher the concerns were in that stage and vice versa. Individual or group profiles were constructed using this instrument. Each category's added score

was converted to a percentile and the guidelines outlined in the quick scoring device were followed. Scoring and interpreting information for the SoCQ was provided.

Data analysis in relation to the research questions

The existing CBAM theory was also used to focus the research questions and to predict the variables of interest. This assisted in determining the initial coding scheme. Mayring (2000) named it deductive category application.

The following research hypotheses were tested in this study:

Research question 1: What types of concerns do FET physical sciences teachers in the Motheo district have about implementing the practical work component of CAPS?

Hypothesis 1: Physical sciences teachers in the Motheo district have significant concerns about the implementation of practical work.

Alternative hypothesis 1:

Physical sciences teachers in the Motheo district will have insignificant concerns about the implementation of practical work.

Research question 2: What are the differences in teachers' concerns regarding the implementation of practical work in relation to a number of demographic variables such as gender, educational level, teaching experience and exposure to professional development sessions?

Hypothesis 2: The teachers' concerns will be significantly related to their demographic characteristics such as gender, levels of education, years of experience teaching physical sciences and attendance of professional development sessions.

Alternative hypothesis 2:

The teachers' concerns will not be significantly related to their demographic characteristics such as gender, levels of education, years of experience teaching physical sciences and attendance of professional development sessions.

An SoC profile was produced for the sample from the CBAM SoCQ data as mentioned by George, Hall and Stiegelbauer (2006). To test the psychometric properties of the SoCQ, an exploratory factor analysis was conducted on the 35-item SoCQ. A detailed seven-factor solution was employed to find out whether items would organise themselves according to the known stages.

Previous research by George *et al.* (2006) states that when the researcher obtains the entire raw scaled scores, these should be changed to scale scores and should be presented for all seven areas of concern. The scale score shows the relative intensity of the concerns in each area. Interpretation of the peak scores was based on the SoC about practical work definition. George *et al.* (2006) propose that researchers should examine the highest and second highest stages' scores (first and second highest score interpretation) to allow for a more detailed interpretation, if possible.

1.7 SIGNIFICANCE OF THE STUDY

Teacher concerns have been shown to affect the way in which science curricula are implemented (Barnea *et al.*, 2010; Singh, 2014; Hollingsworth & Vandermaas-Peeler, 2017). This study sought to shed light on the current challenges and opportunities for successful implementation of CAPS practical work in physical sciences at the FET level in South African high schools and in particular the Motheo district in the Free State. The study is unique for several reasons. Firstly, in South Africa there is recurrent focus on the poor performance of learners in physical sciences, which includes an important practical component (DBE, 2011). This attention puts teacher implementation of CAPS in that subject in the spotlight. The attitude of teachers towards CAPS practical work affects its implementation and therefore needs to be investigated. The findings of this study are significant because they align with previous research on concerns of teachers about resource availability and management, concerns about collaborating with other teachers and attempts to change part of the innovation (Ryder & Banner, 2013; Meng, Sam & Osman, 2015; Torres & Vasconcelos, 2016). This study provides a picture of the current standing of how FET physical sciences teachers in the Motheo district of the Free State feel about CAPS practical work and how successfully it is implemented. Recommendations that give attention to the improvement of current practice with respect to practical work will be provided.

1.8 ETHICAL CONSIDERATIONS

This research project was conducted in an ethically appropriate way. Before data collection commenced, permission to conduct research at the selected schools was obtained from the Free State Department of Education and the relevant teachers, principals, parents and learners (see Annexure 2, 3, 4, 6 and 7 respectively).

Respect for persons

The Office of Human Subjects Research, OHSR (1979), requires that research subjects take part in the study voluntarily. Enough information should be supplied and they should understand the research project before participation. Before the commencement of the research, teachers received detailed information about the research project. The detailed information included the method of inquiry, responsibilities of the researcher as well as the rights of the participants and any foreseeable positive or negative impact from participating in the study. Participants who agreed to take part in the study were supplied with consent forms, which they signed. They also had the option of withdrawing from participating at any time.

Beneficence

Beneficence expects researchers to use the benefits of the research maximally, while minimising the risk of harm to human subjects (OHSR, 1979). The identities and addresses of the participants remain confidential in order to protect their privacy and to assure confidentiality about the participating schools. This confidentiality will ensure that the teachers remain anonymous to prevent negative or punitive consequences if practical work is not being taught by some teachers in the physical sciences classroom.

Justice

The collected data excluded all identifying characteristics. In order to protect the identities and rights of schools and teachers, pseudonyms were used. All research documents from participants were stored in a locked cabinet when the researcher was not using them. The audio records from the interviews were stored on a CD, which will be locked in a protected filing cabinet for 3 years. Justice also involves the duty of the researcher to present accurate data. This adds to the understanding of phenomena and the enhancement of educational methods.

Representations

The successful representation of this study lies in the connection of the data and its usefulness to practitioners and academics. The study hopes to represent the experiences

of teachers when implementing practical work performance in grades 10, 11 and 12 by coming up with emergent themes of the progress of the implementation.

1.9 QUALITY

Lincoln and Guba (2013) identify four criteria that emphasise trustworthiness in qualitative research, namely dependability, transferability, confirmability and credibility.

Steps were taken to incorporate quality measures at every stage of the study. This study aimed to achieve excellence as its standard is measured against other studies in CBAM literature (Christou *et al.*, 2004; Ndirangu & Nyagah, 2013) or practical work in physical sciences (Ramnarain, 2011; Faikhamta, 2013; Ryder & Banner, 2013; Dudu, 2014).

1.9.1 Dependability

This study ensured that the outcomes of the research were reliable by describing the path of the research clearly so that future researchers could follow the steps of the research method. There was a need to pose questions of how practical the claims, analyses and conclusions of this study were to ensure that findings were dependable. Furthermore, the participants' actions and responses were documented by including how methodological and data analysis procedures were performed.

1.9.2 Transferability

Lincoln and Guba (2013) define transferability as the relevance of the research findings to other contexts and locations. This study was set in the Motheo district of the Free State, South Africa, with the focus on physical sciences teachers implementing practical work in their FET classrooms. A similar investigation can be carried out in a different location with other physical sciences teachers using the same data procedures.

1.9.3 Credibility

Lincoln and Guba (2013) state that the assurance a researcher depicts in the truth of the research findings is known as credibility. In this study, the validation of results was informed by the fact that all participants were given the same SoCQ, and interviews and data analysis was calculated accurately. This provided evidence for data triangulation, resulting in reaching the point of saturation during data analysis. Likewise, member checks permitted participants to examine their interview records, which allowed the participants to clarify, add to and/or withdraw statements or interpretations.

1.9.4 Reliability

Reliability refers to the degree of consistency with which the instrument assesses what it is supposed to measure. An instrument is reliable if there are no errors of measurement and the true score is precise. If a study and its results are reliable then the same results would be found if the study were to be redone using the same method. The sampling technique was reliable. Since the SoCQ is a ready-made instrument of CBAM, the reliability values are assumed high. Nevertheless, the instrument was assessed for reliability via a pilot study of 12 teachers who discussed the purpose, resolved any unclear issues and then made suggestions for improvement. A pilot study was conducted for the interview questions that were prepared for the selected sample. It took 10 minutes to complete the questionnaire, while the duration of the interviews was on average 40 minutes. The branching interviews survey instrument received a review from higher education experts and feedback for some improvements. The same interview data was coded consistently by content analysis after participants answered specific questions. This showed consistency in data handling.

1.9.5 Validity

The participants provided information about themselves after which the procedural details of the research study were communicated to them. There was agreement about meanings where mutual understanding was required. The SoCQ and LoU interviews collected the required data to answer the research questions and I believe that the same results will be attained if this study was repeated.

Statement of subjectivity

My interest points towards what teachers feel about the practical work they are expected to put in effect and whether they are actually carrying out these practical activities. I have often wondered why some schools with laboratories do not fully utilise them, with some converting them into staff rooms. Biases as a researcher may affect the study because from my own experiences, high school science teachers hardly let learners perform practical activities. Academic progress is possible for physical sciences learners if they are familiar with experiments that are available in the syllabus. This reinforces the content knowledge that is provided. Though elimination of all potential researcher bias cannot be attained, readers can make judgements about my subjectivity by placing what I have encountered in the context of the research. My experiences may influence the conceptual and theoretical framework that supports the methodology if I analysed the LoU data to support existing theory. I therefore tried to remain objective as far as possible.

As a physical sciences FET educator, I am interested in implementing practical work to the best of my ability. Discovering what other teachers experience concerning practical work, supplied valuable information for me to understand how some are able to execute practical activities while others are not able to do so. What an insider understands to be the truth or reality may be quite different from the observations of an outsider. To be objective I included both perspectives (insider and outsider). Being an FET physical sciences teacher with some of the same demographics as the participants, I am an insider who is in the same shoes as the respondents. I identify with the topic and the teachers.

This is beneficial to data collection, interviewing participants and interpreting results. This ensures that the conclusions are objective and not drawn from my personal needs but from actual findings. I assumed the role of a researcher.

1.10 LIMITATIONS AND DELIMITATIONS

The aspects that influence this research are that only physical sciences teachers teaching any combination of grades 10, 11 and 12 were sampled. The sample was only drawn from the Motheo district in the Free State province of South Africa.

Delimitations: Literature for the (literature) review was obtained from science, chemistry, physics and science, technology, engineering and mathematics (STEM) sources since these fields incorporate experiments.

1.11 OUTLINE OF THE DISSERTATION

This is an articles-based dissertation with three sections. The first section discusses the background, statement of the problem and presents the aim and purpose of the study. The research questions are discussed together with the justification and purpose of the study. A summary of the conceptual framework and methodology are also presented.

In section 2, the two publishable articles are presented. Each article is written using the format and referencing style that is required by each of the journals where it is to be submitted for possible publication. Each article therefore contains its own reference list in its own referencing style. The following two articles are presented in section 2.

SECTION 2

2

ARTICLE 1: South African teachers' concerns with the implementation of practical work in the physical sciences Curriculum and Assessment Policy Statement

ARTICLE 2: Case studies of the level of use of practical work in the South African physical sciences Curriculum and Assessment Policy Statement

In section 3, I describe how each research question was answered in the study. The findings of this study are reported in two articles addressing the research questions. The first article explores the concerns that physical sciences teachers have regarding the implementation of CAPS practical work. The second article examines the extent of implementation of CAPS practical work by physical sciences teachers according to CBAM. A discussion of the findings related to each research question is presented in this last section. Based on the analysis of the data, the researcher attempted to describe the concerns of teachers, their level of implementation as well as recommendations and support for effective implementation.

² The titles were modified slightly after data collection and analysis and may differ somewhat from those in the CTR.

Article 1

Teachers' concerns with the implementation of practical work in the physical sciences Curriculum and Assessment Policy Statement

Abstract

A new Curriculum and Assessment Policy Statement (CAPS) has recently been introduced in South Africa, emphasising learner-centred and constructivist approaches to practical work in the high school subject physical sciences. These demands for practical work and inquiry skills would be a tall order for most teachers under the best of circumstances. The South African context, with limited resources, such as laboratories and supplies, adds a further complication to the implementation challenge. The purpose of this study was to evaluate teachers' concerns and experiences with the implementation of practical work in physical sciences. A quantitative study involving a survey of 81 randomly sampled grades 10, 11 and 12 physical sciences teachers in the Motheo district of the Free State in South Africa was conducted as part of larger investigation. The concerns-based adoption model (CBAM) was used to identify teachers' stages of concern (SoC) of the practical component of CAPS. The findings indicate that more teachers (n=47) in the study had management concerns of high significance while the collaboration and consequence concerns were only slightly significant. This means that teachers are rather perturbed about organising and coordinating the activities required for conducting and supervising practical work in order to achieve the CAPS requirements. There is also limited participatory decision-making and sharing of visions among physical sciences teachers. The paper concludes with a discussion on the variety of concerns and how they can be addressed through professional development and more targeted teacher support.

Keywords: teachers' concerns, practical work, physical sciences, concerns-based adoption model

Introduction

Recent curriculum innovations have heightened the need for identifying the concerns that teachers have in implementing curricula in various countries worldwide (Çetinkaya, 2012; Ramoutar-Bhawan, 2013). Feelings and perceptions that prevent people from engaging with the change process are known as concerns. Studies show that if teacher efficacy beliefs are overlooked, curriculum reform initiatives undoubtedly fail (Christou, Eliophotou-Menon & Philippou, 2004; Charalambous & Philippou, 2010). A major conclusion of the extensive literature on curriculum implementation is that fidelity to curriculum innovations is affected by teachers' concerns regarding their ability to access programmes that assist in professional development, their teaching approaches and content knowledge (Torres & Vasconcelos, 2016). Although there are many other factors that affect curriculum implementation, teacher beliefs are among the main personal determinants of reform execution. According to Hall and Hord (2014), because the demands of innovations could cause uncertainty for new users, knowledge and a better understanding of their concerns are important.

The current study sought to examine and understand the concerns of physical sciences teachers as they implemented CAPS practical work, because teachers' concerns are the lenses through which curricular innovations are interpreted. It is important to understand the frustrations and struggles encountered by teachers as they implement curricula reform. Roehrig and Kruse (2005) affirm the significance of the role of teacher concerns in the enactment of reform-based curricula. It is concerns rather than methods or the curriculum that triggers substantial differences in education transformation (Boz & Boz, 2010). A number of studies pronounce on the idea that teacher concerns affect education reform. Teachers may be concerned about their lack of teaching experience (Christou *et al.*, 2004), the time allocated to the innovation (Charalambous & Philippou, 2010) and assessments with incentives (Tunks & Weller, 2009). Each teacher retains individual concerns regarding a change and these concerns can be at different stages of readiness for adopting an innovation (Hall & Roussin, 2013). It therefore becomes advantageous to know what concerns teachers have early on and during the execution of an innovation

(Fullan, 1999). This study proposed to use CBAM to uncover and track teachers' concerns regarding the new practical requirements of the physical sciences CAPS in one district of South Africa. CBAM in education and other disciplines attempts to investigate the implementation of innovations by mapping out the various SoC that indicate how individuals feel about the innovation.

Practical work in Science Education

In several countries, a noteworthy part of the science education curriculum involves learners attaining skills from practical work (Rogers *et al.*, 2011; Stickles, 2011; Ryder & Banner, 2013; Kapanadze & Eilks, 2014). In South Africa, an active learner-centred laboratory method of experimental work in the Further Education and Training (FET) band is pivotal to the new CAPS. The aim of this laboratory component of physical sciences is

to promote knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationship to technology, society and the environment (DBE, 2011: 8).

Laboratory activities are essential due to their distinctive and central role in the physical sciences curricula. Teachers are therefore required to implement practical work accordingly, emphasising active learner participation (DBE, 2011). This could be challenging for some teachers who may have concerns regarding practical work. Teachers' concerns regarding practical work have gained attention in science education as a potential factor that may affect effective implementation (Luft & Roehrig, 2007). Various concerns regarding practical work may lead to different interpretations of the innovation resulting in different levels of teachers with self-concerns (Bartos & Lederman, 2014), some may worry more about their own efficacy in implementing the reform. Other teachers may have task or impact concerns (Hall & Hord, 2014) and be more interested in the required resources and methods to execute the innovation than in the philosophy that underlies it. For example, some teachers never manage to complete all the activities in a laboratory session even though they may engage in laboratory work more often.

These challenges of lack of time and resources lead to poor implementation of practical work in schools (Tytler, 2012).

The SoC tool is used to understand teachers' concerns and beliefs in relation to the expected behaviours of a reform. Hall and Hord (2014) explain that the CBAM shows educational leaders, reformers and researchers how the people who are most affected by adjustments in the curriculum react to the implementation of such changes. Three diagnostic instruments of CBAM are often used to measure the developmental processes of an innovation. These instruments are referred to as the SoC, LoU and innovation configurations (IC). The SoC was used in this study. Hall and Hord (1987) argue that change can be further sub-divided into seven developmental SoC that emanate from the implementation process.

In the first stage, known as "unconcerned", the teacher pays no attention to an innovation. This is referred to as the unrelated concern. Self-concern consists of the "informational stage" where teachers are interested in the reform and require more information about it in order to implement it successfully. In the "personal stage", the teacher focusses on how the reform affects him/her personally and whether s/he is able to implement it effectively. The task category consists only of a "management stage" where daily managerial tasks that the teacher deals with take up the majority of his/her attention. The impact category consists of three stages, namely "consequence", "collaboration" and "refinement". In the consequence stage, a teacher's instructional practice focuses on how the innovation affects learners. During collaboration, the teacher's aim is to make the reform more effective by reaching out to other teachers, while with refinement the teacher is conscious about the universal benefits of the reform and may have ideas of modifying it or replacing it with a model that is more useful to the context. Attention is given to the improvement of the innovation. The current study used the stages of concern questionnaire (SoCQ) to identify teachers' SoC.

Literature on the concerns that teachers have regarding practical work reveals various teacher concerns ranging from management concerns, concerns on how to maximise practical work for learners, working with other teachers to utilise effective lab methods and at times, concerns regarding the refinement of tasks with learners' abilities in mind.

Surveys of science and mathematics education in the United States of America were conducted for the National Science Foundation (NSF) with the aim of investigating laboratory practices of science teachers. Seventy-one per cent of high school teachers with high management concerns generally involved learners in investigations at least once a week (Banilower, Green & Smith, 2004). Teachers with these concerns, which focused on administrative roles, spent considerable time on preparation and setting up of apparatus. There was less time for teachers to assess learners during the recommended school hours so they often worked late or arrived at work early to keep up with their work. Furthermore, many practical activities require more time than is given on the timetable. Cost limitations may prevent teachers from implementing practical work when schools are unable to afford laboratory equipment (Kelly, 2017). Implementation of practical work required facilities such as new and updated equipment and adequate room for effective participation in practical investigations.

In a study that investigated professional development of science teachers, Vescio *et al.* (2008), found that in order to influence teaching in laboratories and learner understanding of scientific concepts positively, science teachers needed supportive structures. Teachers who anticipated participating in well-developed professional communities were able to implement practical work more effectively than those who had high collaborative concerns.

Some experienced teachers have been found to deliberate about how practical work affects learners to the extent that they question the procedures that learners are given over the years. These teachers had concerns about how detailed instructions assisted learners in “doing the lab work right” (Olsen, Hewson & Lyons, 1996: 785), but the instructions could not assist learners in deriving the essence of the experiments. The teachers were more interested in learners understanding laboratory reasoning and not just following instructions from the laboratory manual. Another study found that while expert teachers focus on developing scientific reasoning as learners collect and interpret their data, less experienced teachers reflected on time-consuming planning requirements (The National Research Council, 2006).

Smith *et al.* (2002) found that 55 per cent of science teachers used laboratory simulations due to the concerns they had of how learners could be positively affected by different teaching strategies, 45 per cent of the teachers engaged learners in solving problems using simulations, while 45 per cent conducted practical work with sensors or probes to collect data. Forty-three per cent of teachers in that study were involved in refining the innovation by encouraging learners to retrieve or exchange data over the internet.

To contribute to the emerging body of scholarship, this study sought to link the theoretical framework of CBAM to the implementation of CAPS practical work in South Africa.

Methodology

The SoC of 81 teachers were analysed using CBAM. The teachers were selected by simple random sampling. Researchers used ideas from Fuller's research (1969) to assess teachers' concerns regarding amendments to any curriculum. This theory is based on the concept that the development of concerns is sequential, i.e. from concerns about oneself to task concerns and then finally to concerns that impact one's profession. The idea behind the theory is that at the beginning of an innovation, teachers are interested in how the change affects them. As time passes, teachers advance to interests in the task and then finally teachers find ways to improve the innovation for their learners and perhaps even change it altogether after gaining more experience. According to Hall and Hord (1987), if the facilitation of the reform is inappropriate then the concerns will remain submerged in the later stages.

The 35-item SoCQ developed by George, Hall and Stiegelbauer (2006), was modified with permission from the developers. The phrase "the innovation" was replaced with "practical work" throughout the questionnaire. Twenty-six items were categorised according to the six SoC that teachers rated using a 7-point Likert scale of intensity, utilising 0 (Irrelevant), 1-2 (Not true of me now), 3-5 (Somewhat true of me now) and 6-7 (Very true of me now). To ensure reliability and validity for the South African context, 12

respondents participated in a pilot study. The questionnaire was adjusted according to recommendations provided by the participants in the pilot study.

We used a pilot study to pre-test research instruments and the adequacy of the SoCQ for South Africa. The SoCQ was piloted with 12 physical sciences teachers to measure concerns as raw scores for each stage and then the data was converted into a graph to create a concerns profile (Hall & Hord, 2014). The SoC framework is a structure that helps in analysis and interpretation of teachers' concerns during reform implementation. Hall and Hord (2014) explain that concerns are apparent at each implementation stage and concerns may occur at more than one stage, resulting in a concerns profile. This assortment of concerns can be presented in a graph with the relative intensity of concerns and the SoC on the vertical and horizontal axis respectively. The less intense stages are represented by the valleys while the peak stages indicate the high intensity of stages. A person can display several peaks of concerns during different stages of implementation. To illustrate, an individual can have significant management concerns during the introduction of the reform but if s/he lacked proficiency then intense concerns at the personal level may predominate.

Permission was obtained from the Free State Department of Education (FSDoE) and from the principals of the schools involved. A consent form to be completed by respondents before participating in the study was provided. After self-administration of the SoCQ, appointments to collect the feedback were set up with secretaries in each school. Additional questionnaires were emailed back from inaccessible schools.

Demographic questions that relate to years of experience teaching physical sciences, years of professional development, gender and the respondents' highest qualification were included in the SoCQ. The figures were used to compute percentages and frequencies for the demographic variables. Means and standard deviations were also calculated for number of years of teaching experience and years of CAPS training.

The reliability of the instrument was tested and the Cronbach alphas are presented in the table below:

Table 5: Cronbach alphas for the respondents

Stage	Information	Personal	Management	Refocus	Consequences	Collaboration
Alphas	.81	.83	.79	.66	.74	.71

All stages attained high enough Cronbach alphas for all respondents. Acceptable reliabilities of the instrument are indicated by the values of the alphas, which should not exceed 0.9 (Streiner, 2003). The last stages had relatively low Cronbach alphas while the alphas for the management stage presented high alphas, as did those for the first two stages. The reliability estimates of the original test (Hall & Hord, 2014) can be compared with this study’s level of reliability. An understanding into the teachers’ general concerns is therefore enabled. The Statistical Application Sciences (SAS, 2013) software was used to examine the survey data. Furthermore, the responses of the participants on the SoCQ were evaluated according to the handbook of the SoC developed by George *et al.* (2006). Missing data were examined first. Respondents’ omission of data ranged from 3.2% to 7.3%.

Findings

The respondents’ feedback was used to investigate the concerns they had regarding the practical component of CAPS. The study hypothesises that teachers will have significant concerns regarding the innovation. The null hypothesis states that teachers will not have significant concerns about practical work.

Table 2 displays the mean raw amount totals and percentile amounts of the physical sciences teachers’ concerns. The interpretation of these concerns are accordingly very high, high, moderate, low or very low, based on the range of their percentile amounts; very high: 81–100, high: 61–80, moderate: 41–60, low: 21–40 and very low: 0–20.

Table 6: Mean raw amount totals and percentile amounts of physical sciences teachers

Stage of concern	Concern	Mean raw amount totals	Percentile amounts
Stage 1	Informational	14.59	57
Stage 2	Personal	14.61	59
Stage 3	Management	18.03	69
Stage 4	Consequence	18.02	24
Stage 5	Collaboration	17.44	36
Stage 6	Refocusing	15.80	47

The corresponding percentile amounts were assessed while the mean raw amount totals were rounded to 2 decimal places and the percentile amount was checked in the table as read from Figure 4.3 in the manual (George *et al.*, 2006: 29).

Table 2 illustrates the SoC profile in a representative sample of physical sciences teachers in the Motheo district of the Free State, South Africa. These teachers are expected to carry out practical work in grades 10, 11 and/or 12. As displayed above, the teachers' percentile amounts in stage 0 are omitted. This is because all physical sciences teachers are already conscious of the presence of practical work in the physical sciences syllabus. The percentile amounts in stage 3(69) (Management) were the highest, showing the most concern. This high amount reveals that individuals focused on the tasks and processes of carrying out practical activities. Teachers were attentive to completing objectives, obtaining resources and covering curricular content within the set time limits.

The percentile amounts in stages 2(59), 1(57) and 6(47) were moderate. Chamblee, Slough and Wunsch (2008), who investigated teacher concerns regarding the use of graphing calculators in mathematics, found that teachers in that study were interested in acquiring more information about that new change. The same result regarding teachers' concerns about the implementation of Strengthening of Mathematics and Science

Secondary Education (SMASSE) was found by Ndirangu and Nyagah (2013), where stage 1(80) concerns surpassed stage 2(78) concerns. In the present study, it appears that personal and informational concerns about practical work are not that important to the teachers since these two concerns deal mainly with how the teachers are personally affected by the innovation and issues of obtaining information on how to execute experiments.

The findings suggest that individuals were less concerned about the financial or personal status effects of practical work at their workplace. Informational concerns are also moderate, indicating that teachers attend to the basic requirements to execute experiments. The Department of Education provides adequate resources on how practical work should be conducted (DBE, 2011). This includes prescribed tasks, procedures, laboratories and access to uploaded experiments on software programs that are handed out. Since the inception of CAPS, the programs have been provided to each physical sciences teacher at the beginning of each year.

The percentile amount at stage 6(47) is at the lower moderate portion of the range showing that although teachers may have concerns regarding refocusing; these do not impede the conducting of experiments. It shows teachers would not consider changing the way the practical work is carried out or attempt to replace it with an alternative that is more dominant. This is because all practical exercises have strict prescriptions from the department on when and how to conduct them (DBE, 2011). The percentile amount of stage 5(36) is low, which is interesting because one would expect that if teachers have high management concerns, they would consequently seek to coordinate their efforts with others to get assistance in order to implement practical work successfully. These results are in contrast to those obtained by Ndirangu and Nyagah (2013) and George *et al.* (2006). Additionally in a different study, Meng, Sam and Osman (2015) also found that teachers' concerns about cooperating with regard to the application of lesson study at the schools were moderate. The lowest percentile amount (24) represents stage 4 (consequence). This relates to how the innovation influences colleagues and learners. The suggestion was that teachers had a lower focus on the significance of practical work

on learner performance in physical sciences, while more attention was given to ways of handling daily instructional practices.

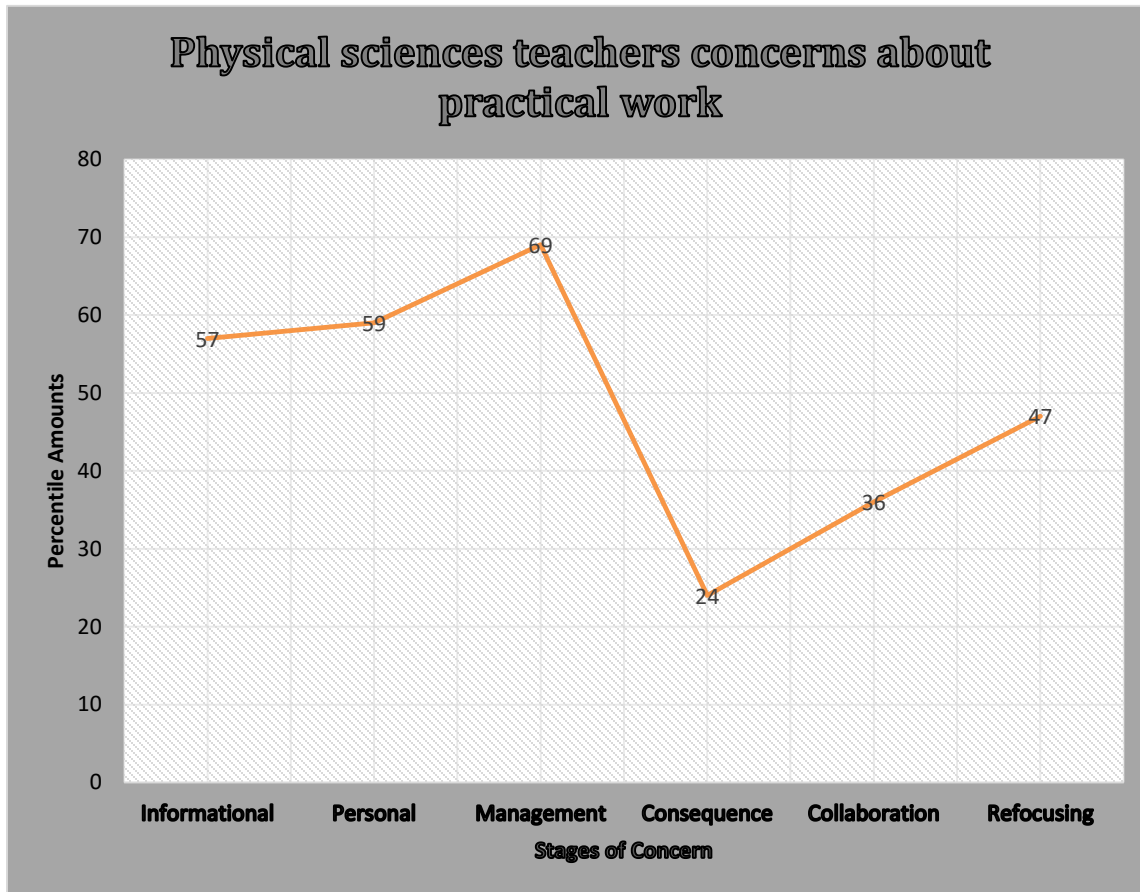


Figure 1: Teachers' SoC Profile

To express raw amount totals, each item response of the SoC was added. The mean raw amount totals were then determined for each stage of concern. Based on the percentile conversion chart for the SoCQ, the mean raw amount totals were changed to percentile amounts. A graphic profile was then plotted using the percentile amounts.

It was observed that male teachers dominated interest in collaboration while female teachers' concerns regarding management issues were significant. This was an unexpected finding because no teachers were discriminated against regarding training or

resources. The result suggests that female teachers may be concerned about the regular planning, organisation, leading and controlling of experiments. An additional observation was that older teachers were engaged with lower concerns at the informational and refocusing stages. The results indicate that, overall, the relatively younger teachers (25 to 35) had high concerns regarding implementing practical work. This result is similar to teachers with the highest qualifications having the most significant concerns at the personal, task and impact stages.

	STAGES OF CONCERN											
	Informational		Personal		Management		Consequence		Collaboration		Refocusing	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Gender												
Male (n=46, 57.5%)	14.35	7.72	14.60	5.38	17.91	5.73	18.08	6.07	18.20	6.54	15.45	5.36
Female (n=34, 42.5%)	14.93	8.29	14.63	7.38	18.19	6.87	17.93	7.01	16.42	6.77	16.27	6.41
Age												
21-24(n=10, 12.5%)	10.25	4.32	11.29	3.35	20.38	5.99	16.95	6.76	18.50	6.04	15.03	4.87
25-35(n=13, 16.3%)	20.19	10.73	18.97	7.91	20.90	8.12	21.23	8.39	21.13	8.44	18.69	7.15
36-41(n=13, 16.3%)	14.62	6.52	13.81	6.94	14.42	5.97	18.15	5.84	14.79	4.93	16.94	5.72
42-46(n=23, 28.8%)	15.43	7.41	13.91	5.90	16.37	5.30	17.75	6.02	17.45	6.71	15.50	5.56
Above 47(n=21, 26.3%)	12.26	6.93	14.79	5.15	19.18	4.76	16.74	5.64	16.29	6.01	13.99	5.51
Qualifications												
ACE/ Diploma(n=11, 13.8%)	12.27	7.78	14.36	6.17	17.91	4.89	15.61	5.53	15.64	5.89	15.45	6.19
PGCE (n=14, 17.5%)	14.82	4.85	13.69	5.46	17.57	6.15	18.82	5.97	17.57	5.02	14.50	5.03
Degree (n=16, 20%)	13.59	6.89	13.02	5.38	17.39	6.14	16.14	5.40	15.34	5.25	12.97	5.00
Honours (n=30, 37.5%)	14.42	9.37	15.50	6.65	17.71	6.79	18.21	7.63	18.30	7.94	16.44	5.92
Masters/PhD (n=9, 11.3%)	19.44	8.08	16.25	8.03	21.08	6.22	22.39	3.24	20.31	6.86	21.11	4.18
Teaching Experience												
<5 years (n=10, 12.5%)	16.75	10.34	15.92	6.85	21.60	6.28	18.48	7.88	19.80	7.45	14.98	7.69
5-10(n=18, 22.5%)	15.83	8.74	16.88	8.06	17.96	7.36	18.49	7.47	17.36	7.48	16.71	5.33
11-15(n=27, 33.8%)	15.28	7.76	14.12	6.58	16.93	5.85	18.55	5.41	16.21	6.38	16.56	6.58
16-20(n=11,13.8%)	11.59	6.15	13.56	2.47	17.00	3.99	15.59	6.97	17.27	6.18	12.11	3.26
>20 years (n=14, 17.5%)	12.50	6.20	12.56	3.95	18.50	6.45	17.96	5.87	18.36	6.17	16.64	4.11
CAPS Training												
<3 years (n=36, 45%)	16.08	8.45	16.50	6.03	18.88	5.75	19.28	6.07	17.22	6.70	15.43	6.99
3-4(n=44, 55%)	13.70	7.53	13.48	6.19	17.52	6.46	17.26	6.60	17.58	6.69	16.02	5.03
CAPS experience												
<3 years (n=30, 37.5%)	15.14	7.70	14.85	6.50	18.80	6.24	19.49	6.29	17.17	7.12	15.80	5.86
3-4(n=50, 62.5%)	14.15	8.16	14.42	6.14	17.40	6.17	16.87	6.39	17.66	6.32	15.80	5.38

Figure 2: Descriptive figures on stages of teachers' concerns with reference to some demographic variables

The descriptive figures regarding teachers' concerns about practical work in the physical sciences CAPS curriculum at informational, personal, management, consequence, collaboration and refocusing stages with respect to gender, age, years of experience in teaching, highest qualification achieved, CAPS experience and CAPS training are presented in Table 3. Subsequently, it was observed that an increase in the level of education from Master's degree to PhD presented more concerns about the reformed practical work. This indicates that teachers with higher qualifications have more concerns compared to those with lower qualifications. This also shows that these individuals are willing to collaborate with others and feel the need to achieve practical work objectives with instructional practices that positively contribute to learners' skills attainment in physical sciences. The lowest p -value at the refocusing concern confirms the notion that teachers do not see the need to restructure practical work in instructional practice.

Teachers with relatively less experience (<5 years) had the highest level of management concerns, followed by collaboration concerns. Interestingly, though, the more experienced teachers also had the same concerns as their colleagues but these were slightly less intense. This reveals less experienced individuals' preoccupation with day-to-day management of experimental activities, which was consistent with the findings of Christou *et al.* (2004). I projected such a result at the beginning of the study. Additionally, these relatively new teachers would like to join forces with other teachers to implement the innovation.

The teachers who had been implementing CAPS for less than three years had more concerns at the consequence stage compared to those who had been executing it for three to four years. This finding was the same as that of teachers who received CAPS training of fewer than three years and those with more than three years' training. This indicates that the former teachers were interested in learners' achievement of expected targets in relation to their involvement in laboratory work. They emphasised this part of CAPS so that learners' formal assessment marks would improve. Some teachers used previous papers with this objective in mind.

Summary of stages of concern by total years of experience and years of teachers' involvement with the innovation

	Dependent Variable	Sum of Squares	df	Mean Square	F	P
Teacher Experience (A)	Informational	9.897	4	2.474	0.9985	.4137
	Personal	7.586	4	1.896	1.2333	.3039
	Management	7.606	4	1.901	1.2469	.2984
	Consequences	2.884	4	0.721	0.4205	.7934
	Collaboration	4.326	4	1.081	0.6063	.6593
	Refocusing	7.595	4	1.899	1.4471	.0068
CAPS Experience (B)	Informational	8.330	2	4.165	1.7108	.1874
	Personal	6.479	2	3.239	2.1419	.1243
	Management	2.083	2	1.042	0.6691	.5151
	Consequences	2.503	2	1.252	0.7470	.4771
	Collaboration	0.113	2	0.057	0.0316	.9678
	Refocusing	1.464	2	0.732	0.5394	.5853

Figure 3: One-Way ANOVA summary of SoC by total years of experience and years of teachers' involvement with the innovation

It was hypothesised that the physical sciences teachers in the Motheo district would have concerns that are significant regarding the implementation of practical work. To examine this hypothesis, a one-way analysis of variance (ANOVA) was conducted with the six SoC based on biographical data.

Based on the CBAM, teachers' concerns were expected to change from self to task and finally to impact concerns. However, the results from the ANOVA do not support this hypothesis, as the F (1.25) and p-value (0.29) indicates. Teachers at less than five years of teaching experience had M (21.60). More experienced teachers had the next highest amount of M (18.50) and the rest of the mean amounts illustrate no sequential trend. The results exhibited in Table 4 on teacher experience (A) reveal that of the six stages presented, only refocusing was significant. For the five stages, it therefore seems as if age is not a significant predictor of teacher concern.

According to Hall and Hord (1987), high refocusing concerns are usually associated with the need to make positive changes to the innovation. Older teachers in this study possibly know of better ways to conduct practical work and are therefore able to make major modifications to the innovation.

Teachers' experience with CAPS reveals that the longer the teacher involvement with CAPS, the more collaboration concerns they have: $M (0.057)$, $F (0.01)$ and $p\text{-value} (0.96)$. Teachers with less CAPS experience on the other hand have significant management concerns: $M (1.04)$, $F (0.66)$ and $p\text{-value} (0.51)$. High management concerns are typically associated with the logistics of the innovation.

Discussion

The study set out to determine the concerns that physical sciences teachers have regarding the implementation of the practical work component of CAPS.

The most obvious finding that emerged from this study was that physical sciences teachers mainly focused on the task stage and experienced high management concerns but low collaboration concerns. This task stage of concern portrays the zone of enactment as expressed through Spillane (1999) that accentuates teachers' efforts to ensure that the innovation proceeds as expected. The hypothesis of this study, according to the obtained results, states that teachers' self-concerns at the inception of CAPS moved progressively to task concerns based on earlier research (Hall & Hord, 2014). Impact concerns are likely to be more significant in the future, as teachers become more involved with experimental environments at their schools and through professional development support. An additional observation is that consequence concerns are also low, prohibiting an improvement in the performance of learners in physical sciences (Bantwini, 2010).

There is an indication that not all teachers react the same way to practical work. Male teachers are willing to collaborate with others while their female counterparts face concerns that place time management issues as barriers to the effective adoption of practical work. Less experienced teachers' concerns did not gradually move from the task to impact stage, proposing that instructional experience was not the most relevant factor

in the explanation of how teaching concerns develop in this study. In this study, novice teachers' attention was focused more on coping with the CAPS curriculum implementation as a whole and less on learners' problems with practical work in particular. In contrast, experienced teachers were interested in the impact experiments had on their learners, and they had more ideas on how to improve their instructional practice compared to novice teachers.

Furthermore, the years of teachers' involvement in CAPS were less vital in explaining the development of concerns in the current study. This is similar to a study by Christou *et al.* (2004) that investigated Turkish teachers' concerns about a mathematics curriculum. In our study, there was a negligible change in teachers' concerns across their experience with CAPS over the time of its commencement. The data also showed slight differences in the types of concerns as teachers moved in implementing practical work.

The SoCQ was a fitting tool to identify the participating teachers' concerns regarding implementing practical work successfully at their schools and as a means to advance, emphasise and support professional development at schools. The findings of this study suggest that teachers require organisational skills to manage their resources well in order to execute experiments successfully. A further study could assess the professional developmental needs for physical sciences teachers, particularly focused on experimental instruction. A qualitative study could be undertaken with the aim of investigating how teachers deal with expectations regarding practical work.

The researchers would like to point out that they have not included the awareness concerns of teachers because there was an assumption that teachers know that practical work is compulsory in every science syllabus, and it can therefore not be ignored by the teachers, as the stage suggests. This assumption may be incorrect, as some teachers admitted to only concentrating on grade12 practical work and not on practical work in other grades. This calls for intense research into teachers' instructional practices regarding practical work at the FET level in South African schools.

Conclusion

The results point to concerns associated with management issues. These concerns might have been lessened if physical sciences workshops specialising in practical work had been conducted more regularly (Makgato, 2007). Directed regular professional development assists teachers in preparing and performing experiments effortlessly, which leads to accepting the importance of practical work as prescribed by CAPS. Results showed that participating teachers found collaboration to be an issue and this could interfere with the willingness of individuals to implement CAPS practical work (George *et al.*, 2006). It is probable for respondents in this study to lower self and task concerns and increase impact concerns for the purposes of implementing practical work effectively. Considering the amount of duties, tasks and roles of a physical sciences teacher, the self and task concerns shown in this study indicate the individuals' uncertainty about CAPS practical work.

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Article 2

Teachers' level of use of practical work in the South African physical sciences Curriculum and Assessment Policy Statement

Abstract

The new Curriculum and Assessment Policy Statement (CAPS) in South Africa prescribes more practical work investigations for physical sciences learners in grades 10-12 compared to all the previous versions, at least since the dawn of democracy in 1994. This qualitative study applied the concerns-based adoption model (CBAM) to investigate the extent to which science laboratory work by four high school physical sciences teachers in one district was implemented. Specifically, the levels of use (LoU) dimension of CBAM was used to explore the level at which the four high school physical sciences teachers teaching grades 10, 11 and/or 12 execute the practical component of the curriculum. Interviews and lesson observations were conducted with the four teachers. Findings showed that teachers' LoU were largely at the mechanical and routine levels, while the refinement level appeared to be less significant. This means that while teachers make the effort to implement practical work in their lessons, they were rather tentative, and characteristic, timeworn instructional approaches that are in opposition to CAPS tend to prevail. The findings of this study seem to suggest that more professional development and collaboration between teachers may be needed to enable better implementation of the CAPS practical work component.

Keywords: curriculum implementation, practical work, physical sciences, concerns-based adoption model, levels of use.

Introduction and background

The premium on practical work in school science is quite high worldwide (Kidman, 2012; Martins, 2013; Achuonye, 2015). Furthermore, there is an assertion that for practical work to be valuable, teachers need to implement it in a constructivist framework (Wink, 2010).

Constructivism supports inquiry based practical work in science curricula where learners participate actively during experiments. Practical work refers to practical features implemented by the teacher. Most national science curricula including the South African curriculum incorporate inquiry based laboratory activities (Bantwini, 2010), which form part of the reform trends in science education. The implementation of learner-centred practical work is designed to encourage learners to ask questions and hypothesise, design experiments, perform the planned experiments, analyse the results and present the results in a scientific way (Hofstein & Lunetta, 2004; Toplis & Allen, 2012). This is to engage fully with the science process skills. Around the world, practical work is not always implemented as effectively (Capps & Crawford, 2013; Stoffels 2006). Despite these findings, the DBE (2011) expects traditional teaching roles to diminish and for inquiry to be assimilated into practical work in line with the new curriculum. Teachers' level of use of science reforms is affected by among others, the administration burdens, intensified workloads and a lack of content knowledge and laboratory materials (Capps & Crawford, 2013). Additionally, a lack of collaborative structures with other teachers and subject advisors may also contribute to poor implementation (Hargreaves & Fullan 2012; Eilks & Hofstein, 2017).

Bantwini and KingMcKenzie (2011) documented that constant amendments and innovations to the National Curriculum Statement (NCS) brought about differences in how teachers implement CAPS. The implementation of inquiry in the South African science curriculum has been unsatisfactory, with teachers implementing science curricula at different levels of enactment (Stoffels, 2006; Webb, 2009).

A single national core syllabus was implemented in South Africa in 1994 with the aim of improving the low quality of education that was offered to previously disadvantaged groups of the South African population (DBE, 2011; Chisholm & Leyendecker, 2008). Three years later the outcomes-based education (OBE) curriculum was launched. In 2002 the revised national curriculum statement (RNCS) was introduced (Castleberry, 2010). The latter aimed to improve the implementation of OBE, particularly in underprivileged areas of South Africa. In 2009, the RNCS of 2002 was reviewed and amendments were

made to it and to the national curriculum statement (NCS) grades 10–12. The two amended curricula were then combined into the NCS grades R–12 and teachers implemented the NCS in January 2012. The Curriculum and Assessment Policy Statement (CAPS) is incorporated in the NCS and informs teachers how to implement the new curriculum (DoE, 2003). Since the implementation of CAPS, it remains unclear how physical sciences teachers have effectively executed the practical work component (Bantwini, 2010). CAPS advocates for a scientific inquiry approach to apply scientific laws, theories and models for the explanation and prediction of scientific events in the environment. CAPS recommends, as stated by Miller (2004) and Tafa (2012), that practical work be integrated with theory to strengthen the concepts being taught. A teacher may do a simple demonstration of an experiment or even a practical investigation (Toplis & Allen, 2012; Choi, Hand & Greenbowe, 2013).

There is a significant shift in the South African science curriculum in the FET band, where practical work has now become a priority (DBE, 2011). Optimal integration of practical work with theory is supposed to fortify concepts that will be learnt (CAPS Free State Assessment Guidelines of physical sciences, 2014). Learners may be exposed to practical investigations, simple practical demonstrations or experiments. According to CAPS, (2011:16),

An experiment refers to a set of outlined instructions for learners to follow in order to obtain results or to verify/test established theory. A practical investigation requires from learners to go through the scientific process, which means that [it] is conducted to test a hypothesis because the result is not known beforehand.

Teachers implement the practical work based on the practical skills required for problem-solving and scientific inquiry. These skills include “process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts” (CAPS Free State Assessment Guidelines, 2014: 5). The expectation from the DoE (2000) is for teachers to develop the competencies to be able to implement practical work. Physical sciences CAPS was well received and supported by the majority of teachers, some of whom took part in

professional development opportunities to enable them to implement it (Naidoo & Govender, 2010; Thompson, 2010). Teachers were also trained in physical sciences and other subjects through the Advanced Certificate in Education (ACE), as was the case in East Timor (Capelo, Cabrita & Lucas, 2015). Although the training for CAPS may have been relevant for physical sciences, significant gaps remain for the practical work (Dudu, 2014). The success of the programme in helping teachers be adept at implementing practical work in physical sciences classrooms remains an open question. Unfortunately, there is an assumption that teachers have a tendency to forget ninety per cent of the material taught at workshops and experience this training as uninteresting and irrelevant (Moeed & Easterbrook, 2014).

Exploring the implementation experiences of teachers of the practical components of the new curriculum is a problem worth researching so that teachers may be assisted in the best implementation strategies in future.

Literature review

Implementation of inquiry in science has been advocated for in various countries (Anderson, 2010; Zerafa & Gatt, 2014). Teachers implement practical work with the aim of giving learners the opportunity to structure investigative questions and hypothesis, conduct the experiment themselves and effectively draw conclusions after collecting the data and interpreting the results (Hegarty-Hazel, 1986; Flick, 2000; Keys & Bryan, 2001; Lederman, 2009). A study by Abrahams and Millar (2008) found that teachers mainly focused on developing learners' basic knowledge, rather than on developing understanding of scientific enquiry procedures. The learners were able to manipulate physical objects but could not use them to derive hypotheses or draw conclusions with the data collected. In another study, the implementation of practical work involved tasks that did not include strategies to help learners link the investigative question and the conclusion (Miller, 2004). The study concluded that considerable time was needed to

organise practical activities and training was required for evident progress in implementing practical work.

Some teachers' implementation of practical work is characterised by learners following step-by-step instructions, specific questions being asked by their teachers (Banchi & Bell, 2008) and information being supplied to them during practical activities (Vhurumuku, 2011). In these instances, learners were given limited opportunities to frame questions or to conduct the investigations, and teachers had predictable teaching methods where data were collected and results interpreted largely with the teachers' assistance. Although learners seldom drew their own conclusions, teachers felt confident with the innovation. The outcome of the experiment was generally known prior to the investigation. Other studies show that when some teachers implement practical work in science, their activities are not focused on the needs of learners because thinking about the proofs, evidence or collected data by learners is discouraged (Songer, Lee & McDonald, 2003; Klassen, 2009). These teachers show partial interest in adjusting aspects of tasks in order to capitalise on the impact on the learners.

In spite of the challenges and constraints (Dai *et al.*, 2011), some teachers do implement practical work accurately with the awareness of its importance to the learners in the future. There is some research about the extent of the implementation of practical work in schools (Keys & Bryan, 2001; Lederman, 2009). Kuhn (2010) for instance observes that teachers who have adequate time are able to collaborate with each other and thus exchange information about methods of dealing with practical-work. Billings (2001) notes high levels of implementation when teachers used learner on stage teaching. This means that learners are given an opportunity to perform the experiment actively. This adjustment in conducting experiments encouraged learner-centeredness.

There are promising developments in the execution of science curricula by teachers worldwide, but the question remains of how far the practical aspects of these curricula are implemented. Historically, curricula in South Africa have poor implementation records,

which calls for a study to uncover and track teachers' progress and challenges as they implement the new requirements regarding practical work in CAPS. Teachers tend to carry out their practices based on their beliefs, behaviours and concerns (Donohoo, 2016). The concerns-based adoption model (CBAM) thus provides a useful instrument for leaders in education to track and assess innovation implementation (Hall & Hord, 2014). Teachers' LoU of a reform can be measured by using CBAM. This study proposed to study the implementation of CAPS practical work in South Africa using CBAM's LoU instruments. This study commenced with the extant literature on CBAM. This was followed by an account of the research methods and procedures used in the study. The outcomes of the investigation were then discussed. Finally, implications, limitations and directions for future research were offered.

Theoretical framework

CBAM

The purpose of this research was to answer the research question: "What are the LoU in the implementation of practical work by physical sciences teachers in the Motheo district of South Africa?" More specifically, this study aims to investigate teachers' level of implementation of the practical work component of CAPS and make recommendations for improvement.

CBAM shows educational leaders, reformers and researchers how the individuals most affected by curriculum change react to the implementation of these innovations (Hall & Hord, 2014). Three diagnostic instruments of CBAM are often used to measure the developmental processes of an innovation. These instruments are referred to as the stages of concern (SoC), LoU – which was used in this study – and innovation configurations (IC).

According to Hall and Roussin (2013), an individual's level of use of the innovation is important in diagnosing the progress attained in implementing a change. This measures the actual work done by the teacher in relation to the innovation. Hall and Hord (2014) argue that the way in which users and non-users of the innovation conduct themselves, indicates at which level they are in the change process. As a teacher moves from one level of use to another, support is required and that is the major aim of investigating teacher behaviour. There are eight LoU, according to Hall and Roussin (2013).

Table 1: The eight LoU according to Hall and Roussin (2013)

Level & description	Behavioural indicators of level
0 – Non-use	There is no observable behaviour of the teacher to be involved in the innovation.
I – Orientation	A teacher actively looks for information about the innovation, its workings and what is demanded from him/her.
II – Preparation	The intention to use the innovation is high, so s/he acquires the necessary materials and resources. This individual would be preparing for first-time use.
III – Mechanical use	A teacher at this level is inexperienced and experiments with different ways of using the innovation. Considerable time is taken up by making plans to get the needed materials and familiarising the learners with the programme. It is not strange for people to stay at this level for a while. If enough training is offered on how to use the innovation, progress will be observed. It is characterised by stress and uncertainty.
IVA – Routine use	The teacher would have learnt the skills to use the innovation and would be comfortable with what s/he is doing. The individual feels relieved, stable and confident regarding the reform.
IVB – Refinement	The behaviours and activities of users at this stage are focused on the needs of learners. Individuals start amending the innovation with the intention of capitalising on its impact on the learners. The teacher makes these changes according to what s/he knows about the anticipated future of the innovation.
V – Integration	If teachers are at this stage, collaboration commitments are made with other teachers with a focus of contributing information to other teachers' methods of dealing with the innovation.
VI – Renewal	A teacher at this stage would renew the innovation by adjusting some aspects of the innovation, while some teachers go to the extent of changing it completely.

An additional instrument, the SoCQ, includes the feelings and emotions that teachers might have when curriculum amendments are made. The aim of understanding teachers' LoU of a reform is to assist them in progressing through the seven SoC in CBAM (Landon, 2010). As teachers advance through the eight LoU, progress would take place from unconcerned at stage 0 to sharing ideas by collaborating (stage 4) with other teachers, then refining the reform to make it more effective and then finally moving on to stage 6 where changes may be made if necessary. The third diagnostic instrument, namely the innovation configuration (IC), deals directly with the characteristics of the innovation and its meaning when the innovation is the frame of reference (as reported by Hall & Roussin, 2013). The IC was not used in this study.

Methodology

The intention of this case study was to provide insights into the levels of implementation of the practical component of CAPS by physical sciences teachers in the Motheo district in the Free State, South Africa. This was investigated using CBAM. A pilot study was conducted in one school, where a grade 10 lesson was observed and the teacher interviewed. The teacher was purposively selected. She taught at a rural farm school with laboratory equipment for CAPS physical sciences. I explained the purpose of the research to the principal, the teacher and a parent component and got permission to proceed with the study.

With 33 years of teaching experience, the science teacher was the head of the science department at that school and taught all three grades (10-12) at FET level. The one-hour interview that was conducted with the teacher was audiotaped after school. A clearer picture of how the instruments generated the data emerged from the pilot study. A summary of the pilot results were given by reiterating the story from the teacher's perspective and performing the content analysis of the data collected through all the instruments. The pilot study did not contribute to the data of the main study. Its exclusion prevents contamination (Simon, 2011). Involving pilot study participants and then

collecting new data from them can contribute to contamination (Teijlingen & Hundley, 2001) and was avoided altogether. Permission was obtained from the Free State Department of Education, affected principals and four teachers to provide lesson observations, which were audio-recorded and narratives that defined the way CAPS practical work was implemented. A research journal was kept and field notes were written on lesson observations. The CAPS document and practical worksheets used during the lessons were analysed via document analysis. It must be noted that the Department of Education provided worksheets for CAPS practical work but teachers may use them according to their contexts. My background, skills, knowledge and experience as a physical science teacher was used as the main source of all data collection and analysis. Qualitative research seeks to make meaning or understand observed phenomena (Lincoln & Guba, 2013). A rich and holistic understanding of teachers' implementation of CAPS practical work was enabled through clarification and follow-up questions. My presence helped to put the spotlight on other issues unrelated to the study. Three teachers mentioned the lack of respect for the laboratories in their schools. Some laboratories were borrowed for teacher interviews or meetings, disciplinary meetings and at times, examination centres.

The criteria used in the participants' selection were that of school quintiles. The quintile system places schools into quintiles one to five and subsidises them accordingly. Schools in quintiles one to three receive more in government funds, often do not charge fees and are usually located in the rural townships (Mestry & Ndhlovu, 2014). Quintile 5 (Q5) are schools that receive relatively less assistance from the government. I assumed that more funding might lead to access to materials including laboratory resources that would result in the effective implementation of practical work. Four teachers from different quintile contexts were studied to obtain as much information as possible on the implementation of CAPS practical work.

The pseudonyms Abram, Ben, Henrie and Naomi (aged 61, 52, 38 and 45 respectively) were used consistently to refer to the same persons throughout the study, as recommended by Creswell (2014).

The interview data was recorded, transcribed, analysed and interpreted using content analysis. Rubin and Rubin (2012) propose that qualitative content could be interpreted by systematically classifying text data. The existing CBAM theory was used to focus the research questions and to predict the variables of interest. The interviews together with observations proved to be strengths of this study because the themes according to CBAM emerged so that more could be understood about how far teachers have implemented practical work.

Teaching with a degree in science (physics and chemistry) at a former model-C (Q5) school and previously at a technical school, Abram had access to a fully equipped laboratory throughout his career. Ben and Henrie also taught in school science laboratories but the latter had equipment for all prescribed CAPS experiments. Both teachers had Masters' degrees in science, with Ben majoring in education in physics, chemistry and mathematics. Henrie majored in chemistry. Ben, an expatriate, teaches at a township (Q3) school. He has taught science at primary and high school levels, he trained prospective science teachers at a teacher training college and had been a physical sciences subject advisor back in his country of origin. Henrie has experience as a laboratory assistant in the United States of America and previously taught science in various countries including Cuba, Namibia and Zimbabwe. He teaches at a rural coloured (Q1) school in the township. A state of the art laboratory was recently taken into use by the school that Naomi teaches at, with each prescribed experimental activity having adequate apparatus. The school that Naomi teaches at is an African (Q4) school in a township. All teachers teach grades 10, 11 and 12 with the exception of Naomi who does not teach grade 10.

Findings

This section discusses the findings of the study. Initially, the findings regarding each teacher's lesson and interview are presented together with the emerging themes from the findings of the study. The aim of this study was to identify the level of implementation of CAPS practical work by FET physical sciences teachers. The teachers provided learners with prescribed practical investigations that included experimental procedures.

Theme 1: LoU-II Preparation

Naomi narrated her experience with CAPS practical work. She is responsible for two grade 12 classes, one grade 11 and three grade 8 classes with an average of 50 learners per class. Her time for experiments is reserved for grade 12 learners. A grade 11 lesson was observed in which learners had to investigate the effect of different surfaces on the maximum static frictional force. The reason she chose to teach this grade for the study was that the practical was scheduled in the CAPS document; thus, she was compelled to perform the experiment. She confessed that because the department focused on this grade when controlling work schedules, she preferred to "push the grade 12 curriculum and not too much of the grade 11 practicals". Grade 11 practical activities have a mainly physics theme, so she experienced stress and seldom attended to this part of CAPS.

Nna I just want to say I hate the physics part, I just love the chemistry part the physics is not simple like when a worksheet asks the learners to evaluate something, physics is too much hey in CAPS.

Naomi admitted to struggling with the setting up of experiment apparatus. When asked about the recently acquired fully equipped laboratory and the adequacy of the apparatus for the learners, her response was that the donors had not provided training for the use of the materials and equipment such that most items were still packed in their boxes. This was expressed in the following statement.

I admit that my lab has equipment but I just need help at least someone to assist me to prepare the lab and apparatus I just don't prepare for the practicals because some of those things I have not unpacked them, but I make sure that I have the worksheet so that they [learners] can follow me during the practical.

Naomi usually provides learners with a worksheet that she revises with them. Revision included most of the practical skills recommended by CAPS, from formulation of investigative questions, hypothesis, apparatus naming and handling, taking measurements, making observations, recording and handling data, analysing and interpreting data and drawing conclusions.

She did not receive much support from the Department of Education either:

I get no support from my Lf even from the district office here so I can't use some of that nice equipment. I get nervous sometimes so I tell some boys to help me with the experiments. If workshops are there I will know what to do by myself. I only attended those ones when CAPS was new, but they didn't show us much practicals in grade 11.

Naomi reiterated her wish to have a laboratory assistant. The role of an assistant would be to explain some concepts, particularly in physics since "didn't like that part of sciences" and to set up and remove apparatus for the learners. While she desired other teachers' backing for successful instructional strategies, she experienced none and worked in isolation. She indicated that whenever teachers met "...it's always about it's a lot of work to be done". There is another science teacher teaching grade 10 at Naomi's school but collaboration is absent because the other teacher claims that she is unable to assist Naomi since she is merely a junior teacher.

Theme 2: LoU-IV-A Routine

Henrie had experience teaching first year science students in the United States of America for two years as a laboratory assistant. He is responsible for two classes in each grade with an average of 40 learners. His current laboratory has the latest apparatus and

he is able to perform practical work with grade 12 learners as recommended by CAPS. Assembling the apparatus for the experiment usually takes up nearly ten minutes, during which time the learners are normally given the experiment handouts. Learners do not get the opportunity to conduct the experiments themselves since Henrie focuses on assessments. Thus, learners observe specific phenomena while Henrie explains the scientific phenomena. The following explains how CAPS practical work is implemented:

The learners usually observe the practical lesson; I first teach the content so that they can conduct the experiments themselves, they have to pass the assessments at the end of the term. They get the worksheets to get all the instructions sometimes before the practical. Then we recap methods of formulating investigative questions and hypotheses during the laboratory period. They have to know what to do in advance. Then I put them in groups. Also at grades 10 and 11 they are tested on theory not practical so at the end of the day I prepare them very much enough for that.

During the observation, the learners completed their worksheets while Henrie hurriedly put the apparatus away. He explained that he had to prepare for another class and it was time consuming to place “everything where it should be in the storeroom so I do it during the previous class”. Henrie explained that the modules are arranged in such a way that teachers should strictly do what was expected of the work schedules. He prepared his learners with formal assessments in mind.

Overall, a teacher-centred approach was still used to implement CAPS practical work as revealed by Achuonye (2015). Henrie admitted that his instructional practice was still the same in CAPS as it had been in NCS. The learners did not construct their own conclusions, while Henrie admitted that he taught them to do so.

Theme 3: LoU-IV-B Refinement

Ben has less advanced equipment than Abram; nonetheless, technology is incorporated in his lab. He is responsible for one grade 12 class, two grade 11 and three grade 10 classes with an average of 40 learners. Nevertheless, this enthusiastic teacher facilitated

practical work with passion and with a purpose of equipping learners with science knowledge for the future. The aim of the grade 11 practical for that session was to determine the resultant of three nonlinear force-vectors. He gives each learner a worksheet, which has the instructions and questions about the experiment then he shows them the practical. The learners are able to create experimental procedures after knowing investigative questions from what has been taught. Solutions are obtained after getting the results from the experiment. The teacher performs the demonstration and the learners see results from their seats on a projector. After the demonstration, the investigation is done in pairs. The appropriate apparatus is then set up and used according to the instructions of the worksheet.

Ben indicated that he had attended all CAPS introductory workshops. The professional development had little focus on practical work; thus, he resorted to self-empowerment. When questioned about collaborative efforts with other teachers, Ben does not see the need for cluster groups as he feels that most involve a presenter who discusses a past exam paper and its memorandum, something that teachers can do on their own. Ben says the cluster group that he participated in attempted to help with implementation by revising some of the practical sessions, but these are rare.

Ben admitted to being unable to facilitate practical work actively and frequently in grade 10, learners were involved in it twice or thrice per term. This was corroborated by a learner's input:

In grade 10 there are many practicals to do even our textbooks show us, and our teacher made sure we do all of them, we did like maybe two by ourselves and then our teacher helped to do them by himself so that we could understand practical exams and not just cram answers from past papers. Now in our grade [11] we do practicals more than last year ourselves. At least when we get to grade 12 we will do all of them, those learners are always in the lab. Our teacher wants us to like science even in university so he encourages us a lot. Also they use technology at university so at least we have started here at school, we will not be lost when we do the work.

Ben adjusted his science practical instruction to improve learners' understanding of concepts:

Rather than the South African [science] because there are things that are South Africanised, aah, science is not obtained from a textbook or past paper examinations but from the teacher researching about a topic and bringing the knowledge as a whole to the learners. I get videos from the internet and show them on the projector.

Ben stated that he always performed the practical alone prior to learner involvement.

This preparation helps me to make sure that the skills that are recommended by CAPS are addressed during the practical. I don't like surprises in the lab. I do the practical work myself alone way before the class...set up do the test to see whether it is working because history has shown me that...it might not work then after that I teach the theory then next I do the practical and finally I give the learners to do the practical. Usually I do this for grades 12 and 11; for grade 10 I usually demonstrate if I do not prepare their equipment.

Theme 4: LoU-VI Renewal

Abram usually conducts grade 10 experimental investigations in the afternoons to have more time for the scope of the work. He was passionate about implementing practical work according to CAPS. He is responsible for one class in grade 11 and 12 and two grade 10 classes with an average of 20 learners. When asked about the frequency of the practicals, learners stated that because of the afternoon classes, they are able to do two practicals a week. A well-equipped laboratory ensures that each learner knows the name of the apparatus used for the activity. Each pair of learners is supplied with their own apparatus. Most equipment in this laboratory is technologically advanced. Abram stated that the high-tech apparatus motivates his learners to perform experiments by themselves; they are also able to formulate investigative questions and hypothesise. He gave learners a chance to handle and collect apparatus despite time constraints. Although he has access to prescribed worksheets, he creates his own. He prepares activities according to the learners' abilities.

Abram uses technology in addition to conventional apparatus such as voltmeters and ammeters, his learners use an application called crocodile clips to create different scenarios regarding electric circuits. His implementation manner is different from Henrie's in that the learners are actively involved in the practical and they do not have to view the procedures from afar. Learners in this lesson handled the apparatus safely and correctly.

Abram further elaborated thusly:

You see in the last five, six years there is something like we call YouTube and there is a lot of experiments... I use the Smart board also I can stop the experiment on the YouTube and explain it...this generation unlike 20 years ago, they want to see the thing visually because they are on cellphones, I also show them Edukite a program from India it shows the experiments very well.

When asked how implementation of CAPS practical work can be enhanced, Abram recalls a previous era when new science teachers were thoroughly trained annually in practical work at the local university.

When I came to start teaching in the 80s, the LFs [learning facilitators] would take teachers to the University of the Free State and we do the experiments in that labs all the experiments for the next term, yes they demonstrate it and we as teachers do it and then I start to like the practicals, but that helped me a lot in these days hey as a teacher we do them in March and June and September then also in January so that we can know how to do the experiments properly. But nowadays the LFs talk about the problem is the money and things like that.

He added that professional development efforts have been hampered due to a lack of finances since CAPS started focussing mainly on supplying teachers with notes and CDs containing experiments.

Data analysis

The purpose of the current study was to determine the level at which practical work was being implemented by four physical sciences teachers in the Motheo district of South

Africa. Fullan (2015) argues that rather than being an event, change is a process. The implementation of CAPS practical work by the four teachers follows a relatively similar thread in some regards. While Naomi and Henrie provided investigative questions and the hypothesis to learners at the onset of the experiments, Abram and Ben did the opposite by designing procedures for the experiment and instructing learners to form investigative questions and a hypothesis. Learners are able to design experimental procedures because they already know the question and solution from the content that they have been taught before the experiment was conducted.

Findings by Dudu and Vhurumuku (2012), established that teachers implement practical work differently in South Africa. Naomi and Henrie provided learners with the opportunity to develop procedural knowledge to a degree to reinforce understanding. The objective of Abram and Ben's implementation was for learners to develop higher order skills resulting in implementation of CAPS practical work at higher level.

The present study provides grounds for the statement that although some physical sciences teachers, as key agents of change, are at relatively low LoU of CAPS practical work (the mechanical level); others practise at higher routine and refinement levels. The teachers in this study are therefore expected to proceed to higher LoU, for example, by analysing learner practical work performance and trying to search for alternative ways of executing experiments so that all learners obtain the skills outlined by CAPS. Naomi appears to be at the mechanical level where the focus is on the short-term, day-to-day use of practical work and she seems to have little time for reflection. The changes she habitually makes – i.e. requesting volunteers – are primarily used to meet her needs of inadequacy rather than the acquisition of learner experimental skills. An incoherent and superficial implementation results mainly due to her mechanical experimental procedure that depicts a lack of mastery at practical work (Wilson, 2013).

There was notable contradiction between the data collected during the practical sessions and data collected during the interviews. Observational data suggested that Naomi was at LoU-II (Preparation) but data from the interviews presented her at LoU-III (Mechanical). She appeared stressed and uncertain about how to carry out the experiment and seeking

the necessary materials seemed like a first-time experience. Although the interview data was a self-report, the extent of the teachers' implementation was accounted for by the actual observation in the laboratory. I employed more than one source for the data in order to obtain reliability. Abram and Ben revealed higher LoU during the lesson observation LoU-IV-B (Refinement) and LoU-VI (Renewal) respectively. Henrie's level of implementation during the laboratory session together with that of Abram and Ben was indicative of LoU-IV-A (Routine), signifying their comfort with the innovation. Their sessions went through the experimental procedure of writing an investigative question, formulating a hypothesis, identifying and describing variables, collecting, assembling and using apparatus, taking measurements, making observations, recording and data handling, analysing and interpreting data using calculations, testing hypothesis and drawing conclusions.

In a study investigating how learners were prepared for the Advanced Level Physics practical in the Zimbabwean school system, Munikwa, Chinamasa and Mukava (2011) found that teachers still taught using guided and demonstrated experiments while lectures and past examination papers were mainly used for revision. Teacher knowledge, skills and monitoring reports were lacking. Similar to the current study, staff development programmes and time were limited, as confirmed by Vasconcelos *et al.* (2015), preventing successful science implementation.

Conclusions

Increased contact time with physical sciences learners is recommended so that teachers can apply the curriculum effectively and move through the stages of LoU as change is being implemented. There is a proposition by Muwanga-Zake (1998) for the allocation of fewer teaching periods for science teachers in order for teachers to prepare laboratory activities. Teachers in this study performed lab work after school hours while others prepared the laboratory for the following class during the last part of a lesson that was in session. Teachers are overburdened with lesson preparations, teaching, setting and

marking of tests and examinations, preparing practical tasks, managing equipment and a laboratory, ordering and replacing chemicals and equipment as well as other tasks such as class registers, moderation and class mark sheets. The administrative workload of teachers needs to be organised in such a way to allow teachers to implement practical work as recommended by CAPS.

Teachers in this study called for laboratory assistants to be introduced in the school system to assist in the preparation of the laboratory for experiments. Thair and Treagust (1999) found that teachers felt that to involve students in more student-centred teaching practices in physics, more preparation time was crucial to prepare teaching materials for classroom and practical activities, and that time in class was essential for these activities, which generated difficulties in covering the content in an already burdened curriculum.

School equipment and programmes should be equitably distributed by the Department of Education but teachers should also improvise and not always wait for departmental intervention. The suggestion by Swift (1983) is for teachers to be aware of prospective visual aids around them. Everyday items could be used to demonstrate or perform experiments (Oyoo, 2013). Our surroundings should be used to enhance teaching by considering improvisation (Carelse, 1983).

Tertiary institutions must offer programmes in the implementation of CAPS. These programmes should emphasise more usage of practical work in teaching. Laboratory management and practical work courses should form part of science teachers' qualifications. Ogunniyi (1996) supports the view for pre-service training to include realistic training that closely matches the school science curriculum. Training in the use of group work is imperative too because some teachers are faced with large science classes. Because many teachers are unfamiliar with the effectiveness of group work, they resort to demonstrations of experiments. Teachers need to know how to prepare suitable activities for group work so that learners actively participate and learn the necessary

concepts of practical work. Conversely, to ensure a training process that encompasses all aspects envisaged by CAPS, teacher trainers and curriculum developers ought to work closely together.

In-service teachers should also be continuously trained to implement all aspects of an existing or new curriculum (Leu & Ginsburg, 2011) with sufficient support from subject facilitators. As documented in Calloids, Gottelmann-Duret and Lewin (1997), vacation classes, short workshops or well-planned circulars can assist in in-service training. This in-service training ought to be progressive, motivational and consistent for optimum teacher participation and implementation of what was learnt. The in-service training involves support based at schools during or after school hours, short weeklong courses, three-month longer in-service courses or in-service days at local centres such as well-equipped schools (Oyoo, 2013). Likewise, teachers should be continuous learners, keeping up-to-date with physical sciences content and in the process becoming self-reliant (Desimone, 2011) in the form of high-quality professional development.

The current findings have demonstrated CBAM as a valuable framework in the exploration of teachers' involvement in the implementation process of practical work according to CAPS. The results on teachers' LoU support the argument that rather than being an event, change is a process (Fullan, 2015). It is important to plan intervention programmes for the support of teachers through reform and progress to higher levels of integration and possibly even renewal.

Policymakers should provide the most appropriate types of support or assistance required for the successful implementation of practical work in this and other contexts. This is consistent with literature by Lee and Buxton (2013), who suggest that continuing professional development policies and systems should be redesigned with teachers' needs in mind.

Despite using a purposefully selected group of four teachers, who may not be representative of all physical sciences teachers in the Motheo district, the findings indicate that teachers' implementation of CAPS practical work is not as effective as expected by curriculum policymakers.

In retrospect, for my data collection approach, video records could be used for each observed lesson to remind me of any information that could have been omitted.

Further research should explore teachers' experiences with cluster meetings and the manner in which these meetings assist teachers with the implementation of practical work.

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SECTION 3

This section summarises the information from the two publishable articles. Research questions and findings from which conclusions are drawn are linked to the existing literature. Initially teachers' concerns regarding practical work according to CAPS are investigated and this is followed by how far teachers have implemented this component of CAPS according to the LoU of CBAM. The findings on the extent of implementation are examined. Support and recommendations for better execution of CAPS practical work for further research are also illustrated.

3.1 Discussion

As discussed in article 1 (see pages 40-62 in this report), this study examined the relationship between teachers' age, gender, academic qualifications, CAPS teaching training, CAPS experience and teacher concerns for 81 physical sciences teachers in Motheo. Additionally, the extent to which physical sciences teachers implement CAPS practical work was investigated. The findings on the research questions will be discussed separately.

Research question 1: What type of concerns do FET physical sciences teachers have about implementing the practical work component of CAPS?

The findings suggest that physical sciences teachers have high management and low collaboration concerns. The percentile score in stage three (69) indicates this, which represents a focus on the tasks and processes of carrying out practical activities. The task stage of CBAM emerged significantly. Teachers' self-concerns at the inception of CAPS moved progressively to task concerns as noted in earlier research (Hall & Roussin, 2013). Teachers' attention mainly focused on day-to-day activities for the implementation of high school experiments. An additional observation is that consequence concerns were low. The moderate percentile score observed in stages 1, 2 and 6 (57, 59 and 47) respectively, contradicted results found by Chamblee, Slough and Wunsch (2008). Those

researchers explored the use of graphic calculators and teacher concerns about their use and the acquisition of more information by teachers in that study was significant. Ndirangu and Nyagah (2013) also found that stage 1 concerns with a percentile score of 80 were slightly higher than stage 2 (78). The implementation of Strengthening of Mathematics and Science Secondary Education (SMASSE) under investigation caused informational and personal concerns. Collaboration concerns were low, indicating that teachers had little concern with collaborating with other teachers in light of the CAPS practical work.

Research question 2: What are the differences in teachers' concerns regarding the implementation of practical work, if any, in relation to a number of demographic variables such as gender, educational level, teaching experience and exposure to professional development?

There was a statistically positive and significant relationship between teachers' academic qualifications and teaching experience, at $0.04 \leq \alpha \leq 0.11$ levels of significance. According to Hall and Hord (2011), high refocusing concerns are usually associated with a presence of strong resistance to change. Older teachers in this study possibly know of better ways to conduct practical work and are therefore able to make major modifications to the innovation. The CAPS training had a positive and significant relationship with teacher concerns. However, teachers' experience with CAPS had a negative and significant relationship with teacher concerns indicating that it was not a significant factor affecting teacher concerns. Based on CBAM, teachers' concerns were because on their experience with the implementation of the practical component of CAPS, and they were expected to change from self to task and finally to impact concerns. However, the results from the ANOVA do not support this hypothesis: $F(1.25)$, p -value (0.29), while teachers at less than 5 years teaching had $M(21.60)$. More experienced teachers had the next highest amount of $M(18.50)$ and the rest of the mean amounts illustrate no sequential trend. Teachers' collaborative efforts were unlike findings of Huberman (1989), who commented that teachers with teaching experience of 19 years or more were less interested and less committed to other teachers as they approached the peak of their careers.

The results exhibited in Figure 2 on teacher experience (A) reveal that of the six stages presented, only refocusing was found significant. For the five stages, age therefore seems not to be a significant predictor of teacher concern. With regard to the South African context, these findings indicate that despite the teachers' age, they were interested in learner achievement.

Teachers' experience with CAPS reveals that the longer the teacher involvement with CAPS, the more collaboration concerns they have: M (0.057), F (0.01) and p-value (0.96). Teachers with less CAPS experience on the other hand, have significant management concerns: M (1.04), F (0.66) and p-value (0.51). High management concerns are typically associated with the logistics of the innovation.

The key findings from article 2 (see this report on pages 55-83) answer research questions 3 and 4.

Research question 3: What are the variations in the levels of implementation by FET teachers in the Motheo district of the physical sciences practical components of CAPS? The second article assisted in answering research question 3 by exploring the various LoU of the innovation, in this case CAPS practical work.

There were notable conflicts between the data collected during the behavioural observations and data collected during the interviews. Behavioural observations were ranked at LoU-II (Preparation) while interviews were confined to LoU-III (Mechanical) for twenty-five per cent of the participants. This occurs when teachers perform under stress and low confidence when implementing an innovation (Wilson, 2013). One participant responded "yes" to the first question on the branching interview and was placed at LoU-III (mechanical) but in practice, the observations suggested placement at LoU-II (Preparation). The self-reported data from the LoU branching and semi-structured interviews might have suggested behaviours that would be viewed as more advanced in their implementation of the CAPS practical work than what was actually observed in the

classroom. This probable limitation of self-report was overcome by using the SoC questionnaire to avoid limiting oneself to a single data source. Additionally, twenty-five per cent of the participants revealed higher LoU during the lesson observation LoU-VI (Renewal) and LoU-IV-B (Refinement) individually. Seventy-five per cent of the participants indicated LoU-IV-A (Routine) during the laboratory sessions, signifying comfort with the innovation. This is similar to findings by Wang (2014). The sessions went through the experimental procedure of writing an investigative question, formulating a hypothesis, identifying and describing variables, collecting, assembling and using apparatus, taking measurements, making observations, recording and data handling, analysing and interpreting data using calculations, testing a hypothesis and drawing conclusions as expected by CAPS.

Research question 4: What suggestions and/or recommendations can be made regarding the teachers' concerns and levels of implementation?

Internationally it was found that although teachers implement the science curricula, there is evidence of minimal practical work (Christou *et al.*, 2004; Wang, 2014; Fullan, 2015). In South Africa, similar poor implementation of the CAPS practical work appears to be associated with a lack of collaboration and time.

Teachers' concerns might have been lessened if professional development focusing on practical work had been conducted regularly and not as one-time events. Gudyanga (2017) reiterates the need for professional development

These contextual factors appear to have a negative effect on the implementation of the CAPS practical work. Targeted and ongoing professional development helps teachers understand how to implement CAPS practical activities effectively (Tunks & Weller, 2009; Selepe, 2016). The four teachers all pointed out that they had insufficient time to implement practical work effectively, as encountered by Taole (2015). Gudyanga (2017: iv) also found out that "CAPS reforms might not have significantly changed teachers' practices".

3.2 Conclusion

There was a need to explore the extent of implementation of CAPS practical work and teacher concerns due to the lack of information on the topic. This study has proved that CBAM is a useful framework to explore the stages at which teachers implement practical work in CAPS together with the stage at which concerns are. It is important to plan intervention programmes for the support of teachers through the reform and progress to higher levels of integration and possibly renewal. Effective programmes to train pre-service teachers can be designed and the most appropriate types of support or assistance required for the successful implementation of practical work. This study will assist teachers as they implement programmes and make decisions for their cluster workshops to guarantee success in the classroom and beyond.

3.3 Implications

Firstly, the analysis and findings suggest that because of the stress associated with experimental activities at FET level regarding day-to-day responsibilities, school management and district officials should review the timetabling of practical activities. This would improve the execution of this component of CAPS.

Secondly, because the syllabus is here to stay, teachers require additional professional development support. The findings of this study support the importance of pre-service and in-service teacher training. Training should focus on hands-on practical work with the teachers actually carrying out the work.

Thirdly, subject advisors should work closely with teachers and heads of science departments at schools to regularly monitor work at all grade levels and not only grade 12. The existing professional learning communities should be more active and supportive.

Fourthly, the challenges posed by “white elephant” education centres lead to the recommendation that managers of such centres reintroduce their services professionally to the communities that they are supposed to assist.

This study exposed the poor implementation of a vital area of physical sciences and how the skills expected by CAPS were undermined. This highlights the need for professional growth and intervention. Insights into the challenges of teaching practical work at FET level have been presented. The study has contributed to the understanding of the growing field of CBAM in South African schools and has highlighted the status of curriculum implementation locally and internationally.

3.4 Limitations

This data identifies the concerns and LoU of practical work of physical sciences teachers in the South African context. A relatively small number of teachers participated in this study and although they may represent other teachers, the limitations are that the results cannot be generalised to all physical sciences teachers in the country. Nonetheless, an interpretation of the findings can contribute to a deeper understanding of the concerns and the extent of implementation regarding practical work. Further research on concerns of other stakeholders such as school management and district officials might provide additional insights that can enhance this understanding. The case study on the implementation of practical work according to CAPS could be improved by exploring the degree to which concerns of teachers are aligned to actual practices. Day-to-day experimental lesson observations could provide more insight into the actual levels of implementation. School management and district officials will find the study useful in understanding the challenges faced by physical sciences teachers when implementing experimental activities and improving learners’ performance in their schools.

Additional research could explore the effects of teachers’ concerns or LoU on learner performance in their first year of tertiary education or pre-service science teachers. High

school learner voices regarding their experiences with CAPS practical work could also be considered.

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³ The references noted here are for sections 1 and 3 only. The two articles each contain their own list of references.

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ANNEXURE 1: STUDENT NAME CHANGE AFFIDAVIT

SWORN AFFIDAVIT/BEËDIGDE VERKLARING

I/Ek ENID CAROLINE NALUBEGA YIGA with/met ID Nr. 7309241210085
Residing at/woonagtig te 77 BRAND STREET THABANATHU FREE STATE
tel. nr. 0842200790 employed at/en werksaam te TLOTANANG COMBINED SCHOOL
met tel. nr. 051 875 1473

Declare under oath in English/Verklaar onder eed in Afrikaans:

I HAVE CHANGED MY SURNAME FROM YIGA TO
OGUOMA. I AM OFFICIALLY MARRIED TO Mr. KECHUKWU
CHWAEZE OGUOMA DATE OF BIRTH 09 JUNE 1976. THE
MARRIAGE WAS ON 12 AUGUST 2016.



I know and understand the contents of this statement / Ek is vertrouwd met die inhoud van hierdie verklaring en begryp dit.
I have no objection to taking the prescribed oath / Ek het geen beswaar teen die aflegging van die voorgeskrewe eed nie.
I consider the prescribed oath to be binding on my conscience / Ek beskou die voorgeskrewe eed as bindend aan my gewete.


DEPONENT'S SIGNATURE

I certify that the above statement was taken by me and that the deponent has acknowledged that he/she knows and understands the contents of this statement and swears to/affirms before me and deponent's signature/mark or thumb print was placed thereon in my presence

at BLOEMFONTEIN on 2017/ 02 / 27 at 19:00 (time)


SIGNATURE OF COMMISSIONER OF OATHS

NOELIANO BAZINA
FULL FIRST NAMES AND SURNAME

NO. 2 PARKWEG, WILLOWS, BLOEMFONTEIN



S. A. POLICE SERVICES
PARKWEG

ANNEXURE 2: PERMISSION LETTER FROM DOE

Enquiries: BM Kitching
Ref: Research Permission:
Tel. 051 404 9283 / 9221 / 082 454 1519
Email: berthakitching@gmail.com and B.Kitching@edu.fs.gov.za



ENC Yiga
77 Brand Street
Thaba Nchu, 9780

084 2200 790

Dear Ms Yiga

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

1. This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

Research Topic: South African Teachers' Concerns and Levels of Use of Practical Work in the Physical Sciences Curriculum and Assessment Policy Statement

2. Approval is herewith granted to conduct research in 75 Schools offering Physical Science in Grades 10 – 12 in Motheo District.
3. **Target Population:** 100 Physical Science Educators.
4. **Period of research:** For three months from the date of signature of this letter. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year.
5. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension.
6. The approval is subject to the following conditions:
 - 6.1 The collection of data should not interfere with the normal tuition time or teaching process.
 - 6.2 A bound copy of the research document or CD should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.
 - 6.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.
 - 6.4 The attached ethics documents must be adhered to in the discourse of your study in our department.
7. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely


DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 29/02/2016

RESEARCH APPLICATION PERMISSION YIGA 23 FEB 2016
Strategic Planning, Policy & Research Directorate
Private Bag X20565, Bloemfontein, 9300 - Room 318, Old CNA Building, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 Fax: (086) 6678 678

ANNEXURE 3: TEACHER CONSENT FORM

(a) INTERVIEW PROTOCOL FOR PHYSICAL SCIENCE TEACHERS

University of the Free State
Bloemfontein
____/____/2016

Dear Participant

Re: Request for permission to participate in interviews on teachers' levels of use about practical work in Physical Sciences.

I hereby invite you to participate in follow up interviews on teachers' levels of use about practical work in Physical Sciences.

My name is Enid Yiga, and I am presently studying for a Masters' degree (Higher Education Studies) at the University of Free State. As part of my studies, I am required to conduct research on an aspect of interest and I am interested in the concerns of teachers about practical work and their level of implementation. The title of my dissertation is: **Teachers' Concerns with and Levels of Use of practical work in the Physical Sciences Curriculum and Assessment Policy Statement**

This proposed research investigates the concerns that Physical Sciences teachers have regarding practical work and their Levels of Use of this part of the curriculum in their classrooms.

The study will involve a face-to-face dialogue with me on the extent of your implementation of practical work in your classroom. You have been selected to participate in a follow up interview that is not more than an hour long. The interview will address issues of curriculum coverage in practical work, your experiences and suggestions on how your instructional practice may be enhanced.

As an educator I believe you have very valuable insights to contribute to this study. I undertake to observe confidentiality and protect you from physical, social and/or psychological harm. At no time will your name or school be revealed in the report of this study-pseudonyms or false names will be used. Your participation in the study is voluntary and you may withdraw at any time you so wish. Results of the study will be used for educational purposes only.

In the event that you need any further information or you experience any discomfort with the interviews, do not hesitate to inform me or contact my supervisor (Prof L.C. Jita +27514017522/lajita@ufs.ac.za)

Once again, thank you for your assistance and cooperation.

Yours Sincerely

Enid Yiga
0842200790
enidyiga@gmail.com

Supervisor Professor Loyiso Jita
+27514017522/lajita@ufs.ac.za

CONSENT FORM

I understand the nature and purpose of the study. I also understand that I have the opportunity to withdraw from the study at any time and that the information I give will be confidential and will not be disclosed for any other purposes other than the research for the present study.

I therefore give my consent to participate

I
Signature: _____ Date: _____

ANNEXURE 4: LETTER TO PRINCIPAL

University of Free State
01 March 2016

School Address
The Principal

REQUEST FOR PERMISSION TO CONDUCT RESEARCH WITH TEACHERS

Dear Sir/Madam,

My name is Enid Yiga, and I am a Masters' degree (Higher Education Studies) student at the University of the Free State in Bloemfontein. For my Masters' dissertation, I am doing research on the topic 'Teachers' Concerns with and Levels of Use of practical work in the Physical Sciences Curriculum and Assessment Policy Statement'. Practical work is an integral part of the CAPS curriculum and we wish to examine the opinions and attitudes that teachers have regarding it, we also wish to investigate how implementation is carried out on this issue. My research project is supervised by Professor Loyiso C. Jita (l.jita@ufs.ac.za or 051 401 7522).

I hereby request permission to conduct research with FET Physical Sciences teachers, who deal with practical work throughout the year. The research involves completion of a short questionnaire for not more than an hour, there will be no interference with teaching and learning time, as the surveys may be responded to at opportune times. There will be a second phase of data collection involving interviews with six (6) teachers. The interviews will last an hour focusing on the extent to which teachers are implementing practical work in their classrooms. The aim is to explore the level of implementation that this part of the curriculum is at. Informed consent will be requested from the teachers, who will be free to participate or not. No names of teachers and/or schools will be used in any reports of the study.

Attached is a letter of recommendation from my research supervisor at the University of the Free State.

Upon completion of the study, I undertake to provide the Free State Department of Education with a copy of the research report(s).

If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my supervisor (l.jita@ufs.ac.za or 051 401 7522)

Thank you for your time and consideration in this matter.

Yours Sincerely,

Enid Yiga

Cell: 084 220 0790 e-mail: enidyiga@gmail.com

ANNEXURE 5: UFS LETTER



Office of the SANRAL CHAIR in Maths & Science
Faculty of Education
University of the Free State
P.O. Box 331
Bloemfontein 9300
08 February 2016

TO WHOM IT MAY CONCERN

CONFIRMATION LETTER FOR Mrs. Enid Yiga

This is to confirm that **Ms. Enid Yiga** is a MEd candidate at the University of the Free State. She is registered with me as the Supervisor, in the Faculty of Education. In the past year, Ms. Yiga has been able to **successfully prepare and defend the required proposal for a research project** on the following topic:

Teachers' Concerns and Levels of Use of Practical Work in the Physical Sciences Curriculum and Assessment Policy Statement

Her research project on the concerns and levels of use of practical work by Physical Sciences teachers with respect to the implementation of the new CAPS curriculum is a very critical investigation that seeks to shed light on how the teachers make sense of practical work in the new curriculum, what their concerns and challenges are and how they work to resolve these challenges in their classroom practices. The research has potentially interesting prospects and lessons for both teachers and policymakers, in that it will document current challenges and opportunities for successful implementation, and provide recommendations for improvement of current practice with respect to practical work. To date, no such study has been done in the context of the implementation of CAPS in Physical Sciences in South Africa, thus making her work all the more important.

Ms. Yiga is presently scheduled to begin data collection in the Motheo district. She has also **submitted drafts of chapters one, two & three** of her dissertation and therefore understands clearly what the research involves and how to conduct the study in an ethical and responsible manner. She also understands the need to get informed consent from the principals and the teachers involved.

Please do not hesitate to contact me by telephone and/or e-mail, should you require any other details regarding his studies and/or progress: +27-514017522 or jitalc@ufs.ac.za

Yours sincerely


Loyiso C Jita (PhD)
Professor & SANRAL Chair in Mathematics and Science Education
Faculty of Education
University of the Free State

ANNEXURE 6: SoCQ
BIOGRAPHICAL DATA

11. Please complete the following information with an x

Age

_____ 25-30

_____ 31-35

_____ 36-41

_____ 42-46

_____ Above 47

Gender

_____ Male

_____ Female

Highest degree earned

_____ Diploma

_____ ACE Certificate

_____ PGCE

_____ Degree

_____ Honours

_____ Masters

_____ PhD

Years of teaching experience

_____ Less than 5 years

_____ 5 to 10 years

_____ 11 to 15 years

_____ 16 to 20 years

_____ More than 20 years

Years of experience with CAPS practical work

_____ less than 3 years

_____ 3 to 4 years

_____ More than 5 years

Years of CAPS training

_____ less than 3 years

_____ 3 to 4 years

_____ More than 5 years

STAGES OF CONCERN QUESTIONNAIRE

Reproduced with permission from the Southwest Educational Development Laboratory.

For this survey, Practical Work refers to:

- Practical Investigations
- Practical Experiments
- Teacher Demonstrations

Section 1

The items for this section of the questionnaire were developed from typical responses of Physical Sciences teachers who were asked about practical work.

For each of the statements below, mark the box in the column that best describes your experience now. Choose the number between 1 (*Not True of Me Now*) and 7 (*Very True of Me Now*) that is most suitable for each statement. If the statement appears to be of little or no relevance to you, mark the box in the column labelled "Not Relevant".

Please respond to the items in terms of your present concerns about your involvement with practical work.

1. What are your present concerns about your involvement with practical work? (*Tick one box on each line*)

Survey of Concerns

Read each statement and tick the number that best represents your perception about

CAPS PRACTICAL WORK in Physical Sciences. Use the rating scale provided below as your guide for representing your perception.

Regarding your involvement with Practical Work		<i>Not True of Somewhat True Very True</i>
--	--	--

	Not Relevant	Me Nowof Me Nowof Me Now						
		1	2	3	4	5	6	7

Regarding your involvement with Practical work		0	1	2	3	4	5	6	7
1.	I am concerned about learners' attitudes toward practical work.								
2.	I now know of some other approaches that might work better in performing practical work.								
3.	I am concerned about not having enough time to organise myself each day.								
4.	I would like to help other teachers in their incorporation of practical work into Physical Sciences teaching.								
5.	I would like to know the effect of the use of practical work in my teaching of Physical Sciences and on my professional status.								
6.	I am concerned about conflict between my interests in practical work and my responsibilities to teach all Physical Sciences ideas.								
7.	I am concerned about revising the way I conduct practical work.								
8.	I would like to develop working relationships with both our teachers and outside teachers using practical work.								
9.	I am concerned about how conducting practical work affects learners.								
10.	I would like to know who will make the decisions in how we perform practical work.								
11.	I am concerned about my inability to manage all that is required to include practical work in my Physical Sciences teaching.								
12.	I would like to know how my teaching and administration is supposed to change.								
13.	I would like to familiarise other departments or persons with the progress of incorporating practical work into my Physical Sciences instruction.								
14.	I am concerned about evaluating my impact on learners.								
15.	I would like to revise the instructional approach to practical work.								
16.	I am completely occupied with other things.								
17.	I would like to modify our use of practical work based on the experiences of the learners.								
18.	I would like to excite my learners about their part in learning by practical work.								

19.	I am concerned about my time spent working with non-academic problems related to practical work.																		
20.	I would like to know what practical work will require in the immediate future.																		
21.	I would like to coordinate my efforts with others to maximise the effect of performing practical work in my Physical Sciences teaching.																		
22.	I would like to know how other teachers perform practical work.																		
23.	I would like to find out how to supplement, enhance, or replace the way I carry out practical work in my teaching.																		
24.	I would like to use feedback from learners to change the way I combine practical work into my Physical Sciences teaching																		
25.	I would like to know how my role will change when I include practical work in my lessons.																		
26.	Coordination of tasks and people is taking too much of my time.																		
27.	I would like to know how incorporating practical work is better than the way we teach Physical Sciences now.																		

THANK YOU!!! Please indicate whether you would like to participate in a follow up interview.
 Yes..... No.....Contact details.....

ANNEXURE 7: INTERVIEW QUESTIONS

The research questions and hypotheses that will guide the qualitative phase of data collection on teachers' LoU of practical work are:

Research questions:

- What are the variations in the level of implementation, by FET teachers in the Motheo District, of the Physical Sciences practical component of the CAPS?
- What suggestions and /or recommendations can be made regarding the teachers' concerns and levels of implementation?

Questions for the structured interview

1. Please provide your background.
2. Please, how often does CAPS practical work occur in your classroom?
3. How do you with perform CAPS practical work?
4. How learner-centred is CAPS practical work in your classroom?
5. How do you prepare for CAPS practical work in your science classroom?
6. What are your major successes regarding the execution of CAPS practical work?
7. What changes if any would you make to the execution of CAPS practical work?
8. How helpful are other teachers' input regarding CAPS practical work?
9. How have you being professionally developed in terms of CAPS practical work?
10. Please, what suggestions can you give to enhance support for effective teaching of CAPS practical work?