AN EVALUATION OF A MATHEMATICS PROFESSIONAL TEACHER DEVELOPMENT PROGRAMME

by

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DECLARATION

I declare that AN EVALUATION OF A MATHEMATICS PROFESSIONAL TEACHER DEVELOPMENT PROGRAMME is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE DATE

Benita Portia Nel

DEDICATION

I dedicate this work to my parents, Percy and Joy Williams, for putting me on a path of lifelong learning, allowing me so many opportunities in life which you yourselves were not afforded. Through your lives and sacrifices I was able to reach this point in my life. I would also not be able to do this without the love and support of my husband, Reginald Nel. Your achievements, constant motivation, support and talks got me though very tough times. Last, but surely not least, I dedicate this work to our beautiful and hardworking daughters, Ranique and Melayna, who understood the sacrifices made, who supported me, but also whose achievements pushed me to give more.

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ABSTRACT

Although South African teachers have ample opportunities for professional development (PD), weak results of learners show that these opportunities have had a limited effect on the development of the Mathematics teachers' instructional skills. The improvement of the teaching of Mathematics is regarded as a solution to learners' poor performance, because teachers play a key role in the improvement of pupils' learning. In the light of this, a Mathematics PD programme implemented in a province of South Africa was evaluated and served as a case study. The aim of this evaluation was to probe the quality of the programme since it had been suggested that improving the quality of teaching can be achieved by offering effective PD programmes. Thus, the evaluation was done in an attempt to establish the academic value of the intervention. The investigated programme – which was implemented in a rural and under-resourced setting – focused on FET Mathematics teachers and used mentoring and workshops as its key intervention implementers. Five teachers were involved in this programme. Data collection methods included semi-structured interviews, lesson observations, mentoring and workshop reports, the results of learners, and pre- and post-test results of the participants. The evaluation of the PD programme revealed the following: that the workshops addressed the participants' content knowledge gap to a limited degree; that mentoring was able to assist with the individual classroom-related needs of the participants, and that the community of practice formed in the workshops helped the participants to develop by means of working together on lesson preparation, micro-teaching, and content knowledge exercises. Other findings revealed that the duration of the workshops were adequate, however their intensity was insufficient to effectively address the participants' needs, and that the workshops were carefully planned, given that the same topics were repeated. The mentor teachers and other facilitators encountered challenges relating to the long intervals between the mentoring sessions, the limited post-lesson-observation discussion time, the significant distances between the involved schools and the heavy teaching load of the participants. Nevertheless, recommendations on improving the effectiveness of future PD programmes included careful selection of the dosage of interventions, site-based mentoring, to incentivise participants of PD programmes, alleviating the teaching load of overburdened participants and the creation of conducive environments in rural areas for the formation of communities of practice.

ABBREVIATIONS

ABET	- Adult Basic Education and Training
ANA	- Annual National Assessment
CAPS	- Curriculum Assessment Policy Statement
CENESA	- Cooperation in Education between the Netherlands and South Africa
CEO	- Chief Executive Officer
CIPP	- Context, Input, Process, and Product evaluation model
CPD	- Continuous Professional Development
DBE	- Department of Basic Education
DIPIP	- Data Informed Practice Improvement Project
DoE	- Department of Education
ECD	- Early Childhood Development
FET	- Further Education and Training
GDE	- Gauteng Department of Education
GET	- General Education and Training
GPLMSP	- Gauteng Province Language and Mathematics Strategy Project
HOD	- Head of Department
HSRC	- Human Sciences Research Council
IEB	- Independent Examination Board
INSET	- In-service Education and Training
JET	- Joint Education Trust
ML	- Mathematical Literacy
MOU	- Memorandum Of Understanding
MSDF	- Michael and Susan Dell Foundation
NAPTOSA	- National Professional Teachers' Organisation of South Africa
NCS	- National Curriculum Statement
NGO	- Non-Government Organisation
NSES	- National School Effectiveness Study
OPR	- Output to Purpose Review
PCK	- Pedagogical Content Knowledge
PD	- Professional Development

PEM	- Programme Executive Manager
PLESME	- Programme for Leader Educators in Senior Phase Mathematics Education
PS	- Physical Sciences
QLP	- Quality Learning Project
SADTU	- South African Democratic Teachers' Union
SPSS	- Statistical Package for Social Sciences
SSIM	- Systematic School Improvement Model
TIMSS	- Trends in International Mathematics and Science Study
UNISA	- University of South Africa

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1.1 Background

Considerable resources have been invested in the development of the Mathematics teacher in South Africa, with the aim of improving the quality of Mathematics teaching (Government Gazette, 2007: 24). The Mathematics teacher development initiative is primarily supported by provincial education departments, universities, NGOs, community-based organisations, teachers' unions, and faith-based organisations (Government Gazette, 2007: 24). The private sector also funds some of the in-service Mathematics teacher development programmes as part of its social responsibility. However, despite these efforts, poor learner performance in Mathematics prevails. This observation is supported by data supplied by the Department of Education (DOE) at a symposium organised in February 2011. This symposium focused on grade 12 Mathematics and Physical Science results for 2010. According to the data provided by the DOE, grade 12 Mathematics pass rates were respectively 45.7% in 2008, 46% in 2009, and 47.4% in 2010 (DOE, 2010: 26). These figures indicate a minor improvement over the three years. It is important to emphasise that a 47.4 % pass rate implies a 52.6% failure rate.

Consequently, Adler (2002: 2) questioned the effectiveness of the INSET professional development programmes implemented in South Africa in the mid-1980s with the aim of fostering educational improvement in Mathematics. The Human Science Research Council (HSRC) (2006: 118) attributes learners' poor results to, among other reasons, poor preparation on the part of teachers. This is supported by the Trends in International Mathematics and Science Study (TIMSS) report which reveals the non-inclusion of Mathematics in the initial training of one third of Mathematics teachers (HSRC, 2006: 116). However in the TIMMS Report of 2012 in South Africa 89% of the Mathematics teachers have either Mathematics or Mathematics Education included in their training (Mullis, Martin, Foy & Arora; 2012:

291). The HSRC 2006 report further indicates that, although South African teachers have ample opportunities for professional development, learners' poor performance shows that these opportunities have had a limited impact on teacher development. It is also claimed that the "quality control measures (of PD programmes) are frequently inadequate or absent" (Government Gazette, 2007: 24). In the light of the above observations, it becomes essential to elaborate mechanisms for an external evaluation of professional development (PD) programmes and make appropriate recommendations. This is because donors' continued investment of considerable resources in Mathematics teacher PD programmes depends on their ability to yield positive results.

Thus, this study suggests that one possible way of redressing the low Mathematics pass rates in South African schools is to improve the quality of teaching by offering effective PD programmes to teachers. The envisaged in-service programmes should, among other things, provide Mathematics teachers with further skills and knowledge, as well as update and upgrade their existing skills and knowledge.

1.1.2 Problem statement

Although the TIMSS report reveals that one third of Mathematics teachers did not have Mathematics as a subject in their initial training (HSRC, 2006: 116), the need for in-service training for teachers in South Africa has resulted in a plethora of Mathematics PD programmes. Examples of such programmes include the Quality Learning Project (QLP), the Programme for Leader Educators in Senior Phase Mathematics Education (PLESME), and the Gauteng Province Language and Mathematics Strategy Project (GPLMSP). Despite the availability of these Mathematics teacher development programmes in South Africa – where a vast amount of funds and resources are invested and bursaries made available to practicing teachers to enable them to further their studies, there is not a significant increase in the grade 12 Mathematics pass rate in schools. It must be emphasised that an increase in grade 12 Mathematics pass rate is desperately needed to address the shortage of highly-needed skills in Mathematics. It is therefore not surprising that there remains a question over the effectiveness of these programmes insofar as Mathematics teachers' performance and competence are concerned.

Thus, this study aims to investigate this problem, through an in-depth evaluation of one PD programme, in order to gain strategic insight that would inform the design of future teacher development programmes.

1.1.3 The Mathematics teacher development programme under investigation

For ethical reasons, the name of the teacher development programme being investigated in the current study is not disclosed. Nevertheless, it is worth noting that the programme was designed and piloted by the Joint Education Trust (JET), which is also the service provider of the programme. Furthermore, the programme was implemented in the Eastern Cape and the North West Province. However, this assessment focussed solely on the North West Province where only five high schools were considered out of the 26 schools that participated in the broader programme. The reason for only focussing on these five schools is that they were the only schools which fell in the Mathematics Further Education and Training (FET) section of the programme, which is the focus of this study. The aim was not only to gain new insights in order to make an original contribution to the discipline of Mathematics Education, but also – and ultimately – to improve the practice of teacher development. In other words, the aim of the study was not to (again) highlight the failures and challenges, but rather to creatively contribute to the development of effective Mathematics PD programmes. The selected PD programme, because it was based in one of South Africa's provinces that face serious challenges, met the criteria of a programme implemented in a rural under-resourced area that strives to improve its Mathematics results. Here, it becomes important to provide an overview of the broader project.

The broader Mathematics Teacher Development School Improvement Project had six main components (JET, 2010: 1):

1. Stakeholders mobilisation
2. Planning and organisation
3. Teacher performance
4. Parent involvement
5. District support
6. Teacher competence

The outcomes of the broader project include:

1. Improved support and mentoring of schools by districts
2. Increased parent and community involvement
3. Enhanced functionality of schools as organisations
4. Boosted teachers' competence and performance
5. Better-quality learning and educational outcomes

The model used in this programme is based on the belief that optimal school improvement is dependent on partnerships between key stakeholders, namely, district and circuit officials, school managers, teachers and their unions, parents, and funders. The broader project started in 2009 as a 5-year project that was implemented in a district of the North West Province, in a cluster where the grade 12 results were the lowest. Although this project extends from grade 1 to grade 12 and includes subjects such as Mathematical Literacy, Physical Science and English, this research only focused on the Mathematics teacher development in the FET section. This included grades 10, 11 and 12. The Mathematics teacher development component was sponsored by one donor, and was planned and implemented for three years, namely, 2010, 2011 and 2012.

Given that there were five schools in the Mathematics cluster which offered the FET phase, all five FET Mathematics teachers from each of these schools were involved in this study. Given that this research centred on the development of Mathematics teachers, in terms of outcomes 4 and 5 above, the components that were focused on were the improvement of teachers' performance, the enhancement of teachers' competence, and the improvement of the quality of learning and educational outcomes. The related intervention strategies included are:

- Content-and-classroom-based workshops (4 per year).
- Mentoring of teachers
- Self-directed learning
- Teacher book club
- Professional learning cluster involvement
- Common work plans and assessments

Ultimately, the programme aimed at bringing about improved learner results. It started with a baseline assessment of teachers in Mathematics, Physical Science, and English. The topics and issues that surfaced in the analysis of the pre-tests were discussed in the content-and-classroom-based workshops, with the intention of filling the gap in the content knowledge of the participating teachers. A facilitator was assigned to mentor these teachers inside and outside the classroom. This was an appropriate way of supporting the teachers, by virtue of its potential to address the unique needs of individual teachers. Furthermore, the self-directed learning intended to assist teachers with the enrichment and actualisation of their knowledge. As for the teacher book club, it sought to foster a culture of reading which is conducive to professional development. For this development to occur, teachers were expected to engage with articles that add professional value. As far as professional learning clusters were concerned, they were expected to provide opportunities for the establishment of an effective community of practice in which teachers could share their experiences, particularly the challenging ones.

One key characteristic of the studied PD programme was the involvement of the various stakeholders. Indeed, this programme involved the provincial Department of Education, through district and circuit officials, the South African Democratic Teachers' Union (SADTU), the National Professional Teachers' Organisation of South Africa (NAPTOSA), the communities surrounding the selected schools, and the learners' parents. All these stakeholders were represented on the steering committee of the programme. The latter met once a term to discuss the programme's progress, its challenges, and their possible solutions. This broad involvement sought to ensure buy-in from all stakeholders, as well as sustainability on completion of the programme. Furthermore, given that a school is not an island, a collective effort was necessary to ensure multi-pronged support to teaching and learning. Interestingly, the teachers who were employees of the Department of Education viewed this programme as an extension of their employer's mandate, instead of a duplication of work.

In this study the focus was on investigating the effect of the workshops and mentoring as interventions. The self-directed learning, the teacher book clubs, the

professional learning clusters and the common work plans and assessments were not investigated. The reason for not focusing on the mentioned interventions was the fact that either these interventions did not get off the ground or the interventions were not sustained throughout the span of the programme.

1.1.4 Research question

This study addressed the following research question:

What was the effect of the identified Mathematics professional teacher development programme on the teachers' competence and performance and learners' success?

In addressing this question, I focused on the following sub-questions:

1.1.4.1 How did the workshops affect teachers' development in terms of their competence and performance?

1.1.4.2 How did the mentoring affect teachers' development insofar as their competence and performance?

1.1.4.3 How did the participating teachers' competence and performance affect their learners' performance?

1.1.5 Significance of the study

The effect of a Mathematics professional teacher development programme was evaluated in an attempt to establish the worth of this intervention. In the process, the results and discussions (at least for this region) could shed light on why the Mathematics results in South Africa are not improving at a significant rate, despite the fact that a reasonable amount of resources and time is invested in these kinds of endeavours. Possible recommendations emanating from this research could be of value to professional developers, in their broader endeavour to redress and improve education in South Africa at large.

1.1.6 Rationale for the Study

Since the advent of the new dispensation in South Africa in 1994, the status of Mathematics as a gateway-subject to careers such as engineering and science – in which the previously disadvantaged sector of the South African population is

underrepresented – has been re-emphasised. Consequently, more value has been attached to Mathematics education in previously disadvantaged communities. There is an effort by both the public and private sectors of South Africa to build the nation by improving Mathematics Education in different ways. Different interventions have been initiated to equip Mathematics teachers with the necessary knowledge and skills that would enable them to address the challenges faced in the South African context (Adler & Reed, 2002: 32). The improvement of the teaching of Mathematics is regarded as a solution to learners' poor performance in this subject (Loucks-Horseley et al., 2010: 86). In other words, one way of improving learners' (Mathematics) pass rates is to up-skill teachers involved in the current system. However, the up-skilling of teachers is dependent on the quality of and effective implementation of programmes such as the Mathematics teacher professional development.

As it becomes evident, South Africa's Mathematics teacher development programmes need to be evaluated to assess their worth. An evaluation "distinguishes what works from what doesn't, and helps separate effective change makers from resource wasters …" (Patton, 2008: xviii). Sparks (2002: 11-6), for instance, has questioned the contentment of some, in the field of staff development, who tolerate programmes and activities of low standard. In other words, very few people have endeavoured to critique these ineffective programmes which waste the time of the teachers participating in them. Thus, the researcher argues that there is a need for an in-depth evaluation of the Mathematics PD programmes offered to teachers in South Africa. This study aimed specifically to investigate the effectiveness of a Mathematics teacher development programme implemented in the North West Province of South Africa.

The selection of this programme was based on the fact that it was a pilot programme aimed at achieving sustainable transformation in the South African Mathematics Education context, over a long period (five years for the broader programme). This is a key strategic objective. Should this programme engender significant improvement in the performance of teachers and learners, the model could be duplicated and used widely.

1.1.7. Definition of key terms

1.1.7.1 In-service education and training (INSET)

In-service education and training is defined in some countries as the preparation teachers receive on-the-job, without having a qualified teacher status (Villegas-Reimers, 2003: 55). However, in the context of this study, INSET programmes are defined as professional education and training activities which primary and secondary school teachers and principals engage in, after their initial professional qualification. The intention of these activities is to improve the participants' professional knowledge, skills, and attitude (Villegas-Reimers, 2003: 55). The ultimate aim of these programmes is to improve teaching and learning.

The investigated programme is an in-service professional development programme. It uses training and mentoring to develop teachers in underperforming schools.

1.1.7.2 Professional development (PD)

Different definitions of professional development are provided in various research reports (Villegas-Reimers, 2003). However, this study follows the definition provided by Shaw (1995: 17) who states that:

> 'It encompasses the first-hand experience learned at the chalk-face, courses and in-service training attended by the individual, professional reading, good practice in teaching and management learnt from other colleagues both consciously and unconsciously, as well as individual and team staff development gained in meetings with other teachers to discuss matters of common concern.'

1.1.7.3 Teacher competence

Teacher competence, in the context of the investigated PD programme, refers to the knowledge and skills that teachers use to facilitate learning.

1.1.7.4 Teacher performance

Teacher performance, in the investigated PD programme, relates to the ability or inability of teachers to fully implement annual work schedules, to effectively use different teaching strategies, and to actively involve and support learners in the classroom, in an attempt to enhance teaching and learning.

1.2 LITERATURE REVIEW

The following is only a preliminary review of the literature that will be developed further in Chapter 2. It suffices to note that there is a growing consensus that competent teachers and leaders play a key role in the improvement of students' learning. This accounts for the significant investment in teacher development in nations with the best academic achievement scores (Darling-Hammond, 2010: 198). Indeed, current knowledge-based and information-driven economies require teachers with expertise and the ability to keep up with the rapid explosion of information. Thus, professional development must be geared towards helping teachers cope in situations characterised by, among others, limited resources. In other words, it is essential to establish effective professional development programmes which will enable teachers to keep abreast of ever-increasing educational needs, and the challenges associated with the teaching and learning of Mathematics. But, most importantly, it is essential that these programmes be evaluated so that the necessary improvements can be made.

Evaluating existing PD programmes could help to assess their value. This might assist in ascertaining which programmes add value to the teacher development landscape and which ones need to be discontinued because of their ineffectiveness. Furthermore, well-designed evaluations can be valuable tools in establishing whether current professional practices are worth investing in, or whether they must be adjusted or even replaced by other endeavours (Guskey, 2000: 1). Thus, this preliminary literature review section introduces the following aspects, which will be discussed in detail in Chapter 2:

- Evaluation of an educational programme;
- Effectiveness of a professional development programme;

- Mentoring as an teacher development method;
- The challenges encountered in the South African Mathematics teacher development context; and
- What to keep in mind when striving to implement successful professional development programmes.

1.2.1 Evaluation of an educational programme

Evaluation can be defined as "the systematic investigation of merit or worth" (Guskey, 2000: 41). The evaluation of programmes distinguishes those that are effective from those that are ineffective. In other words, evaluation helps to determine whether it is worth investing further resources in a specific programme (Patton, 2008: 4). Adler (2002: 2) stresses that "we need to identify, and then describe and explain the kinds of programmes that are beneficial, or in the language of finance, add value…". Even though I concur with this view, my concern is on how to identify PD programmes that are also "beneficial" to teachers, in South Africa's specific context of transformation.

Another definition of evaluation is provided by Weiss (1998: 4) who construes it as a "systematic assessment of the operation and/or the outcomes of a program or policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the program or policy". In my view, this definition highlights five important aspects. The first aspect, *systematic,* implies that the evaluation procedures are of a scientific nature. The next two aspects that need to be focused on are the *operations* and *outcomes* of the programme. These are referred to as process-based and outcomes-based evaluations. Process-based evaluations are done when one wants to fully understand how a process works. These evaluations are usually used for long-standing programmes about which complaints have been received, or for programmes which seem ineffective (Weiss, 1998: 5). Outcomes-based evaluations seek to establish whether a programme is using the appropriate activities to achieve its outcomes. The fourth aspect of the definition refers to comparison *standards*. This is where the merit of a programme is measured against some set of expectations, after the evidence on its process and outcomes have been collected (Weiss, 1998: 5). The fifth and last aspect of the definition is concerned

with whether or not the evaluation contributes to the *improvement* of the programme. In essence, an evaluation is undertaken to improve a programme/policy. However, it remains to be established if evaluations are always carried out for this purpose. Thus, this study used the outcomes-based evaluation to assess whether the investigated programme reached its expected outcomes in terms of teacher development, and whether the workshops and mentoring were appropriate activities in trying to reach these intended outcomes.

Furthermore, it is important to distinguish between formative, summative, and planning evaluations. Formative evaluation occurs while the programme is in operation. The purpose of formative evaluation is to continually provide information on whether the implementation is happening as planned. It is undertaken for improvement purposes. Summative evaluation occurs at the end of the programme. Its aim is to judge the programme's overall worth. Planning evaluation takes place before the commencement of a programme. Its goal is to provide a clear understanding of the procedure to follow, what needs to be accomplished, and how success will be determined/measured (Guskey, 2000: 56-58). The current study uses summative evaluation to investigate the merit/worth of the PD programme after its completion. The reason for evaluating the programme after its completion was that the researcher was busy collecting data on another teacher professional development programme, in Gauteng, so as to evaluate it. Unfortunately, this programme was cancelled due to very poor attendance by the target group. When consent was obtained to do research on the substitute programme, it was already coming to an end.

1.2.2 The challenges encountered in the Mathematics teacher development context

The lack of a teacher education policy framework, the absence of a coherent strategy aimed at effectively upgrading under-qualified teachers, the ineffectiveness of endeavours geared towards the development of teachers' ability to teach reading and numeracy, and the scarcity of evidence-based research that could inform policy and practice on teacher education in South Africa are some of the challenges relating to teacher education identified by both the Department of Education and the

Council for Higher Education (GDE, 2010: 14). Therefore, there is a need to increase evidence-based research that could account for the work done in terms of teacher education. For example, a study can be conducted to establish whether a PD programme has achieved its objectives and, if so, to what extent?

The Gauteng Mathematics, Science, and Technology (MST) Strategy indicated that the South African government had a vision regarding support to professional development initiatives aimed at Mathematics teachers (GDE, 2010: 20). Yet, Metcalfe (2011) observes that "the state (and NGOs) continue to invest resources in education without achieving any improvements in quality" (Sunday Times Review, 20 Nov. 2011:5). The question remains whether the plans/programmes designed and implemented in order to achieve the aforementioned vision are appropriate. Garaway (2003: 705) stresses the need to design context-appropriate teacher development programmes. Therefore, I argue that in order to design an appropriate PD programme the needs of the teachers should be taken into consideration. Put differently, the implementation of a professional teacher development that is informed by the needs of the beneficiary teachers is central to the accomplishment of the aims of the programme (Luneta, 2012: 11; Joyce & Showers, 1988).

Hence, Metcalfe (2011) suggests that the desired impact of teacher PD programmes is imperceptible "because efforts have been fragmented; learning has not been shared; and innovations have been isolated from system change" (Sunday Times Review, 20 Nov. 2011: 5). In the light of this explanation, the researcher established a pressing need to share with other practitioners and stakeholders the lessons learnt and the innovations implemented, regardless of whether or not these innovations were successful. One way of doing this would be to undertake a comprehensive evaluation of all PD initiatives and then share the findings with other practitioners and stakeholders.

The current South African educational landscape predominantly uses the off-site model in its continuous professional development programmes, during school holidays and after school (Luneta, 2012:12). However, effective PD interventions require teacher training to be moved to the classroom (McKinsey et al., 2007: 26; De Clercq & Phiri, 2013: 78), where it would be most relevant and applicable (ibid:

27). The inability to run effective professional development programmes results in a disconnection between practice and theory, and a disjunction within the school as a whole (Luneta, 2012:12). The effects of school-based professional development programmes which involve mentorship, and are linked to the needs of the school, are more sustainable.

Another important factor that can impact on the effectiveness of PD programmes is teachers' qualifications. Indeed, research conducted by Scholtz et al. (2004) shows that experienced and better-qualified teachers are more inclined to participating in PD programmes. This finding is alarming since it has been established that many South African Mathematics teachers are inadequately equipped to teach this subject (Makgato & Mji, 2006: 254). Therefore, PD practitioners should be innovative, when planning and implementing PD programmes, to ensure that under-qualified teachers become actively involved in these programmes and that they actually implement what they would have learnt.

It is important to note that teacher training is not the panacea to all education problems. The South African education sector is negatively affected by a myriad of factors such as poverty, unemployment, lack of parent support to learners after school, illiterate and innumerate parents (De Kadt, 2010: 6), as well as by reading challenges resulting from learners being taught in mother tongues (Setati & Barwell, 2008: 2). A study conducted by Howie (2003: 1) in South Africa identified proficiency in English as a strong predictor of success in Mathematics. In other words, the low level of Mathematics skills among a considerable number of teachers is but one of many factors that affect learners' performance. In this regard, teacher training should not be viewed as the solution to all the challenges faced in the broader South African educational landscape.

Thus, it becomes important to establish whether the content of teacher development programmes should be geared towards fostering the implementation of effective or best practices, or rather towards sustainable long-term changes (Franke, 2001: 654). Franke (2001: 658) suggests that "the interest (of professional development) is in having teachers come to see themselves as on-going learners, seeking classroom practices that are responsive to the needs of the students and continually evaluating

and adapting classroom practice". What this means is that professional development must help teachers to develop reflective teaching skills and life-long learning. The lessons learnt by teachers from their exposure to reflective practice in their teaching should result in their engagement in new practices. According to Onwu and Mogari (2004), the results of the UNIVEMALASHI programme (a Mathematics professional teacher development programme) stressed the positive effect of its built-in supportive component. This supportive component contributed to its success and sustainability. Indeed, evidence shows that after workshops on the theory, teachers implemented the learnt skills in cluster meetings in which reflections took place, and real classroom experiences were discussed and analysed. In another PD programme implemented in South Africa, the success of the Data Informed Practice Improvement Project (DIPIP) programme in changing classroom practice and learners' behaviour is attributed to the combined effect of teachers' active participation in discussions in a professional learning community, and support received from principals and district officials, even after the programme (Brodie, 2013: 15).

Wenger (1998) also stresses the importance of a community of practice in which people can learn through their collective involvement. Previous work done by the researcher on an ACE reskilling programme showed that teachers learnt a great deal through collaborations with colleagues (Nel, 2012). By exchanging knowledge/information and by sharing experiences/skills, teachers developed in terms of their confidence and classroom practice, as well as their assessment practices and facilitation skills. The abovementioned observations need to be taken into account when elaborating professional development programmes. Franke (2001: 685) also emphasises that "teachers need time to develop relationships with others that they can talk with in ways that meet their needs and push their thinking".

The preliminary results of the UNIVEMALASHI research project, a three-year professional development programme for outcomes-based education implemented in the Limpopo Province of South Africa, "demonstrates that an appropriate teacher development programme results in changes in teacher classroom practice and learner behaviour" (Onwu & Mogari, 2004: 176). This is in line with Garet et al.'s (2001: 935) claims that "sustained and intensive professional development is more

likely to have an impact … than a shorter professional development". It remains to be established whether the studied programme is "intense" enough to have an impact on the professional development of the participants, and whether this impact can be sustained.

However, Garet, Porter, Desimone, Birman, and Yoon (2001: 917) claim that, although there is a significant amount of literature on professional development, relatively little systematic research has been conducted to assess the effects of professional development on the improvement of teaching or students' outcomes. Thus, I agree with Penuel, Fishman, Yamaguchi, and Gallagher (2007) that, in the past, insufficient attention was paid to the outcomes of professional development, although it is key when evaluating a programme (Luneta, 2013: 106). This is because the emphasis was on the evaluation of teachers' opinion on their professional development experiences rather than the actual change in their practice and skills (Joyce & Calhoun, 2010: 116). This is evident in evaluation reports on professional development programmes run in South Africa. One of the major initiatives designed to improve Mathematics and Science education, through a PD component, is the Dinaledi Programme. It is run by government in an attempt to improve Mathematics and Science results in schools. After 10 years of existence, this programme has revealed major gaps through its evaluation. For instance, the absence of a process evaluation limits the ability to adequately measure the effectiveness/impact of this programme (Narsee, 2011).

Hence, some studies (e.g. Graven, 2002) have directed their attention towards both the complex link between the design of professional development programmes and teachers' learning as a result of their exposure to these programmes, as well as the subsequent changes made in classrooms (Penuel et al, 2007:923). This study aimed to investigate this link in the context of the studied programme. Countries like Finland, Korea, and Singapore – which have recorded a significant improvement in their students' achievements – attribute exploit to their investment in teacher preparation and development (Darling-Hammond, 2010: 194). This clearly suggests that teacher development initiatives have the potential to change South Africa's current situation for the better.

1.2.3 Mentoring as a teacher development intervention

The programme under investigation used a mentoring component as a means to achieve the professional development of the participants. This mentoring component supported the workshops and consisted of classroom visits, one-on-one sessions with the participants, as well as checking the progress of the participants with regards to the work schedule, lesson plan, and so forth, at their respective schools. Therefore, discussions on mentoring as a component of the PD programme were incorporated in the evaluation of the programme, because mentoring was crucial to the development of the participants.

Mentoring has various definitions (see, for example, Allen, Finkelstein & Poteet, 2009; Shulman & Sato, 2006). In the context of this research, mentoring was defined as an intentional strategy aimed at developing a person, based on individual and institutional support. Mentoring aims to create a learning partnership that fosters professional development (Fischer, 2002: 3). Generally, mentoring involves a relationship between a more experienced person (the mentor) and a less experienced individual (the mentee) (Shulman & Sato, 2006:2). The primary focus of this relationship is the growth and development of the mentee, although the mentor may also benefit (Allen, Finkelstein, & Poteet, 2009: 2). One of the major modes of developing teachers who participate in this specific PD programme was the use of facilitators for a one-on-one mentoring of teachers inside and outside their classrooms (Project Proposal, 2009). The constructive criticism (Guskey, 2000: 28) and experience that the mentor provided the mentee with – through co-teaching – was meant to assist with two of the intended outcomes of the identified programme, namely, the improvement of the mentee's competence and the enhancement of his/her performance as a teacher. Darling-Hammond (2010: 206) supports the inclusion of content knowledge and active learning in a teacher development programme and adds such components as assessment, learning, and performance assessment to the list. Her aim in doing so is to develop the participating teachers' skill of reflective teaching in relation to learning.

The TIMSS report revealed that, despite the above-average attendance of professional development activities internationally, only a small percentage of South

African teachers have indicated their involvement in professional development activities which included Mathematics and Science pedagogy and instruction (HSRC, 2006: 116). This implies that South African teachers either do not attend PD programmes offered to them, or that there are limited opportunities for PD in South Africa, compared to the international arena. Whatever the case may be, South African Mathematics teachers need to attend more professional development programmes to better equip themselves so as to improve the dismal Mathematics results of school learners. The inclusion of mentoring, pedagogy, and instruction in a PD programme has the potential to yield better-equipped teachers (Guskey, 2000: 28). The report on the evaluation of the Quality Learning Project (Taylor & Prinsloo; 2005), a 5-year teacher development programme which ran in all the provinces of South Africa, contained a recommendation on the inclusion of mentoring in teacher development in order to increase the impact of PD programmes. This confirms the valuable role that the inclusion of mentoring can play in a teacher education PD programme.

Mentoring can provide both a career function and a psychosocial function to the mentee (Ragins & Kram, 2007: 5). The career function involves helping the mentees to "learn the ropes" and preparing them to perform better and efficiently. This can be achieved by increasing positive exposure and visibility, giving the mentees challenging assignments, and recommending them for possible advancements. With the psychosocial function, trust, intimacy, and interpersonal bonding are built. These can enhance the mentees' professional and personal growth, and both their self-worth and self-efficacy (Ragin & Kram, 2007: 5). In the education context, effective mentoring is associated with the improvement of classroom performance, an involvement in a context created by change initiatives, and the sharing of good practices (Rhodes, Stokes & Hampton, 2004: 2). This can create an environment where the effectiveness of the school organisation increases and, by implication, the performance of learners.

The possible organisational constraints in a mentoring process include the lack of a supportive environment which encourages collaboration between colleagues, the ineffectiveness of the implementation process, the non-inclusion of the mentee in the selection of the mentor, staff's lack of commitment to the process, inappropriate

needs analysis, and time constraints (Rhodes et al., 2004: 23-24). So, when mentoring is evaluated, the above constraints must be considered.

1.3 CONCEPTUAL FRAMEWORK

The current study is conceptualised around one of the four types of evaluation, the CIPP model for evaluation, which was developed by Daniel Stufflebeam (2003). CIPP stands for Context, **I**nput, Process, and Product evaluation. It is a utilitarian model (management model) which counteracts the production factor of evaluation, where the output for educational programmes is test scores (Stufflebeam, 2003: 15). This implies that if all schools are given adequate resources and are provided with the necessary support, the learners' performance in tests, among others, can improve. However, it is important to note that test scores are not always the best predictors of the effectiveness of a PD programme. This is because they do not take into account the uniqueness of situations. Indeed, different groups apply different standards to a PD programme and, therefore, select different indicators of effectiveness for the same programme (Stufflebeam, 2003: 15).

CIPP refers to the following four types of evaluation:

1. Context evaluation
2. Input evaluation
3. Process evaluation
4. Product evaluation

These four types of evaluation serve several but also different functions (Stufflebeam, 2003: 31). The context evaluations assess the "needs, problems, and opportunities within a defined environment; they aid evaluation users to define and assess goals and later reference assessed needs of targeted beneficiaries to judge a school programme…" (Stufflebeam, 2003: 31). The input evaluations assess the "competing strategies and the work plans and budgets of approaches chosen for implementation; they aid evaluation users to design improvement efforts, develop defensible funding proposals, details action plans, record the alternative plans that were considered, and record the basis for choosing one approach over the others."

Process evaluations monitor, document, and assess activities; they help evaluation users to carry out improvement efforts and maintain accountability records of their execution of action plans. Product evaluations, which this study focused on, identify and assess the short-term, long-term, intended, and unintended outcomes of PD programmes (Stufflebeam, 2003: 31-32).

The researcher had the challenge that after the permission was granted to evaluate the programme, it was realised that the implementation thereof was very close to completion. Thereafter permission had to be granted from the Department of Education as well as the schools, including the participants. So when the research finally got underway, the workshops and mentoring already came to an end. This lead to the researcher not being able to assess the needs of the teachers and schools prior to the commencement of the programme as the interventions were already done. So the Context evaluation was not possible. The chosen strategies and work plans as well as budget chosen could also not be altered at that stage as the implementation was already done. Therefore the inability to do the Input evaluation. The Process evaluation also could not be conducted as the assessments of activities and improving efforts pertaining to the programme could only be assessed in retrospect, though nothing could be altered at the time. Therefore, the researcher could only do the Product evaluation pertaining to the CIPP model regarding evaluating the PD programme.

1.4 RESEARCH METHODOLOGY

1.4.1 Research design

Given that this study sought to evaluate whether a Mathematics PD programme addresses the participating teachers' competence and performance, this research used rich descriptive data. As such, it lent itself to a qualitative study insofar as the first and second research questions. Qualitative research could scientifically describe persons and events pertaining to this PD programme without using numerical data (Best & Kahn, 1998:73). It suffices to note that the world we live in is complex and multifaceted. For this reason, social science research needs to match its methodology and methods with the multidimensionality of lived experiences (Mason,

2006: 11-12). With regards to answering the third research question, a quantitative approach was followed in the analysis of the participants' pre- and post-tests as well as the learners' results. In quantitative research, the type of information that the researcher obtains from the participants is expressed in numerical form (Cumberbatch, 2004: 2) and the analysis thereof is largely statistical and reports on the size of the effects and the significance of the statistical relationships (Weiss, 1998: 82). It must be noted that the quantitative component of the study was small, compared to the qualitative one. Hence, the study can be regarded as a qualitative study with a quantitative component.

The qualitative research methods used in this study were the interviews with the participants and both the programme executive manager and the mentor, mentor reports, and documented studies of the different workshops. The quantitative research method came into play when learners' Mathematics results and the participants' pre- and post-tests were analysed. These analyses were done in order to establish possible trends in terms of the participants' content knowledge competence and learners' performance after their teachers' involvement in the activities of the PD programme under investigation.

1.4.2 Participants selection

The target population for this study was constituted by the five schools involved in the identified PD programme. In one of the schools, two Mathematics teachers participated in the Mathematics component of the broader programme, taking the number of participants in the Mathematics PD programme to six. However, later on, one teacher who stopped attending the programme was excluded, reducing the number of participants to five. These participants were given pseudonyms, for anonymity purposes. The teacher who taught at the school that experienced a decrease in the number of grade 12 learners was moved to a nearby school. This latter and its Mathematics teachers were not part of the study. The remaining five teachers were willing to participate in the study and were thus included. The four remaining schools were called School A, School B, School C, and School D, respectively, for the sake of anonymity. Sampling was then done at the stage of choosing the schools. Weiss (1998) stresses that although the sample for qualitative

evaluation is a small subset of the population, it would generate a large amount of data about each teacher considered (Weiss, 1998: 284). The sampling of the specific schools was based on their involvement in the PD programme and their willingness to participate in the research. In other words, the selection of schools was motivated by their involvement in the PD programme.

1.4.3 Data Sources

Primary as well as secondary data sources were used in this study. The primary data sources were the interviews with the participants the mentor, and the programme executive manager, as well as lesson observations done by the researcher. The secondary data sources were the document analysis of written materials pertaining to the PD programme, documents relating to the professional learning community, mentor reports on school visits, workshop reports by the facilitator, reports written by the programme executive manager, lesson observations done by the mentor, learners' results, and the participants' pre- and post-test results.

Primary sources

1. The lesson observations done by the researcher were used and analysed to evaluate whether knowledge and skills acquired through the PD programme were implemented in the classroom.
2. The researcher conducted semi-structured interviews with all the participants in the PD programme. Where possible, these interviews took place on the same day that the researcher had to observe lessons conducted by the interviewed participants. The aim of these semi-structured interviews was to do an in-depth exploration of the issues pertaining to the implementation of the investigated PD programme, what the participants picked up from the programme, the teachers' ability to implement what they may have learnt in the programme, the strengths and weaknesses of the programme, and the challenges experienced. The objective of this exploration is to make possible recommendations for the improvement of future PD programmes. The semi-structured interviews conducted in this study helped to address the lack of valuable information on the assessment of the success of PD programmes. A thematic analysis was undertaken based on the themes that the researcher had identified through the

literature review. More or less the same themes were used for the analysis of the mentoring and workshop reports, the interviews with the mentor, and those with the programme executive manager.

3. The researcher also conducted a semi-structured interview with the first mentor, after the interview with the teachers, in order to triangulate the data, especially those pertaining to the development of the participants. An interview with the second mentor (appointed in 2012 when the first mentor left) was not possible, because she had passed on.
4. A semi-structured interview with the execute programme manager was also conducted, to elicit data pertaining to the achievement of the programme's goals, the roles of the stakeholders, challenges, and recommendations on the improvement of the programme.

Secondary sources:

5. The secondary documents pertaining to the investigated PD programme included the history of the programme, information about the service provider, the aims and objectives of the programme, definitions of the terminology used, and the different interventions used to reach the aims and objectives of the programme. These documents had valuable information which was used to establish the aims and objectives of the programme and to derive how they would be accomplished. Gathering this information would enable the researcher to get an understanding of the roll-out of the programme. Vos, Strydom, Fouche and Delport (2005: 323) referred to this way of data collection as the document study method; and, they classified these documents as official documents.
6. The document analysis of the different mentor and workshop reports for 2010 and 2012, for every participating teacher and every workshop, was done, to triangulate the data in conjunction with the lesson observations and interviews done with the participants, as well as the interviews with the programme executive manager and the first mentor. The purpose of the document analysis of the mentor reports was to ascertain the individual participants' possible development. The purpose of the document analysis of the workshop reports was to determine what was covered in the workshops, how the participants responded to the workshops, and who selected the content of the workshops. These mentor and workshop reports were written by the mentor and workshop facilitator who

was the same person, for the better part of the programme's roll-out. These reports were written from this person's perspective; as such, they could be perceived as one-sided. However, the triangulation of the data obtained from these reports with those gathered through the interviews with participants, the mentor and the programme executive manager would help to counterbalance this possible one-sidedness. This would help to eliminate the mentor/workshop facilitator's possible bias, as different peoples' views and voices were infused to ensure a more comprehensive perspective on what transpired in the programme.

7. The lesson observations done by the mentor were used and analysed to evaluate whether the knowledge and skills that may have been acquired through the PD programme were implemented in the classroom.
8. The analyses of the grade 9 learners' Mathematics results of School A as well as the grade 12 learners' Mathematics results of Schools B, C and D were done to identify general trends for the period ranging from 2010 to 2013. The motivation for examining the grade 9 and grade 12 Mathematics results stems from the fact that, in South Africa, these results are used as indicators of success in schools. Grade 9 and grade 12 signify the end of a phase in public schools. Indeed, grade 9 marks the end of the Senior Phase, whereas grade 12 signals that the end of the FET Phase. Through the analysis of the learners' Mathematics results, the researcher was able to verify if the results of the learners whose schools/teachers were involved in the investigated Mathematics teacher professional development programme had improved or not. The Statistical Package for Social Sciences (SPSS) – especially the Friedman Test – was used to analyse the data. This test was decided upon because the data comprised of the same sample of cases, which were measured at three points in time (in the case of School A) and at four moments (in the case of the other schools) (Pallant, 2007: 228). Given that the grade 12 learners of School A had been moved to another school, the grade 9 learners' results for the period 2011-2013 were used.
9. Pre- and post-tests were administered by the service provider, to investigate whether the participants' content knowledge changed. Because the pre- and post-test results were interval data, the SPSS was used to analyse the results, using The Wilcoxon Signed Rank Test. This test has been designed to be used when "your subjects are measured on two occasions, or under two

different conditions" (Pallant, 2007: 223). The scores were then converted to ranks and the two different occasions' scores were compared.

1.4.4 Data collection and analysis

The primary data were collected by means of at least two lesson observations per participant, one or two semi-structured face-to-face interviews with each of the participants, as well as a semi-structured face-to-face interview with the programme executive manager and the first mentor of the programme. The lesson observations were done and recorded according to the lesson observation schedule compiled by the researcher. Semi-structured interviews – which were audio-recorded and transcribed – were conducted on the same day as the lesson observation. Thematic analysis was then done using themes that emerged from the literature review on effective PD programmes.

The secondary data included the mentor reports on the different participants, workshop reports, learner results, and teachers' pre- and post-test results. The reports and pre- and post-test results were acquired from the service provider. The learner results were obtained from the District Office and the schools, respectively. The reports were analysed to ascertain the aims, objectives, and modes of training delivery used in the development of the participants. The learner results of the different schools were also analysed in an attempt to establish a pattern in these results, from the time that the teachers began to attend the PD activities of the programme. The interviews with the participants provided the researcher with the opportunity to further probe into certain aspects of the observed lessons that needed clarity.

The results generated by the analysis of the data were thematically-organised, discussed, and interpreted to make appropriate recommendations.

1.4.5 Trustworthiness of the research

The trustworthiness of this study was ensured by, among other things, the researcher's choice of appropriate methods of data collection, to suit the qualitative

approach adopted. In other words, the trustworthiness of this study is strongly linked to its adoption of an interpretive approach which uses a combination of observation schedules, document studies, semi-structured interviews, learners' results, and the pre- and post-test results of the participants.

Thus, in conducting this research, particular attention was given to the reliability and validity of the work. Validity refers to the accuracy with which the instruments used measure the concept in question (De Vos, Strydom, Fouche & Delport, 2002: 166). A research instrument is considered reliable if the results of a study can be reproduced under similar methodology (Joppe, 2000: 1). This highlights the idea of repeatability and replicability of observations or results (Golafshani, 2003:598). However, Lincoln and Guba (2000), and Graven (2002) question the applicability of reliability and validity in qualitative studies. In qualitative research, the assumption is that in the natural setting, there exist multiple realities constructed by individuals who are constantly in an interactive relationship with the social world (Graven, 2002). The use of the term reliability, which implies a test aimed at establishing consistency in measuring (Best & Kahn, 1998: 283), is also contested. When it comes to qualitative research, the investigation is based on a range of experiences rather than the average experience (Krefting, 1991: 216). This suggests that realities not be replicated; as such, similar results cannot be expected. Hence, the term trustworthiness is now used instead of reliability and validity. Trustworthiness relates to the need to ensure that the data are truthful and dependable in terms of the context under which data collection was done. Trustworthiness was ensured in this study (Krefting, 1991: 215) by accommodating the multiple realities of the teachers, the mentors, and the programme executive manager by means of triangulation.

Triangulation was done by collecting data from different sources in order to answer the research questions. Patton (2002: 247) claims that "triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches". Hence interviews with the five participating teachers, the project manager, and one mentor, as well as lesson observations and the analysis of mentor reports were done. The analysis of learners' results was also done as a mode of data collection. This elicited similarities and differences in describing the different realities that exist.

1.4.6 Ethical considerations

Before, during, and after the collection of data, the researcher strove to ensure that the rights of the participants were respected. She formally applied for and received written permission – to conduct research in the investigated PD programme – from both the management of the service provider, JET, and the North West Department of Education. Furthermore, formal permission to conduct this research was also obtained from the University of South Africa (UNISA) (see Appendix 3). What is more, written consent was also obtained from the participants who declared that their involvement in the study was voluntary, after the researcher had informed them of the aims and objectives of the study, as well as their right to withdraw from the research at any time, without any consequences. The researcher ensured that the participants' identities were protected through the use of pseudonyms, both for them and the schools that they were teaching at. The researcher also assured the participants of the confidential treatment of the collected information.

1.5 CHAPTER OUTLINE

Chapter	**Headings**
Chapter 1	Introduction
Chapter 2	Literature review
Chapter 3	Description of the programme
Chapter 4	Research methodology
Chapter 5	Analysis of secondary sources
Chapter 6	Analysis of primary sources
Chapter 7	Findings, conclusion, and recommendations

Table 1.1 Chapter Outline

1.6 DISSEMINATION PLAN

The researcher plans to write academic papers on the findings and conclusions of the proposed research. She will begin by presenting them at national and international conferences on teacher education and programme evaluation. The resulting articles will then be submitted to accredited journals for publications. A copy of the thesis will also be given to the North West Province's Department of Education and to the Service Provider, JET.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

McKinsey and Company (2007: 16) observe that “the quality of an education system cannot exceed the quality of its teachers”. Therefore, every country should invest in its education system to ensure that its teachers are high-quality instructors who can keep abreast with the latest developments (ibid). As indicated in Chapter One (Section 3), professional development must be geared towards enabling teachers to cope in rapidly changing situations which are often characterised by limited resources. In other words, it is essential to establish effective professional development programmes which enable teachers to keep up with the ever-increasing educational needs and the challenges associated with the teaching and learning of school Mathematics. Thus, it is essential that these programmes be evaluated continuously, so that the necessary improvements can be made.

Evaluating PD programmes can help to assess and increase their value. Moreover, evaluations might assist in ascertaining which programmes add value to the teacher development landscape and which ones need to be terminated due to their ineffectiveness. Furthermore, well-designed evaluations can be valuable tools in establishing whether current professional practices are worth investing in, or whether they must be adjusted or even replaced by other endeavours (Guskey, 2000: 1). Thus, this literature review will discuss the following aspects:

- Evaluation of an educational programme;
- Effectiveness of a PD programme;
- Mentoring as a means of teacher development;
- The challenges encountered in the Mathematics teacher development context; and

- What to keep in mind when intending to implement successful professional development programmes.

2.2 EVALUATION OF AN EDUCATIONAL PROGRAMME

An evaluation can be defined as “the systematic investigation of merit or worth” (Guskey, 2000: 41). The evaluation of programmes can be used to distinguish between those that are effective and those that are ineffective. In other words, evaluation helps to determine whether it is worth committing further resources in a specific programme (Patton, 2008: 4). Adler (2002: 2) emphasises that “we need to identify, and then describe and explain, the kinds of programmes that are beneficial, or in the language of finance, add value….” A central question in this regard is how to identify PD programmes that are “beneficial” to teachers?

Another, more detailed, definition of evaluation is provided by Weiss (1998: 4) who characterises it as a “systematic assessment of the operation and/or the outcomes of a programme or policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the program or policy”. This definition highlights five important aspects. The first one, systematic, implies that the evaluation procedures are of a scientific nature, that is, evaluation is a purposeful, intentional, and thoughtful process (Guskey, 2000: 42). The next two aspects that need to be focused on are the operations and outcomes of the programme. These are referred to as process-based and outcomes-based evaluations. Process-based evaluations are done when one wants to fully understand how a process works. These evaluations are usually used for long-standing programmes about which complaints have been received, or programmes which seem ineffective (Weiss, 1998: 5). Outcomes-based evaluations seek to establish whether a programme is using the appropriate activities to achieve its outcomes. The fourth aspect highlighted in the definition relates to comparison standards. This means that the merit of a programme is measured against some set of expectations, after the evidence relating to its process and outcomes has been collected (Weiss, 1998: 5). The fifth aspect of the definition is concerned with whether the evaluation contributes to the betterment of the programme. Generally, an evaluation is done so as to improve a particular programme/policy. However, whether this is the case in practice

still needs to be established. Loots (2008: 1213) claims that evaluation is a means to ensure quality in programme delivery and outcomes. It is this understanding of evaluation that the researcher will adopt in this study. Hence, the intended outcomes of the programme should be clearly stated. Friedman claims that the "pre-specification of intended outcomes allows their assessment to be more clearly defined and independently judged" (2012: 185). General statements such as 'improving the quality of life', 'empowering', or 'changing' are insufficient descriptions of the goals or outcomes of programmes (Loots, 2008: 1214). Indeed, although such outcomes formulations do state values, they can neither be measured nor evaluated (ibid).

Education PD programmes are costly investments made by governments, business, and non-profit organisations. Hence, it becomes imperative to establish whether these programmes are in fact doing what they are meant for, that is, if they yield the expected results or if better results can be achieved – even with a smaller budget. The best means of determining if PD programmes are reaching the desired outcomes – and if the same outcomes can be achieved with a smaller budget – is by evaluating these programmes (Weiss, 1998: 6). Evaluation helps to measure possible change and assess results (Zepeda, 2008: 37). In addition to asking whether programmes worked or not, there must be questions relating to the factors that make them work, why some programmes succeed while others fail, or even how the successful ones can be improved (Weiss, 1998: 55).

To assess whether a PD programme is valuable, its design must be examined to determine the likelihood of it producing the intended results (Killion, 2005: 5). Besides the design of the programme, its goals, objectives, standards of success, and indicators of success should also be scrutinised (ibid).

When a PD programme is initiated, there should be a set of objectives that it is meant to achieve; ideally, these objectives should be informed by a needs-analysis of the intended participants. The evaluation of the programme is therefore the systematic process of determining whether these objectives were achieved (Luneta,

2013: 109). However, it is not enough to know what the programme aims to achieve, it is also important to establish how it intends to achieve its stated objectives (Weiss, 1998: 55). In order to measure this, each objective should have a performance indicator that assists in determining the success of the programme. A PD evaluation, in particular, “requires examination of programme goals, duration of PD activities, levels of implementation, change in beliefs and practices” (Zepeda, 2008: 36), to name but a few.

Three broad types of evaluation can be distinguished, namely, planning, formative, and summative evaluation (Guskey, 2000: 56). Planning evaluation takes place at the beginning stages, before the programme or its activities begin. The intent of this type of evaluation is to assist decision-makers in determining whether they are choosing the correct direction and if their desired results can be achieved (Guskey, 2000: 57). Formative evaluation occurs throughout the programme. The aim of this type of evaluation is to regularly feed information back into decision-making for the purposes of modification and improvement. The teachers and administrators are the audience of the evaluation (Zepeda, 2008: 45). Summative evaluation happens at the end of the programme and aims to assess the overall worth of the programme, to enable decision-makers to make a pronouncement on the continuation, termination, or revision of the PD programme (Zepeda, 2008:45). This study used summative evaluation, because the researcher undertook this investigation at the end of the lifespan of the programme. Thus, the researcher looked back to the PD programme to assess its overall worth.

The successes of the professional development of teachers are measured in terms of increases in their knowledge and skills, changes in classroom practice, and improvement in the students’ learning (Kilion, 2002; Sparks, 2002). This is in contrast to documenting activities completed by participating teachers or measuring teachers’ satisfaction with the PD programme (Blazer, 2005: 14; Killion, 2005: 5; King, 2014: 2). This can, however, only be done if the way in which the attainment of the programme’s goals will be assessed is clearly outlined (Blazer, 2005: 14). Cochran-Smith (2005: 302) argues that there is a need for better and more research on the

outcomes of teacher education. This includes separating the impact of preparation from the entering characteristics of participating teachers. It also requires careful consideration of how the teachers use what has been learnt in the classroom. Ultimately, teacher and classroom quality is embedded in what teachers do in the classroom with learners, and not just in their credentials or in course work (Pianta, 2005: 8; Bansilal, 2012: 254).

2.3 EFFECTIVENESS OF A PROFESSIONAL DEVELOPMENT PROGRAMME

When investigating the effectiveness of a PD programme, one should not focus on the satisfaction of the teachers involved or their happiness quotient; one should rather consider the effect that the professional development has had on learners' learning (Kelleher, 2003: 752). The question that arises relates to the factors/components to consider when one endeavours to evaluate the effectiveness of a teacher PD programme. Desimore (2009: 181) emphasises that "understanding what makes professional development effective is critical to understanding the success or failure of many education reforms". The traditional approaches to PD, which include short workshops, seminars, and conferences attendance and which use a technical and simplistic view of teaching (Boyle, Lamprianou & Boyle, 2005: 4; Lee, 2005: 40), have proven ineffective. This is because these methods are detached from the practical transfer of knowledge and skills into the classroom. Using the piecemeal approach in the professional development of teachers has also proven ineffective (Borko, 2004; Katz, Earl & Ben Jaafar, 2009) and has failed to yield depth and application of learning (Weiss, 2005:1). Kgalema (2001: 25-31) identifies eight essential components in the assessment of the effectiveness of a PD programme: 1) sufficient funding; 2) use of partnerships to optimise and interweave resources for quality service delivery in a cost-effective manner; 3) involvement of participating teachers in as many processes as possible; 4) incentivising the participants; 5) establish close monitoring and evaluation of the programme; 6) be context-specific and outcomes-driven, when planning and implementing an INSET programme; 7) employ staff with sound academic, professional and leadership skills; and 8) have clearly defined roles and time scheduling for the different activities of the

programme which should latch onto the participants' interest, convenience, and abilities.

However, sufficient funding is important in ensuring that professional development adheres to the prescribed standards. Put differently, resources and funding are crucial factors in the implementation of PD programmes (Singh, 2011: 1626). This is because most of South Africa's Continuous Professional Development (CPD) programmes are done off-site (Johnson, Monk & Hodges, 2000; Luneta 2011), especially in the case of some rural area schools, and are very far apart. Therefore, teachers' travelling expenses must be considered. In a similar vein, Adler and Reed (2002:6) remark that longer and more intensive school-based CPD programmes are more effective but difficult to implement, due to the cost and resource implications. This is echoed by Adler and Davis (2006: 279) who observe that the South African Mathematics CPD context has limited financial and human resources. Sufficient funding can increase the quality of programmes which have the potential of improving the education landscape. However, sufficient funding should be linked to the effective management of funds, to ensure that the latter are used optimally, through accountability.

Thus, I agree with Kgalema's emphasis on partnerships as these are closely linked to and can also address the challenge of limited funds. Indeed, partnerships can to resolve the issue of limited resources and can foster the enhancement of cost-effectiveness. Partnerships can also enhance the sustainability of CPD programmes after their completion, especially when other organisations which have key expertise can identify with the aims and objectives of these programmes. These partnerships should also be created with key role-players, in particular the teachers.

The involvement of the participating teachers in as many processes of the programme as possible (Kgalema, 2001: 25-31; Luneta, 2013: 80; Lee, 2005: 46) can yield many benefits in terms of the development of the participants. Singh (2011: 1627) and Du Preez and Roux (2008: 78) agree that teachers' input is needed when designing professional development initiatives. If participating teachers are included

in the planning and decision-making of the programme, they may feel valued. As a result, they will take more ownership of the programme and will voice their needs and views. This can enhance the CPD programme. Consequently, consultation and collaboration should, as much as possible, be increased.

It is important to rely on teachers' intrinsic motivation to attend PD programmes; however, other ways of acknowledging their participation and possible growth and development should be sought. Different kinds of incentive can be used, such as obtaining credits towards a formal qualification or for licensing purposes (Killion, Croft, Coggshall, Dolan & Powers, 2010: 10). Huber (2011: 843) agrees with this view and adds that the participants' involvement and the importance of PD can be increased by linking teachers' participation with certificates.

The monitoring and evaluation of PD initiatives should be an ongoing process. This should take place from the initial stages of the programme up to and beyond its completion (Research Point, 2005: 4). The monitoring and evaluation will then inform the administrators about the benefits and shortcomings of programmes, and how well the training meets the intended goals.

Indeed, to be regarded as effective, PD must address the needs of teachers in a specific context (Singh, 2011; Du Preez & Roux, 2008). Thus, professional developers should take context-specific needs of the teachers and schools that they are serving into account, when designing PD programmes. Adler (2002, 2) concurs that context matters. To adjust to the individual needs of the participants, PD programmes should begin by first determining the prior knowledge, expectations, goals, attitudes, motivation, and subjective theories of the teachers (Huber, 2011: 840).

To enhance the effectiveness of PD programmes, facilitators should be equipped with extensive skills and knowledge of most recent strategies and concepts. They

should also have teaching experience in the discipline – at or near the grade level that the participants teach (Blazer, 2005: 9-10). They should also, as experts, be well prepared for sessions (Steyn, 2009: 120). Moreover, these facilitators should be thoroughly trained to perform this function. They should also know and understand what is going on at "ground level" (Steyn, 2009: 127). Facilitators can have different formal roles, such as mentor, teacher leader, or subject-area specialist. They should also know what excellent teaching entails, in order to support teachers in improving their practice (Killion et al, 2010: 9).

Clearly defined roles (Blazer, 2005) and time schedules need to be highlighted in the planning and implementation of PD programmes.

The American Institute for Research (Buchanan, 2002) identifies six factors that are critical in ensuring the effectiveness of a PD programme. These factors are duration, content, form, active learning, collective participation, and coherence. Desimore (2009, 183) agrees with five of these six factors, namely, content focus, active learning, coherence, duration, and collective participation. The inclusion of subject knowledge in professional development is one of the cornerstones of effective professional development; it is an essential way of deepening teachers' content knowledge and developing their teaching practices (Desimore, Porter, Garet, Suk Yoon & Birman, 2002: 81). Research Points (2005) strongly encourages the strengthening of content knowledge in professional development initiatives, because it can enhance teachers' capacity to teach better. Kanyongo and Brown (2013: 107) claim that teachers' subject knowledge is a proxy for teacher quality, and this can in turn impact their students' achievement (ibid). They also claim that several other studies found that teachers' content knowledge is important in three main ways: (1) it influences how teachers engage students with regard to the subject matter, (2) it affects how teachers evaluate and use instructional materials, and (3) it is related to what students learn in the classroom (Kanyongo & Brown, 2013: 108).

However, concerns as to whether South African Mathematics teachers have sufficient content knowledge to facilitate their teaching of Mathematics have been

raised (Makgato & Mji, 2006: 260). Studies conducted in South Africa point to the poor content knowledge of teachers as one of several reasons South African learners rank very low in Mathematics – nationally and internationally (CDE, 2011; Makgato & Mji, 2006). As such, teachers need to increase their content knowledge to ensure sound teaching practices, since "a well-intended pedagogical decision in the classroom can be betrayed by faulty content knowledge" (Wu, 2005: 9). Bansilal, Brijlall and Mkhwnanzi (2005: 37) claim that teachers need to be able to anticipate common misconceptions and student errors, predict what learners are likely to do with specific tasks, and interpret learners' incomplete thinking, among others. However, in order for teachers to perform these functions, they need solid content knowledge to guide them (ibid). However, the study conducted by the abovementioned authors provided evidence that the cohort of South African FET Mathematics teachers that they included in their research did not have sufficient knowledge of school Mathematics (Bansilal et al, 2005: 49; Makgato & Mji, 2006: 254).

Cohen and Hill (2001), and Lee (2005: 39) found that the duration and intensity of professional development determine how much teachers change. However, the distribution of the timeframes spent in a PD programme is important, because "teachers need blocks of time without responsibilities for optimal learning" (Steyn, 2009: 119). Killion (2005: 5) claims that "ongoing sessions of learning, collaboration, and application, accompanied by school- and classroom-based support, over an ample time period are necessary to incorporate new behaviours fully into a teacher's repertoire". So, the duration of PD programmes is not necessarily an indicator of teacher change. Linking the duration of the interventions with their intensity and other support activities incorporated in the PD programmes is a more accurate indicator of teacher change. Guskey (2005: 13) agrees with this and notes that doing ineffective things longer will not make them effective. Thus, although Research Points (2005) agrees with the positive correlation between times spent in professional development and teacher change, it stresses that this will only be the case if professional development activities do focus on high-quality subject-matter content.

The six key features of professional development identified by Desimore et al. (2002, 83) are divided into two categories, as shown in the table 2.1 below.

A: Structural features	**B: Core features or characteristics of the substance of the activities**
- Whether the activities are organised as a reform type (such as group study, teacher network, mentoring relationship, committee or task force, internship), in contrast to a traditional workshop, course, or conference.	- Active learning (which indicates opportunities for teachers to become actively engaged in a meaningful analysis of teaching and learning).
- Duration of the activities (total number of contact hours that participants spend in the activity; span of time over which the activities take place).	- The degree to which the activity promotes coherence in teachers' professional development by incorporating experiences that are consistent with teachers' goals – which are aligned with state standards and assessments – and which encourage continuing professional communication among teachers.
- Collective participation of groups of teachers from the same school, department or grade level, as opposed to the participation of individual teachers from many schools.	- The degree to which the activity has a content-focus (degree to which the activity is focused on improving and deepening teachers' content knowledge).

Table 2.1: Six key features of professional development

Luneta (2012: 365) latches onto Desimore's key features of effective PD to which he adds active learning, collective participation, collaboration among the participants, the focus on knowledge bases and effective instructional approaches. Research done by Rogers, Abell, Lannin, Wang, Barker and Dingman (2006: 516) reveals that teachers view collaboration and networking among the participants as an essential

aspect of an effective PD programme, based on previous experiences. Collaborative PD methods showed evidence of PD's ability to effectively improve instructional practice and, by implication, student achievements (Russo, 2005: 6). With regards to instructional approaches, teachers should be trained to connect different ideas relating to Mathematics and various representations of each idea. This can be done through a variety of symbols, words and diagrams. Teachers should also encourage learners to verbalise their methods and reasoning, and should gear their teaching towards the development of learners' mental skills (Clarke & Clarke, 2002: 310). This is echoed by Anthony and Walshaw (2009: 152) who conceive teachers' role in terms of instilling the articulation of mathematical explanations and justifying solutions to learners. This requires teachers to ask open-ended, higher-order questions which will assist learners in terms of "how" to think and not "what" to think, in the quest to improve learners' scholastic performance (Moodley, 2013). Teachers value the classroom applicability of what was learnt in PD encounters. This is because this applicability assists them in successfully implementing, in their classrooms, what was acquired in these sessions (Rogers et al., 2006: 516). However, heavy teaching loads lead to limited time to plan, explore and incorporate what had been acquired (Fraser-Thomas & Beaudoin, 2002: 265; Darmody & Smyth, 2011: 12). Desimore's reference to traditional approaches relates to PD approaches that are not linked to teachers' work in the classroom, and which do not allow the transfer of the acquired knowledge and skills to learners within the classroom (National Staff Development Council, 2010). Burbank and Kauchak (2003: 500) refer to some traditional PD approaches where teachers assume passive roles that include "implementing ideas that are often conceptually and practically far removed from their classes". These approaches result in teachers not changing their ways after the completion of PD programme. This is because the production of these ideas and material was external (Harrison, 2005: 256) and, therefore, not internalised.

However, microteaching is a teacher development technique which has the potential to help teachers to internalise what they have learnt, as they observe fellow teachers who are conducting lessons (Remesh, 2013: 160). Microteaching also has the potential to strengthen teachers' approach to teaching, enhance their understanding

of a variety of effective teaching styles, and identify a teacher's personal strengths and improvement areas (Teaching Support Services), among other things. Microteaching was used in the PD programme under investigation; as such, its effect on the participants' development would be investigated.

Different research (Desimore, 2002; Kgalema, 2001; Guskey, 2005) also extensively refers to the core features or characteristics of the substance of the activities in PD. The planning and implementation of PD programmes should scaffold activities so as to promote coherence in teachers' development. This can be enhanced by supporting the development plan of individual schools, instead of adopting a one-size–fits-all planning and implementation approach (Rogan, 2007: 118). Thus, this study will investigate these six features, to evaluate the effectiveness of the relevant professional development programme. It will also explore whether a needs-analysis was done in the planning and implementation of this programme, given that literature identifies needs-analysis as one of the indicators of the effectiveness of a PD programme (Luneta 2012, 373). Indeed, the needs-analysis assists in addressing the actual challenges that teachers face (Mestry, Hendricks & Bisschoff 2009, 478). By conducting a needs-analysis, PD programmes can help teachers to handle their daily challenges. Therefore, for a PD programme to be effective, an analysis of the participating schools' needs – in terms of the formative evidence of both learners' and teachers' performance – must be undertaken (Killion et al., 2010: 8).

Mentoring was also used as one of the interventions in the PD programme under study. The section that follows investigates the effectiveness of mentoring as a method of teacher professional development.

2.4 MENTORING AS A TEACHER DEVELOPMENT METHOD

In Chapter One (Section 1.2.3), the notion of mentoring as an avenue of teacher professional development was introduced. Mentoring has been variously defined. Megginson and Garvey (2004: 2) define mentoring as "a relationship between two

people with learning and development as its purpose". Mentoring as method of PD can also be defined as an intentional strategy based on individual and institutional support. The aim of mentoring is to create a learning partnership that fosters professional development (Fischer, 2002: 3). Generally, mentoring involves a relationship between a more experienced person (the mentor) and a less experienced individual (the mentee) (Shulman & Sato, 2006:2). The primary focus of this relationship is the growth and development of the mentee, although the mentor may also benefit (Allen, Finkelstein & Poteet, 2009: 2). A key question for this study relates to how mentoring has been understood and implemented in the specific PD programme under investigation, since mentoring is one of the components of the programme. Another important question pertains to the components that mentoring, as a vehicle for professional teacher development, should consist of or the conditions that are conducive to the professional development of the participating teachers.

In this study, mentoring was defined as the professional practice that occurs in the context of teaching, wherever an educational expert supports, challenges and guides a teacher in his/her teaching practice (adapted from Odell & Huling, 2000: xv). Sibanda and Jawahar (2012: 260) refer to the term 'school visit mentors' because the latter also lend classroom support to in-service teachers on a short term basis. These 'school visit mentors' then assist with lesson planning and will submit written reports on how the lesson was conducted and which suggestions were made to improve their teaching practice. Therefore, one of the dominant roles of a mentor would be to provide feedback to the mentees on their teaching (Edwards, 1998). In addition to the feedback, support can also be provided in terms of creating a comfortable learning environment, treating the mentee as a colleague, and communicating effectively with him/her (Ambrosetti & Dekkers, 2010: 47). These different forms of support given to teachers on-site have proven more effective than PD interventions done outside of the classroom (De Clercq & Phiri, 2013:78). Teachers' professional development aims to develop them by improving and upgrading different aspects of their competence and performance such as subject knowledge, new teaching and assessment strategies, reflective practice, and action research (Hatting, 2009: 343). In the programme under investigation, mentoring also

includes assistance with lesson preparation. In South Africa, professional development is steered by different role-players such as tertiary institutions which offer teachers post-graduate qualifications and opportunities to upgrade their qualifications. The Department of Education, through its different district offices or circuits, conducts ad hoc training workshops, and curriculum advisors visit schools to offer all kinds of support and do monitoring (Hatting, 2009: 343). Different non-governmental organisations (NGOs) are also involved in PD programmes (Hatting, 2009: 343). Another way in which PD is achieved at school level is through subject heads who support teachers in various respects. However, in the South African context, a subject head may be assigned a group of subjects; as a result, it might happen that he or she is not an expert in all the subjects assigned to him or her. In such a case, the subject head might not fully support the school's Mathematics teachers. Thus, outside mentors should be assigned to support these teachers.

Existing literature reports extensively on mentoring with pre-service and novice teachers, whereas very little is said about the mentoring of in-service teachers, as confirmed by Halai (2006). If they are mindful of the South African Mathematics teachers' challenges, mentorship interventions can assist with the alleviation of poor performance by both the teachers and the learners. This is achieved by means of mentors supporting teachers in the classroom to improve their classroom practice, lesson preparation, and content knowledge, to name but a few.

The marginal impact of some PD programmes is due to the fact that they are not being linked to the needs of both the individual teachers and the schools, that is, they are not connected to school and classroom realities. It also results from the lack of support to the promotion of reflective practices. Nevertheless this marginal impact can be increased by including mentor support which is more conducive to sustainable teacher development (Hatting, 2009: 343). One of the major methods of developing the teachers involved in the PD programme under investigation is the use of facilitators for a one-on-one mentoring of teachers inside and outside the classroom. The constructive criticism and team-teaching experience that the mentor provides to the mentee might assist in the achievement of two of the intended

outcomes of the PD programme, namely, the improvement of both the mentee's competence and performance. This can be done by the mentor's modelling of good practices to the mentees (McLaughlin & Talbert, 2006) during co-teaching which offers the mentee the opportunity to watch how the mentor teaches. In this way, the mentee may acquire a better understanding of how to interact with learners, learn other aspects of instruction, and develop through reflective conversations after the lessons (Badiali & Titus, 2010: 74). In this regard, mentoring is an intervention during which a teacher's specific needs can be addressed. It can happen in the school context and can accommodate the participating teacher's learning style. Mentoring provides opportunities for teachers to get individual attention, receive support, have some of their uncertainties clarified on an individual basis, and share knowledge and experience (Murray, 2010: 6). As such, mentoring has the potential to counterbalance the limitations ad-hoc workshops and seminars which are detached from context and do not address the individual needs of the participants. These interventions had been criticised for providing teachers with ideas that could not easily be tested in the teachers' own practice (De Clercq & Phiri, 2013: 78).

It suffices to note that mentoring is very labour-intense. Hence, I agree with Fricke, Horak, Meyer and Van Lingen (2008) that the mentoring of teachers in their work environment is a sustainable way of changing the dismal state of Mathematics education in South Africa. Mentoring can improve learners' performance in Mathematics by addressing the quality of teaching and improving the teachers' skills, knowledge and attitudes (Luneta, 2012: 365).

Mentoring can provide teachers with new ways of doing, since regular discussions and lesson observations can foster perseverance in terms of the incorporation of new ideas (Harrison, 2005: 262). Mentoring can include assisting teachers to adopt a practice that seeks to turn the classroom into a community where teachers care about their learners' engagement in class (Sibanda & Jawahar, 2012: 267), foster the development of relationships between learners so that they do not become over reliant on their teachers, provide opportunities for learners to struggle with Mathematics so that perseverance can be nurtured, plan Mathematics learning

experiences that allow learners to build on their existing experiences, interest and proficiencies (Anthony & Walshaw, 2009: 148–150). The development of critical thinking in Mathematics is central to the justification of solutions. For this reason, it must be inculcated in time and care must be taken to ensure that learners develop the ability to provide sound mathematical explanations (ibid). Thus, teachers must listen to learners attentively in the classroom in order to support learning where necessary (Lobato, Clarke & Ellis, 2005). Follow-up support should also be provided by the mentor, given that one needs to practise new ways of doing in order to perfect them. This can ensure lasting change in teacher practise. The report on the evaluation of the Quality Learning Project (2005), a 5-year teacher development PD programme which ran in all the provinces of South Africa, contained a recommendation on the inclusion of mentoring in the teacher development to increase the impact of PD programmes. This confirms the valuable role that the inclusion of mentoring can play in a teacher education PD programme. School-based professional development programmes which involve mentorship and are linked to the needs of the both individual teachers and the school are more conducive to sustainable teacher development (Hatting, 2009: 343). Though mentoring can add value to CPD programmes and has proven effective in enhancing Mathematics instruction, the mentor should be equipped with mentorship skills and knowledge (Luneta; 2010). In a study conducted by Sibanda and Jawahar (2012: 259), retired teachers with expertise in the teaching of Mathematics, Science, and Technology (MST) subjects were recruited as mentors. This was potentially challenging because retired teachers might lack the appropriate energy levels and understanding of the recent developments in Mathematics education research and might therefore not necessarily be open to new ways of doing. Some of these retired teachers might see this more as an opportunity to earn extra income to supplement their insufficient pension funds; as such, they might not have the necessary enthusiasm and vision for this kind of programme. Despite the value mentoring can add to teacher development, practitioners should guard against using mentoring for critique and evaluation purposes (Murray, 2010: 6).

2.5 THE CHALLENGES ENCOUNTERED IN THE MATHEMATICS TEACHER DEVELOPMENT CONTEXT

It has been proven that high-performing school systems invest in improving instruction due to the direct impact that it has on learner achievement (McKinsey & Company, 2007: 13). Therefore, teacher development should be an important focus-area in the South African schooling system's quest for equity and redress of the inequalities caused by the country's apartheid past in a post-1994 context (De Clercq & Phiri, 2013; Rollnick, Bennett, Rhemtula, Dharsey & Ndlovu, 2008). In response to the challenges faced in South Africa, where learners lack reading and writing skills and their Mathematics and Science performances are poor, different interventions were launched as PD initiatives aimed at addressing the situation. The question, however, is whether the inability of the South African Mathematics Education landscape to produce good results can be attributed solely to incompetent Mathematics teachers. In South Africa, Mathematics, Science, and Technology education have been of national interest for a number of years (Kriek & Grayson, 2009: 185); but, as indicated in the problem statement, no significant improvement has been observed in learners' results.

Although the South African context is characterised by the demand to redress the past (Adler & Davis, 2006: 276), transformation cannot happen overnight. Many teachers who are in the current education system were trained in apartheid-created Colleges of Education (Gordon, 2009). It is crucial to note that Mathematics was not part of some of their initial trainings (Makgato & Mji, 2006: 254). Therefore, Mathematics PD programmes should strongly consider including high-level scientific knowledge which these teachers need to acquire to be able to successfully implement the ever-changing curriculum policies (Modiba, 2011: 14). The lack of a teacher education policy framework, the absence of a coherent strategy to effectively upgrade under-qualified teachers, the ineffectiveness of initiatives aimed at developing teachers' ability to teach reading and numeracy, and the paucity of evidence-based research that informs policy and practice on teacher education in South Africa are some of the challenges in teacher education identified by both the Department of Education and the Council for Higher Education (GDE, 2010: 14). The state's inability to supervise the performance of teachers is another cause of concern

(De Kadt, 2010: 6). In schools where learners are performing poorly, there is also evidence of teachers not completing the syllabus for the particular year (Makgato & Mji, 2006: 261). Another challenge emanates from the fact that in Mathematics topics builds on each other. Thus, without the much needed prior skills and knowledge learners were supposed to acquire in the previous year, they will be unable to master the new grade's syllabus. Over the past twenty years of South Africa's democracy, many interventions have been implemented in an attempt to reverse the damages caused to teaching and learning by the previous dispensation (Bansilal, 2012: 236). It is also claimed that PD in South Africa has been sporadic and that the implementation thereof has been problematic (Singh, 2011: 1627). Therefore, studies should be conducted to increase evidence-based research that is essential to justifying the work done in teacher education, notably in PD programmes which include the evaluation of all the achievements of teacher development. This is echoed by Adler and Davis (2006: 279) who argue that, although Mathematics teacher PD programmes are of paramount importance, the effect of these efforts on the country's education system remain under-researched.

The Gauteng Maths-Science-and-Technology Strategy indicates that the South African government has a vision insofar as supporting professional development initiatives aimed at Mathematics teachers (GDE, 2010: 20). Loucks-Horseley, Stiles, Mundrey, Love and Hewson (2010: 9) regard professional development as "a critical link between where one is and where one wants to be". Yet, Metcalfe (2011) observes that "the state (and NGOs) continues to invest resources in education without achieving any improvements in quality" (Sunday Times Review, 20 Nov. 2011: 5). The question is whether the plans/programmes designed and implemented in order to achieve the aforementioned vision are conducive to reaching the overall outcome of these programmes. In this regard, Garaway (2003: 705) stresses the need to design context-appropriate teacher development programmes. The designing of appropriate PD programmes requires that the needs of the particular contexts be taken into consideration. Put differently, the implementation of a professional teacher development informed by the needs of the beneficiary teachers is central to ensuring the accomplishment of the aims of the programme (Luneta, 2012: 11; Joyce & Showers, 1988).

Metcalfe (2011) claims that the desired impact of PD programmes is imperceptible "because efforts have been fragmented; learning has not been shared; and innovations have been isolated from system change" (Sunday Times Review, 20 Nov. 2011: 5). PD programmes may also be ignorant of the fact that a significant amount of teachers experienced poor schooling themselves. Put another way, PD programmes may disregard the needs of the people they are supposed to help (Bansilal, 2012: 252). It is also claimed that some PD programmes offered have multiple and sometimes competing goals geared towards reforming the current teachers' corps, in the midst of limited human and financial resources (Adler & Davis, 2006: 279). In the light of the above explanation, there is a pressing need to share with others in the field both the lessons learnt and the innovations implemented, regardless of whether these innovations are successful or not. One way of achieving this is by performing comprehensive evaluations of all initiatives and publishing the ensuing reports, keeping in mind that "... the reasons for the programme are the purpose for the evaluation" (Luneta, 2013: 107).

The current South African educational landscape predominantly uses the off-site model in its continuous professional development programmes, during school holidays and after school hours (Luneta, 2012:12). However, effective PD interventions require teacher training to be moved to the classroom (McKinsey & Company, 2007: 26; De Clercq & Phiri, 2013: 78), where it would be most relevant and applicable (ibid: 27). The inability to run effective professional development programmes results in a disconnection between practice and theory, as well as a disjunction within the school as a whole (Luneta, 2012: 12). This interrogates the effectiveness of most of South Africa's continuous PD programmes.

Another important factor that impacts on the effectiveness of PD programmes is teachers' qualifications. Research conducted by Scholtz et al. (2004) shows that more experienced and better-qualified teachers are more inclined to PD programmes. The level of teachers' qualifications and their teaching experience also influence whether or not they would take advantage of PD programmes. This finding is cause for concern, since it has been established that many Mathematics teachers are inadequately equipped to teach this subject. There is also the claim that "a common maxim in the educational platform is that one teaches the way one is

taught" (Thomas & Pedersen, 2003: 319). Teachers who are in the current system were exposed to poor teaching and teacher-centred teaching and learning. This takes a great effort to undo (ibid).

It is important to note that teacher training is not the panacea to all education problems. Some solutions to the dilemma faced by the South African education system lie in the country's ability to effect changes in the economic, social, and cultural realms of society. Indeed, the South African education sector is affected by a myriad of factors, such as poverty, unemployment, lack of parent support to learners after school, illiterate and innumerate parents (De Kadt, 2010: 6), and reading challenges resulting from being taught in the mother tongue. A study done by Howie (2003: 1) in South Africa identified proficiency in English as a strong predictor of success in Mathematics. In other words, the low level of Mathematics skills among a considerable number of teachers is but one of many factors that affect learners' performance. In this regard, teacher trainings should not be viewed as the solution to all the challenges faced in the broader South African educational landscape.

It becomes important to establish whether the content of teacher development programmes should be geared towards fostering the implementation of effective or best practices, or sustainable long-term changes (Franke, 2001: 654). Franke (2001: 658) suggests that "the interest (of professional development) is in having teachers come to see themselves as on-going learners, seeking classroom practices that are responsive to the needs of the learners and continually evaluating and adapting classroom practice". Learning takes place when teachers and learners interact. Therefore, the quality of this interaction should improve, if the intent is to improve learning (McKinsey & Company, 2007: 26). So, PD programmes need to also focus on changing the way teachers interact with learners and the way teachers allow learners to interact with one another in the classroom. This implies that teachers have authority over the degree to which learners are allowed to participate in classroom interactions. As such, they should be skilled to optimally use this privilege. However the PD programmes in South Africa have limited inclusion of pedagogy and problem solving skills development in them and rather have predominant focus on content, curriculum and assessment (Mullis et al, 2012: 301). This indicates a lack of focus on developing the teachers in terms of these classroom interactions. The

TIMMS report also reveals that only 35% of students in South Africa are engaged in the Mathematics lessons (Mullis et al, 2012: 373) which highlight the need to more support for teachers to develop the skill of engaging learners in the lesson.

The endeavour to get teachers to see themselves as on-going learners implies that professional development must assist teachers to develop reflective teaching and life-long learning. The lessons learnt from their exposure to reflective practice in their teaching should result in teachers' engagement in new practices. According to Onwu and Mogari (2004), the results of the UNIVEMALASHI programme (a three-year teacher development PD programme that was implemented in the Limpopo Province, in South Africa) revealed that this programme had a built-in supportive component. This supportive component contributed to the PD programme's success and sustainability. Indeed, evidence shows that after professional development workshops on the theory, teachers implemented the learnt skills in cluster meetings in which reflections on real classroom experiences were shared, discussed, and analysed. In short, the success of the Data Informed Practice Improvement Project (DIPIP) in changing classroom practice and learners' behaviour is attributed to the combined effects of teachers' active participation in discussions, the existence of an established network of peer/colleague support, and support received from principals and district officials, even after the programme. Harrison (2005: 261) claims that "peer discussion and deliberation is a fundamental feature of professional sense making and an instigator of professional learning". This assumes that these components need to be considered when designing new teacher development programmes.

Wenger (1998) also highlights the importance of a community of practice in which people can learn through their collective involvement. Previous work done by the researcher on an ACE reskilling programme revealed that teachers learnt a great deal through collaborations with colleagues (Nel, 2012: 152). By exchanging knowledge/information and by sharing experiences/skills, teachers developed (Harrison, 2005: 261) in terms of confidence and classroom practice, as well as assessment practices and facilitation skills. The observations need to be taken into account when developing professional development programmes. Franke (2001: 685) also argues that "teachers need time to develop relationships with others that

they can talk with in ways that meet their needs and push their thinking". Teachers in rural areas lack these kinds of opportunities to form relationships where they can assist each other. This will not only help them end their working in isolation but will also give them the opportunity to learn about each other's practice (De Clercq & Phiri, 2013: 79). This can create opportunities where teachers can observe one another and share skills and knowledge on what works and what does not (McKinsey & Company, 2007: 31).

The preliminary results of the UNVEMLASHI research project "demonstrate that an appropriate teacher development programme results in changes in teacher classroom practice and learner behaviour" (Onwu & Mogari, 2004: 176). This is because "the only way to improve outcomes is to improve instruction" (McKinsey & Company, 2007: 26). This is in line with Garet et al.'s (2001: 935) claim that "sustained and intensive professional development is more likely to have an impact … than a shorter professional development". It remains to be established whether the teacher development programme under investigation is effective enough to have an impact on the professional development of the participants, and whether this impact can be sustained.

Indeed, Garet, Porter, Desimone, Birman, and Yoon (2001: 917) claim that, despite the vast amount of literature on professional development, relatively little systemic research has been conducted to assess the effects of professional development on teaching improvement or student outcomes. Thus, the researcher agrees with Penuel, Fishman, Yamaguchi, and Gallagher (2007) that, in the past, insufficient attention was paid to the outcomes of professional development, although they are central to a programme evaluation (Luneta, 2013: 106). This is because the emphasis was more on the evaluation of teachers' satisfaction with their professional development experiences. This is evident in evaluation reports on professional development programmes run in South Africa. As a matter of fact, one of the major initiatives aimed at improving Mathematics and Science education through a PD component, the Dinaledi Programme, has revealed gaps, after 10 years of existence.

Thus, more recent studies have directed their attention to the complex link between the design of professional development programmes, teachers' learning as a result

of their exposure to these programmes, and the subsequent changes in classrooms (Penuel et al, 2007:923). Countries like Finland, Korea, and Singapore – which have recorded a significant improvement in their students' achievements – attribute it to their investment in teacher preparation and development (Darling-Hammond, 2010: 194). This clearly suggests that teacher development initiatives have the potential to change South Africa's current situation for the better. It suffices to note that the abovementioned states are First World countries. Therefore, one wonders if their educational research outcomes can be directly compared to those of South Africa which is a Third World country whose curriculum is ever changing and whose teacher component is significantly less qualified to teach Mathematics.

2.6 WHAT TO KEEP IN MIND WHEN AIMING TO IMPLEMENT SUCCESSFUL PROFESSIONAL DEVELOPMENT PROGRAMMES

PD programmes should revolve around the acquisition of content knowledge, pedagogic content knowledge, and conceptual and procedural knowledge which is essential to effective teaching (Department of Education, 2006). Teachers use their knowledge to make important decisions about mathematical tasks, how to sequence them so as to enhance the development of concepts, classroom resources, assessments, and when and how to intervene when learners struggle or when to support learning by reducing the complexity of tasks (Anthony & Walshaw, 2009). Therefore, PD programmes should focus on ensuring that participants' content knowledge is strongly rooted, and that attention is also given to development in terms of assessment and when and how to support learners. Teachers should assess learners' performance regularly, that is, assessment should form an integral part of teaching and learning, because it helps to ascertain learner performance (Vandeyar & Killen, 2007: 103). Learning can be supported by using the learners' ideas, and by means of questioning, structuring and probing which are vital support mechanisms (Killen, 2010: 142). The value of this would be to challenge learners to think (Magano, Mostert & van der Westhuizen, 2010: 45). This implies asking open-ended questions which require learners to express their views instead of providing one-word answers. However, what takes place in the classroom should be planned in advance in order to complete the syllabus timeously. In this regard, written lesson

plans are needed for every lesson conducted. They should describe what the teacher plans to do in the classroom (McKay, 2010: 1). As Killen (2010: 84) observes, “You cannot expect individual lessons to be successful if they have not been planned thoroughly and integrated carefully into medium and long term plans”. The preparation of daily lesson plans contributes largely to a teacher’s sense of organisation; and, the more organised the teacher is, the more effective teaching and learning will be (Adedeji & Olaniyan, 2011: 52). Hence, lesson plans help teachers to plot out the curriculum content. They are also used by education officials to ensure that teachers are doing what they are mandated to do (Dunn, Craig, Favre, Markus, Pedota, Sookdeo, Stock & Terry, 2010: 194). It is also claimed that one of the reasons teachers teach entire classes in the same way is because of the way they designed the lesson plans (ibid). Therefore, PD should also include the development of teachers in terms of lesson planning so as to make the participants aware of the need to teach in ways that include every learner in the class. The development should emphasise the fact that teachers should first consider the purpose of the lesson, decide on the learning outcomes, select their teaching strategies, choose the learner activities that will take place, and determine how learning will be assessed after the content has been decided upon (Killen, 2010: 68, 87-89). Lesson plans should also link the content with the learners’ real life context (Nel, 2009: 34) to ensure that they keep learners interested. Relating what is learnt in the classroom to learners’ real life not only enables them to see its relevance to them, but also stresses the importance of understanding the world at large (Killen, 2010: 29).

However, although teachers should be monitored and frequently visited by the subject advisor and other district officials to assess whether they operate within the frameworks of the education requirements, rural schools are less likely to be visited (Adedeji & Olaniyan, 2011: 49). This implies that rural schools are not monitored as regularly as they should be, keeping in mind that monitoring and evaluation are important in ensuring that an institution delivers good results (Adedeji & Olaniyan, 2011: 78). It is therefore difficult to ensure quality in teaching and learning in rural areas.

It must be noted that adult learning is selective in that it filters information, whether consciously or subconsciously (Huber, 2011: 839). However, it is more sustainable when practical application is attached to what has been learnt (Steyn, 2009: 127). So, to enhance new competences, the theory learnt should be followed by practice, feedback, and reflection (Huber, 2011: 839). Indeed, if themes are not linked to existing cognitive systems, they may remain abstract and will be quickly forgotten. Hence, the current context and experiences of the participants, as well as their needs and problems should be the reference point when selecting the content and methods of interventions of a PD programme (Huber, 2011: 840; Bansilal, 2012: 242). A teacher who finds the PD programme responsive to his/her real needs and relevant to his/her context will be more determined to apply what is learnt through programme.

Huber (2011: 840) identifies demand orientation, practice orientation, and sustainability orientation as the most important aspects that PD should focus on. For a PD to be effective, it should meet two important requirements:

- Integrate diagnostic means into PD training and development programmes so that prior knowledge, existing attitudes, motivation, expectations, and goals can be used to plan the PD and its approaches to learning.
- Focus on the sustainability of learning by translating theory into praxis.

Besides course attendance, the increased awareness of the value of other forms of professional development is important. This includes the sharing of expertise between teachers in the same school, the sharing of skills and knowledge with teachers in other schools, and the use of consultants to run in-school programmes to support teachers who are grappling with specific needs (Boyle et al, 2005: 3). Makgato and Mji (2006: 264) also recommend school-based PD as well as PD initiatives that create an environment where teachers can share strategies that work, knowledge, problems, and challenges. Thus, PD programme developers should keep the above in mind when developing programmes aimed at increasing the impact of PD on the participants.

The “scaffolding” of PD opportunities for teachers, with different levels of content and skills, is suggested by Desimore, Smith and Ueno (2006: 108). They believe that it would alleviate the repetition of PD programmes for the same audience (Steyn, 2009: 127) and thus avoid boring the participating teachers. This implies that PD programme developers should do a thorough analysis of the participants’ prior knowledge, to determine what kind of training they were involved in earlier. With the differences in content and skills knowledge in mind, PD developers should plan in such a way that participants are challenged in areas where they need individual assistance. This implies that a programme may commence with a certain portion of the targeted participants and, as the “scaffolding” progresses, more participants would be included or, at the same time, different activities would run for different groups of participants, depending on their current skills and knowledge.

2.7 CONCLUSION

This study applied the outcomes-based evaluation which focused on the outcomes stipulated in the research questions. The investigation sought to establish if the reviewed PD programme used the appropriate activities to achieve its intended outcomes. Summative evaluation was also conducted as this evaluation happened at the end of the programme. This could assist in deciding to continue, terminate, or revise the PD programme.

An investigation was also conducted to determine whether a needs-analysis was done before the interventions were planned, if teachers’ competences and performances had changed – by using the performance indicators stipulated by the programme – whether the participants’ classroom practice had changed, and if the participants’ knowledge and skills had improved.

In order to investigate the effectiveness of the PD programme under investigation, a number of components were examined. These include whether the activities were organised as a reform type; the duration of the activities; if active learning occurred;

if there was collective participation; if there was collaboration among the participants, if the participants were involved in the planning of the programme, and if the scaffolding of activities was foregrounded in the execution of the programme.

The next chapter provides a description of the PD programme under investigation.

CHAPTER 3

DESCRIPTION OF THE PROFESSIONAL DEVELOPMENT PROGRAMME UNDER INVESTIGATION

3.1 INTRODUCTION

Chapter Two discussed the evaluation of educational programmes, the effectiveness of PD programmes, mentoring as a teacher-development method, the challenges encountered in the Mathematics teacher development context, and aspects of successful professional development programmes. In order to evaluate the PD programme under investigation, the researcher needs to describe both the planning of the programme and the context in which it was implemented. Thus, this chapter will begin by providing both the description of the project's service provider and some background on the work done by the latter in other parts of South Africa. Subsequently, the context in which the programme was rolled out will be described, that is, the district and the respective contexts of the various participating schools. Afterwards, the overall goals and planned interventions of the PD programme will be discussed, under the headings of the different components of the programme.

Based on the vast amount of work that the service provider has done before, they will draw from the lessons learnt in the past to guide the implementation of this particular PD programme. These lessons will also be highlighted. The Systematic School Improvement Intervention Model (SSIM) designed and used by the service provider will also be described, using the different components as headings. Lastly, the project log frame will be presented, together with the different strategic objectives, key performance indicators, and objectively verifiable indicators. This chapter concludes by emphasising the purpose of this research and its rationale. The websites, and relevant brochures, reports and newsletters relating to the programme will be used as sources of information in shaping this description. It must

be noted that the teacher professional development under investigation was a subsection of a broader project which was therefore referred to as 'the broader project', whereas the subsection was referred to as 'a programme'.

3.2 WHO WAS THE PROJECT'S SERVICE PROVIDER?

The service provider for this project was JET Education Services, formerly known as the Joint Education Trust (JET). JET was established in 1992 as a result of a partnership between leaders from South Africa's corporate world, trade unions, the country's major political parties, and organisations representing black businesses (http://www.jet.org.za). This partnership, which was pioneered by Mr. Mike Rosholt, was formed when South Africa was on the verge of becoming a democratic country characterised by huge educational inequalities caused by the apartheid policies[1] (Mouton, 2010: 90). JET received R500 million to assist with the restructuring of the country's education system. Its main focus areas were early childhood development (ECD), adult basic education and training (ABET), vocational and further education, in-service teacher training and development (INSET), and youth development. As an institution, JET Education Services is an independent, non-profit organisation which strives to improve the quality of education and the relationship between education, skills development, and the world of work (Section 51 of JET Education Services' manual, www.jet.org.za). The stated aim of this organisation is to bring about change in the education system of South Africa. Thus far, over 35, 000 teachers have been supported through in-service training (History of JET Education Services, www.jet.org.za), and nearly 2.5 million learners have been reached in the process.

However, JET's viewpoint is that the primary responsibility of providing education in South Africa lies with the government; JET is mainly a partner of education departments and schools (Project Proposal, 2009: 3). With this philosophy in mind, JET operates across the South African public education sector, from pre-school through to FET colleges. JET's initiatives focus on poor, marginalised and disadvantaged communities across South Africa. This organisation has been involved in numerous projects and interventions since its inception. These include,

for example, the Cooperation in Education between the Netherlands and South Africa (CENESA), the National School Effectiveness Study (NSES), the Centres of Excellence Project, and the Family Literacy Project.

Clearly, JET Education Services has a rich experience in the upliftment of education in South Africa. Through this engagement, this organisation strives to provide knowledge-based education, as well as training programmes in research and evaluation and in school and education systems, to improve the youth's life opportunities.

As part of its endeavors in schools, the South African community involved in teacher professional development, held a conference in 2008 and grappled with what works in terms of school development. In some of the papers urgency was expressed in relation to the need to improve the poorly functioning schools and the consistently-low level of performance in numeracy and literacy (Bodenstein, 2008: 2). Thus, it became imperative that school interventions be customised to the relevant schools' functionality, that donors and government work closely together, that teacher capacity be built, and that programmes aimed at effecting systemic change in the educational arena be implemented.

JET Educational identified the following aspects that, based on its experience, were necessary to implement in other projects – including the programme under investigation (Project proposal, 2009:8):

1. Recruit a high-level, fulltime School Development Facilitator (from the district) who takes the primary responsibility for integrating the project into the district's operations.
2. Minimise the use of 'traditional service providers' and engage fulltime, experienced practitioners at both the district and circuit levels, to complement the district's capacity to plan and rollout school support. Where service providers are used, their dedicated staff should report to the School

Development Facilitator, and should commit to implementing the approved project-specific design.

3. Involve the district and the teachers' unions in the design, the governance, and the delivery of the interventions.

4. Engage in teacher professional activities that combine self-study, as well as in-school and external trainings. To improve the responsiveness of the professional development activities, JET plans to base our teacher development programmes on systematic assessment of the teachers' knowledge that will provide individual teachers with their own performance scores. The composite data will be used to design group-level interventions.

5. Improve action research and educational dialogue among the participating schools and district officials. Action research and records of innovations and good practices will be disseminated through newsletters and seminars and will serve as a way of improving the ethos of the teaching corps.

The overall project was funded by the DG Murray Trust, the Murray and Roberts Group, and the JET Board of Directors (Sustainable School Improvement, 2010: 18). The investigated teacher PD intervention was financed by the Michael and Susan Dell Foundation (MSDF). The latter's role in the South African education context is to ensure that youngsters from disadvantaged communities have access to quality schools and complete high school in such a way that they can succeed in Higher Education, as this will increase their opportunities for long-term employment thereafter (http://www.msdf.org/). This is against the backdrop of data that reveal that less than 5% of black students achieve a post-high-school qualification (MSDF, 2013:1), compared to 50% of white students. MSDF's belief is that by working towards systemic change, by taking the smartest and most pragmatic steps to achieve transformation (MSDF, 2013: 1), it is possible to accomplish lasting change so that the above figure of 5 % can increase significantly. It suffices to note that more funding was given to the Further Education and Training (FET) phase than to the General Education and Training (GET) phase (Output to Purpose Review (OPR), 2012: 6).

3.3 WHERE WAS THIS PROJECT SITUATED AND WHAT WAS THE CONTEXT OF THE PARTICIPATING SCHOOLS?

The programme under investigation was rolled out in a medium-size province covering 9.7% of South Africa's total surface area. This province is home to approximately 3.7 million people, about 8.2% of the South African population, and contributes about 7% of the national economy (North West Provincial Growth & Development Strategy, 2004: 6). According to the 2003 figures, this province had the lowest number of people aged 20 years and older (5.9%) with a Higher Education qualification (http://www.nwpg.gov.za/Premiers/Office%20of%20the%20premier/Overview.html, Feb. 2014).

The specific area where the programme was implemented is a circuit of a district. This circuit was selected by the North West Department of Education as an appropriate area for the implementation of the PD programme because of its low status in terms of the performance of its grade twelve learner (Learning Brief 1, 2010: 1). Consequently, the five participating schools were enrolled in this particular professional development programme. The subjects that were included in the programme were Mathematics, Physical Science, Mathematical Literacy, and English First Additional Language. The reason for including these subjects, it was argued, was that Mathematics and Physical Science were prerequisites when learners wanted to venture into scarce skills careers like engineering (DBSA, 2009: 38). Moreover, these subjects were identified as problematic by the Education Department, when the overall grade 12 results were analysed (Mabe, 2013: 12).

Economically, this district was also part of a strategic mining and agricultural province (North West results, 2014: 5) albeit being mostly a rural area. The fact some of the roads were not maintained (North West Provincial Growth & Development Strategy, 2004: 7) made access to rural areas problematic. The predominant language in this province is Setswana (Mabe, 2013: 9). However, in the

Annual National Assessment (ANA) Tests of 2012, it was observed that the grade 9 learners mostly chose English as their first additional language, instead of Setswana (Mabe 2013: 8). This may have major implications for teaching and learning in that the learners' mother tongue is not dominant in their educational sphere. This issue was address in Chapter 2. The participating schools were more than 50 kilometers away from the nearest town. Most of the participating schools were also relatively far from the district office.

It suffices to emphasise that the education district's role in improving the education system is to support schools by providing them with the relevant resources, systems, and professional development. They also monitor schools' utilisation of their inputs and the achievement of their set targets. However, the understanding of this role and how it is discharged differs from one province to the other, and even among districts situated in the same province. There is also no common district framework in terms of staffing, resourcing, and programming. In the North West province, for instance, the district is two ranks below the provincial level. The district, which is responsible for a number of circuits, reports to the cluster Chief Director. Nonetheless, districts are still vital in the plan to achieve sustainable systemic school improvement.

It must be stressed that the schools in the relevant circuit are relatively small in size. As a matter of fact, one of the five schools involved in the professional teacher development programme consisted of less than 60 learners (JET Learner Numbers, 2012: 1). Due to a shift in enrollment patterns, which is characterised by a decline in learner numbers, two middle schools have merged with nearby high schools whereas one primary school has closed down (OPR, 2012: 5; 22). The one school which only has grades 8 and 9 learners is set to be closed down. The abovementioned developments created situations over which teachers had no control, even though they were directly affected by them (Project report, 2013: 2). The abovementioned school mergers and closures resulted in the following:

a) Redeployment of teachers to other schools.

It was decided that the teachers from the schools which had been closed or merged should be redeployed to schools located in other areas.

b) The assignment of teachers to subjects in which they had no formal training.

As schools' enrollment declined and some teachers were redeployed, those remaining had to teach more subjects, even subjects in which they were not trained. Furthermore, due to the small size of some schools and therefore their small staff component, each teacher had to take more subjects. This also resulted in some teachers teaching subjects that they had no formal training in.

c) The appointment of temporary teachers – out of the District's budget – for short periods.

The District appointed temporary teachers (some of whom were not even qualified) to relieve existing teachers from their heavy workloads. However, these temporary teachers were appointed for short periods; thus, they only provided a temporary relief. When the contracts of these temporary teachers expired, the permanent teachers were again left with huge workloads and a lot of administrative work to do.

d) Teachers being promoted or seconded.

Teachers who had become redundant at some schools were promoted to new positions or seconded to other positions that were far from the areas where they lived. Sometimes, these shifts were decided against the relevant teachers' will.

e) Migration of teachers to urban schools.

The investigated PD programme was rolled out in a rural area. Some of the teachers commuted daily, from the urban areas, using very bad roads. When urban positions became vacant, those commuting teachers would find it more convenient and would opt for those positions. This resulted in a situation characterised by teachers migrating to urban schools.

f) Demotivation of teachers due to change-related uncertainty.

The fluctuation of enrollment numbers, the uncertainty relating to the closure of schools, and the challenge of dealing with a heavy workload account for the fact that some teachers felt demotivated. In some cases, the Department of Education was not communicating effectively in advance, leaving teachers uncertain about both the future of the schools and their own future placements.

The next section provides a close description of the context of the schools participating in this study. The five schools involved in this study were all classified as quintile 1 schools. This meant that they were school-fees-exempt establishments that were subsidised by the government at R855 per learner (2010 stats; Hall & Giese, 2009: 39). Quintile 1 schools are the poorest in terms of the poverty ranking which is based on the income levels, dependency ratios, and literacy rates in the schools' vicinity (Hall & Giese, 2009: 37). Schools in this category were under-resourced in terms of infrastructure, teaching equipment, and staff. Consequently, existing teachers had to take more than one subject area, even in fields where they did not have any expertise. In this study, all five schools did not have a library, a laboratory or a school hall. Some of these schools did not even have a staffroom; teachers used a vacant classroom as their staffroom (researcher's personal observations). A significant number of staff members commuted, daily, to and from the school – some in lift-clubs. This also impacted negatively on the running of the school. Only one school's principal was permanently employed in this position, the remaining four were acting principals. This had implications for the schools' long-term planning. Indeed, people in acting positions do not always have a long-term vision for the organisation.

3.4 AN OUTLINE OF THIS PROJECT

3.4.1 Overall goal and strategic interventions

Most of the youth whose educational circumstances are categorised as poor come from disadvantaged, black households – generally from rural areas. The area chosen for the implementation of this project is situated in such an environment. Thus, its selection is part of an attempt to bring about substantial educational improvements. In order to achieve this, Mathematics (which includes what is often called "pure Mathematics" and Mathematical Literacy), Physical Science, and English language teachers, as well as the school management team (SMT) were targeted by the interventions. This project uses a systemic approach to school development, as opposed to both a mere improvement of teachers' subject knowledge and a generic school management and governance approach. This

model is based on the belief that, in order to successfully improve schools, partnerships must be formed among the key stakeholders (Learning Brief 1, 2010: 1). This systemic approach includes the following key players: district and circuit officials, school management, teachers' unions, NGOs, teachers, the general community, and parent communities (JET Education Services, 2010: 18).

The overall goal of the project is to improve the quality of education in the North-West Department of Education. To achieve this goal, the project aims to implement the following strategic interventions over a period of five years, starting in 2009 (Project Proposal, 2009: 7):

1. Mobilising the key stakeholders through social processes aimed at establishing development charters that support the implementation of the project;
2. Developing and implementing school-specific development plans following a detailed profiling of the schools' needs;
3. Improving teachers' performance by equipping them with efficient curriculum delivery systems and raising their awareness of the necessity to achieve their teaching goals;
4. Improving teachers' competency by profiling their content and skills requirements;
5. Increasing the capacity of the districts to monitor and support schools on the basis of school performance data; and
6. Increasing the involvement of households in the education of their children, by managing their behaviour after school in relation to homework completion and how they spend their time.

Thus, the programme at large had the abovementioned six strategic interventions planned over the five years. As mentioned before, the learning areas include English, "pure Mathematics", Mathematical Literacy, and Physical Science – across both the senior and FET phases. The JET Education Services formed a partnership with the North-West Department of Education and other key stakeholders (Annual Report launch speech, 2011: 2), namely, district officials, teachers' unions, schools,

the community, and the parents. This partnership acknowledged that the primary responsibility for providing education in South Africa lies with the Department of Education (now called the Department of Basic Education). Thus, JET Education Services formed a partnership with the provincial education department, the funders, teachers' unions, and 29 schools.

JET Education Services adopted a Systemic School Improvement Model (SSIM). This model was piloted by JET Education Services in two education circuits, one in the Eastern Cape and one in the North West province (JET Learning Brief 1, 2010: 1). Within this context, the focus of this study is on the teacher development in pure Mathematics in the FET phase. Therefore, this study focuses on the last third and fourth objectives, as indicated earlier: improving teachers' performance by equipping them with efficient curriculum delivery systems and raising their awareness of the necessity to achieve their teaching goals, improving teachers' competency by profiling their content and skills requirements.

The implementation of this specifically selected section of the programme under investigation (Mathematics professional development in FET phase) started in July 2010 and lasted for two and a half years. Thus, this study examines the implementation of the abovementioned interventions aimed at improving the Mathematics teachers' competence and performance.

3.4.2 The different components of the project

JET Educational Services proposed that a seven-component intervention model be implemented in the participating schools. Diagram 1 illustrates the proposed intervention model. For JET, the key philosophical assumption underlying this model is that educational outcomes will increase, if teachers are effective and the teaching and learning environments are supported by effective school organisation, community involvement, and district support and monitoring. The key concepts entailed in this intervention philosophy (educational outcomes, effective school

organisation, community involvement and district support) are complex and often carry more than one understanding. In the context of this study, *educational outcomes* refer to the skills, aptitudes, knowledge, behaviours, attitudes, and values expected from learners in their engagement in schooling.

The next section briefly explains the different components of the proposed model, following the numbering applied in Diagram 1.

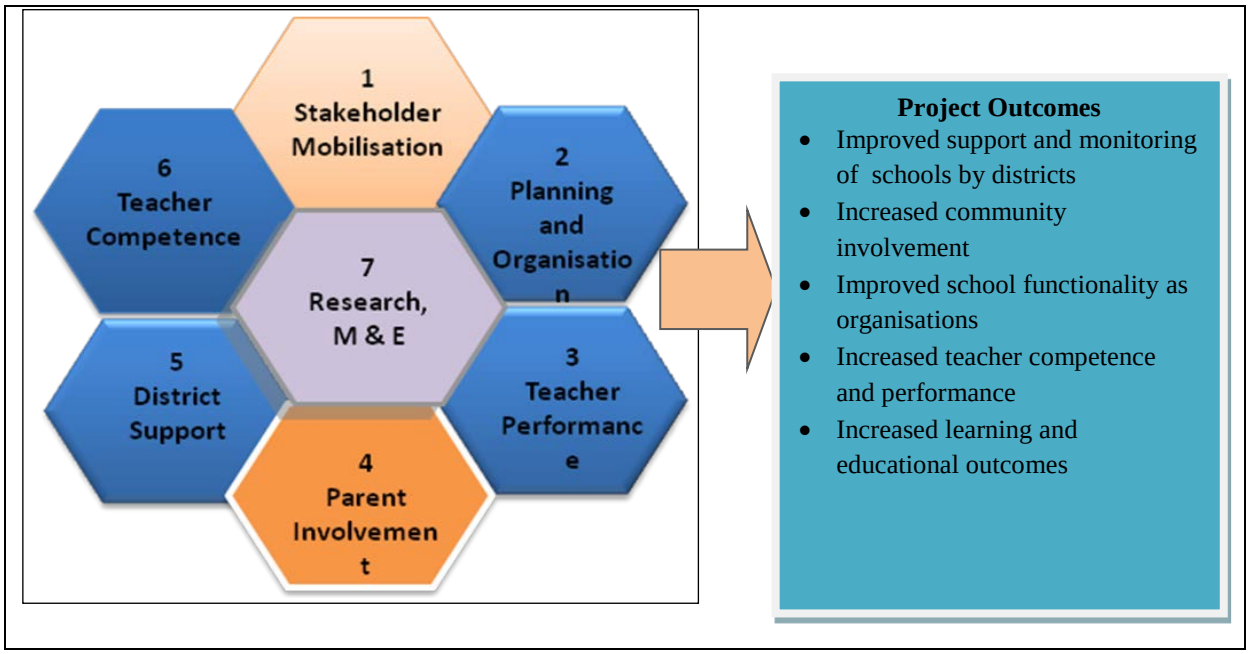


Diagram 1: Systematic School Improvement Model (Project proposal, 2009: 9)

3.4.2.1 Stakeholder mobilisation and parent involvement

Proponents of this model argue that educational improvement is enhanced by partnerships between the schools, the government, local authorities, and the communities. This is the essence of stakeholder mobilisation. By forming these partnerships, social investment in and allocation of resources for teaching and learning can be increased (JET learning brief 1, 2010: 2). The discussion will first focus on the role of parents before elaborating on that of teachers' unions.

Parents' participation aims to increase their role in their children's schooling, mobilise additional resources for schools, and inculcate a sense of accountability among all stakeholders. This can possibly lead to parents, in partnership with other community members, assisting learners as far as possible so that they may excel both in their school work and as individuals. Community and parent support can contribute to sustainable school change (JET learning brief 1, 2010: 2). Bhengu (2013: 64) confirms that the collaboration between schools and the communities in which they are located can result in the provision of quality education, and can also positively impact on learner performance. Smit and Liebenberg (2003: 2) identify barriers between main stream schools and parents from poor communities. These barriers hinder such parents' involvement in their children's education. These barriers include teachers being out-of-touch with community realities, parents' disempowerment by means of teachers "shutting them out" of the educational system, to name but a few (Smit & Liebenberg, 2003: 2-3). By involving parents on in the education of their children, the synergy between the school and the home can be increased. This may lead to greater buy-in from both sides with regard to the quest for quality education. Hence, schools need to consciously strive to gain a greater understanding of the communities they function in. Schools should also attempt to overcome any barriers that prevent schools and parents from working together. It must be emphasised that parents do have the desire to be actively involved in their children's education (Smit & Liebenberg, 2003: 4).

The envisaged outcomes of the parent involvement component were:

- An evidence-based improvement in the involvement of parents in their children's education, demonstrated by increased monitoring of home study, the number of completed homework exercises, school visits by parents, and parents' interest in their children's school reports.
- Improved learner behaviours at school and after school/at home. This refers to learners' conduct, especially how they manage their after-school time, homework, study, reading for enjoyment, and so on.

The other stakeholders are the teachers' unions that have a relationship with the North West Department of Education. Teachers, in South Africa, are usually

registered members of a teachers' union; as such, they adhere to the requests and demands made by their unions. It is therefore advisable, when a PD programme is initiated, that the unions are consulted and that they buy into the programme. This will enhance the smooth running of the programme. This programme ensured that the unions were part of the steering committee which met on a regular basis to discuss the progress of the programme.

The involvement of these stakeholders in the planning and execution of this programme is of utmost importance if one wants to bring about sustainable change (DBSA, 2009: 43). Moreover, planning processes need to be shifted from planning for the people to planning with the people (DBSA, 2009: 43). However, this is not enough; the administrative aspect must also be considered. Hence, this study focuses on both the planning and administration of the programme, which will now be developed.

3.4.2.2 Planning and administration/organisation

This component is incorporated so as to improve the functioning of schools as organisations. Indeed, schools may have effective teachers, hardworking learners, and strong partnerships with all the other stakeholders; but, if these schools are dysfunctional, meaningful learning will not occur (Sustainable School Improvement, 2010: 10). Thus, school management teams are supported, with the aim of improving the technical operation of the schools. This means increasing the effective utilisation of such resources as textbooks and teaching time. This could ultimately result in better quality teaching (JET learning brief 1, 2010: 3). In this respect, the school management team (SMT) is the centre of the school's functioning. This body manages curriculum delivery, monitors the different aspects of the entire school, and makes planning and resourcing decisions (Bush, 2007: 379). However, it is important that these decisions be based on information gathered about the different aspects of the school and, where necessary, actions must be taken in order to improve the effective running of the school. Based on research, JET Education Services has adopted a set of 47 indicators to assist school managers to keep abreast of what is

happening in their schools so that they are able to swiftly act on possible challenges, notably those related to teacher performance.

3.4.2.3 Teacher performance

To gauge and change a teacher's performance can be a very complex endeavour. This is because it is influenced by various factors which include the teacher's characteristics, learner and classroom characteristics, and the school's features (Sustainable School Improvement, 2010: 12). This component of the model is concerned with the classroom environment. As such, it seeks to ensure that teachers:

- Are aware of the teaching goals that they need to pursue;
- Embrace their agency in the learning process, since teaching is an 'intentional and reasoned act' (Anderson, 2004:33);
- Focus teaching on learning outcomes;
- Have access to efficient curriculum delivery systems and resources to achieve their teaching goals;
- Are excited to teach.

To achieve the goals of the teacher performance intervention, Mathematics, Physical Science, and English language educators are provided with curriculum planning and delivery materials, school support visits, and cluster-level activities. The curriculum materials provided to the teachers include learning programmes, work schedules, lesson plans, and assessment tasks. It is hoped that, through these interventions, a new, efficient and effective curriculum delivery system will be institutionalised in classrooms. This, in turn, should assist teachers to improve their classroom practice.

The envisaged outcomes of the interventions are that:

- All target teachers implement an effective curriculum delivery system that covers annual work schedules and common assessments;
- All schools cover the curriculum set out for each year as well as the required amount and quality of written work for the learners;

- Teachers reflect daily on the effectiveness of their teaching of the curriculum; and
- Teachers monitor and assess learner performance, as per the curriculum policy.

3.4.2.4 District support

This project's district support is pitched at two levels: the district office and the circuit level where the project is hosted. The project's support of the district's development is multipurpose. It seeks to provide additional strategic capacity in the planning and programming of the school support and monitoring activities, coordinate project activities with those of the district, and integrate the project's activities with those of the district. It is envisaged that, with the additional support provided to the district, the District Director (DD) will be able to devote additional time to the operations of the project.

To achieve these objectives, the project appointed a fulltime Education Improvement Facilitator whose role was to:

a) Serve as a counterpart to the District Director in the implementation of the project.
The reason for this was to allow this person to devote his/her full attention to this programme, in the hope of adding to the success of the programme.
b) Plan and oversee the implementation of the project.
The intention was for this person to focus on the planning and implementation of this programme, and to devise intervention mechanisms timeously, if needed.
c) Work with the District Director, to coordinate the inputs of the district officials, teachers' unions, and the technical assistants to the project.
As one of the aims of this programme was to involve all the stakeholders, this person's functions also included coordination between the different stakeholders. This was to support the District Director in discharging his/her mammoth duties in the district.
d) Conduct research, assume knowledge management roles pertaining to the project, and provide educational inputs directly to the schools, where necessary.

The service provider placed an emphasis on a research-based approach to training and development, which was also a function of the Education Improvement Facilitator. This person should have information about what was happening in the programme at grassroots level, by conducting research on it, and must provide educational input on matters which would arise.

e) Work with the District Director insofar as reporting to the funders and stakeholders about the implementation of the project.

This person was earmarked to work hand-in-hand with the District Director and jointly report and communicate with funders and stakeholders on the implementation and other aspects of the programme.

f) Work with the department to raise the additional funds required for the project.

At some stage, the total expenditure of the programme was not yet covered by funders. Thus, this person, in conjunction with the Department of Education, had to try and secure more funding to make up for the deficit.

The anticipated outcomes of the district's intervention are:

- Improved district operations in terms of school support and monitoring;
- Improved communication and cooperation among the education stakeholders in the circuit;
- Effective implementation of the project;
- Mobilisation of additional financial and non-financial resources from the partners;
- Achievement of the project outcomes.

3.4.2.5 Teacher Competence

Teacher competence refers to the knowledge and skills that teachers use to facilitate learning (Sustainable School Improvement, 2010: 13). Teachers' competence is central in building a bridge between the learners and the material to be taught (Van der Westhuizen & Smith, 2000:350). Without basic knowledge and skills, teachers

cannot effectively facilitate learning, even if all the required school, classroom and learner factors are in place.

The project has identified the following outcomes in its endeavour to address teachers' competence:

- Generate the content knowledge profiles of the teachers and subject advisors for Mathematics, Physical Science, and the English language;
- Develop teacher allocation plans in all the 29 schools;
- Elaborate circuit level teacher development plans;
- Devise long term teacher development strategy for the circuit;
- Establish responsive teacher development projects.

3.4.2.6 Research, monitoring, and evaluation

The research, monitoring and evaluation sub-component is an important aspect of the model. It serves as the compass and gauge of the programme. As such, it acts as a lever for change. It constantly supplies relevant information in order to stimulate change among the participants. This sub-component upholds the principle of evidence-led change. Monitoring and evaluation will be conducted in three phases: baseline, mid-term, and summative. In addition, research will be carried out on an ongoing basis, on topical matters which schools and the district may require further information on. Examples of these include multi-grade teaching, the use of home language in foundation phase, and literacy teaching. Teachers will be encouraged to research and write about these matters, with some assistance from experienced researchers, so as to bring in practitioners' understanding and bolster teachers' confidence.

The envisaged outcomes of the research, monitoring, and evaluation sub-component are:

- Research reports on educational matters and questions facing both the schools and the districts;
- Programme evaluation reports (baseline, formative, and summative).

3.5 THE DIFFERENT INTERVENTIONS OF THE TEACHER PROFESSIONAL DEVELOPMENT PROGRAMME

The following interventions were planned in the drafting of the Professional Development (PD) programme under investigation: content training workshops, school support and monitoring visits and on-site mentoring, professional development through professional learning clusters, self-directed learning, community of practice, and teacher seminars (OPR, 2012: 24-25). These interventions form part of the teacher development component of the bigger project. The aim was to enable the project to reach its ultimate goals.

Due to the change in learners' enrolment numbers in the schools located in the area under investigation and the accompanying redeployment of teachers, the numbers of pure Mathematics participants in the teacher development programme also fluctuated over the two and a half years that it lasted. The numbers of participants, for the duration of the programme, were as follows (Project report, 2013: 2):

Year	Mathematics
2010	5
2011	8
2012	6

Table 3.1: Number of participants for the duration of the programme

3.5.1 Content training workshops

Residential workshops were conducted with the participants at off-site venues. These sessions were scheduled for three consecutive days, in such a way that the participants would sleep at the venue. This was to allow them to work undisturbed and to minimise their time constraints. Transport was provided by the programme. The topics covered in the workshops were determined by analysing the baseline test written by the participants and by liaising with the participants to establish their individual needs. These tests were assessed and the results were used to compile

the participants' profiles. The latter were then used to measure the possible changes in the participants' competence and performance (JET learning brief 1, 2010: 5). Whatever aspects the mentor identified, during the class visits, as areas of possible improvement were also incorporated as needs that the programme had to attempt to address in the workshops. In the workshops, the mathematics subject content knowledge, lesson planning, lesson presentation, pedagogical content knowledge, and assessment practices were addressed in an attempt to improve teacher competence and performance. Common curriculum delivery plans were shared and training relating to them was provided. This was in an attempt to develop the participants' ability to complete each grade's curriculum within the timeframe prescribed by the districts.

3.5.2 School support and monitoring visits, and on-site mentoring

On-site school support and monitoring were also part of the programme. A subject-specialist mentor was assigned to do school visits. Class visits were conducted in order to give the participants hands-on support. These visits were initially happening once a month, but their frequency was later increased to accelerate the impact of the programme. During these school visits, the mentor would support the participants with regard to their curriculum delivery when it was established that they were not on par with the curriculum delivery year plan. Lesson plans were also analysed and discussed according to the criteria agreed upon in the workshops. During the lesson observations, the mentor assessed whether the lesson plan was reflected in the actual lesson and she would have a discussion with the relevant teacher afterwards. Thus, the mentor's input was given according to the observations made against a set rubric.

3.5.3 Professional development through professional learning clusters, self-directed learning, community of practice, and teacher seminars

Cluster level activities were planned to assist in developing the participants' competence and performance, as well as to venture into the establishment of a

community of practice among the participants. The programme also planned reading clubs for teachers to help them to keep abreast with the latest development in the broader educational field. Academic articles were also distributed to the participants as a means of achieving self-directed learning which is another avenue for professional development. The mentor should then assess whether the participants had done some reading, when did school visits.

3.6 PROJECT LOG FRAME

JET Educational Services also proposed a specific and detailed plan of action which is unveiled here in its entirety. The project log frame consists of the strategic objectives, their corresponding indicators of success, and the identified objectively verifiable indicators. The log frame was included here so as to establish what the service providers regard as indicators of success and how they intend to measure it.

Strategic objectives	Indicators of success (Key performance indicators)	Objectively verifiable indicators
1. Stakeholder mobilisation	• Training of the JET staff in the Development Charter process by the end of August 2009. • MOU between JET, SADTU, and the NW DoE by October 2009. • Twenty-village education development charters by April 2010.	
2. Planning and organisation	• Development profiles of 27 schools. • 3-year school-self-development SDP by 2010. • Evidence of the regular monitoring of curriculum delivery and assessments by the SMT. • Evidence of SMTs supporting teachers in the classroom. • Districts and SMTs set curriculum delivery targets according to the work schedules, common assessments, and so on. • Individual school improvement profiles outlining the school performance successes and challenges, as well as the proposed solutions (April 2009). • Individual school improvement plans. • School Monitoring Reviews by district and circuit officials. • Education dialogue programmes including seminars at cluster level, newsletters, and action research by teachers from project and non-project schools (e.g. Model C schools). • Proper financial management systems in all schools by 2011. • Budgets that cover the key programmes in the schools by 2012. • All schools with section 21 status. • All schools with unqualified audited financial statements.	

3. Teacher performance	Common work schedules are designed, customised, and implemented.	Implemented schedule in teachers' subject files
	Common assessment tasks designed and implemented.	•Teachers' assessment records •Learners' assessment portfolios
	Teachers administer the required amount and quality of written work to learners.	•Learners' daily exercise and homework books show evidence of work done and assessed. •Teachers' records of homework and classroom-based tasks in file or in lesson plans.
	Teachers monitor and assess learner performance as per the curriculum policy and design appropriate remediation.	Teachers' files show evidence of: • Assessment plan • Assessment tasks and memoranda

		• Learners' performance
	Teachers practice effective classroom management, which creates a positive learning environment.	• Classroom rules displayed on walls • Discipline policy in file • Evidence of appropriate groupings for lessons • Teachers' logbooks • Teachers' preparation file • Registers • Evidence of LTSM in the classroom
	Designing of quality lesson plans	Lesson file showing: • Lesson plans • Mentor feedback
	Teachers illustrate appropriate teaching methodologies to mediate content knowledge.	
4. Parent Involvement	• Constitution of Parent Action Committees in each of the schools • Participation of PACs in developmental workshops	• Minutes of meetings

	• Engagements of the PAC with broader parental communities. • PAC's identification and implementation of two action plans per year: one academic and one social plan/ project • Increased number and monitoring of home study groups. • Increased number of completed home exercises.	
5. District support	• Existence and implementation of monitoring and support systems and strategies in all schools. • Increased number of visits by district officials to schools for the purposes of support and monitoring. • Sustainability of the interventions after the completion of the project. • Effective project management.	• District report and school register • School register • Grade 12 exit results • ANA and grade 12 results
6. Teacher competence	Alignment between project and circuit-level teacher development plans	• Compare the 2 teacher development plans
	Individual teachers' content knowledge profiles are compiled through standardised tests and/or diagnostic assessment	• Evaluated scripts in teachers' professional development file • Individual assessment reports

		• General overall reports for each assessment
	Teachers demonstrate improvement in pedagogic and subject content knowledge	• Mentoring reports • Communities of practice: reports from such meetings
	Teachers carry out reflective practice in relation to the teaching of the curriculum	• Communities of practice reports of discussions • Self-directed learning activities completed • Mentoring reports show discussion of feedback
	Increased incidences of professional development among teachers are attained through various modes of communication	• Evidence of communities of practice:

		dates and minutes of such meetings • Reading of subject related and literary texts and articles: copies of such texts and discussion records • Dissemination of knowledge -Presentations -Production of articles across various genres
	Improved learner performance	• Grade 12 exit examination results: quantity and quality of passes • Annual improved ANA results in subjects in which intervention was done

		• Baseline learner performance in JET standardised tests(GET) • Increased results in JET standardised learner performance (GET) • Reports on learner assessment(GET)
7. Research, monitoring and evaluation	• Baseline evaluation • Formative evaluation • Summative evaluation • Ongoing research and dissemination products and processes	

Table 3.2 Project log frame

3.7 EMPHASIS OF THIS RESEARCH

This research sets to evaluate the Mathematics teacher professional development components of the project. This will be achieved by not only measuring the aforementioned goals against the actual development in teachers' competence and performance, but also by determining the possible effect this development will have on their learners' results. The reason for this course of action, which will be pursued in the next chapter, is the main thrust of the study, as articulated in the research question.

The overall research question seeks to evaluate how teachers' participation in the specific Mathematics teacher PD programme under investigation – which was implemented by JET – affects the teaching, learning and educational outcomes of their practice as professionals. Although stakeholder mobilisation is important, particularly at the initial and implementation stages of the programme, the focus of this research is more on the improvement of the teaching of the Mathematics teachers who participated in the programme. The planning and organisation component seeks to improve the functioning of schools as organisations; as such, it is concerned with the technical operations of the schools. Although this does impact on what happens in the classroom and the effective functioning of the teachers, it is not the focus of this research.

The parent involvement component is an interesting component to include. This is because increased parent involvement can yield significant benefits in the long run. Parent involvement can also strengthen teachers' role in the classroom. Indeed, the fact that parents are actively involved in their children's education does enhance teaching and learning in the classroom. The envisaged outcomes of this component, according to the project proposal, are demonstrated by increased monitoring of home study, the number of completed home exercises, school visits by parents, and parents' interest in school reports (Project proposal, 2009: 16). However, it is difficult to measure these outcomes. How does one rate parents' monitoring of their child's/children's homework? How does one measure whether a parent is interested

in their child's school report? This component will thus not be included in this research. Indeed, this research initiative was part of the research, monitoring, and evaluation component; as such, it does not constitute a separate component. Therefore, the focus will be specifically on teacher performance, teacher competence, and district support components. This is the focus of the next chapter.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter discusses the research methodology used in the investigation of the professional development programme described in Chapter 3. It suffices to reiterate that the aim of a researcher is to collect data pertaining to the specific field that is being investigated, to interpret them, and to deduce findings. The researcher's field of investigation is a specific Mathematics PD programme with the focus on the possible development of the participants in and through the programme. This is done to deduce whether Mathematics PD programmes in South Africa is adequately designed or implemented to cater for the needs of the participants and to make possible recommendations to further improve these programmes. Ultimately can this investigation contribute to the improvement of Mathematics teaching and a possible improvement in the Mathematics results of learners in our country.

Opie (2004: 16) indicates that "methodology refers to the theory of getting knowledge, to the consideration of the best ways, methods or procedures, by which data that will provide the evidence basis for the construction of knowledge about whatever it is that is being researched, is obtained". Thus, in this chapter, the researcher describes the data collection process and the instruments used to collect the data, she indicates how the data were analysed, how trustworthiness was ensured in the study, and how ethical considerations were observed. Structurally, this chapter comprises sections on the research methodology and therefore including the research paradigm or research approach and research methods, and thus describing the data collection process, the data analysis process, and research ethics.

4.2 RESEARCH APPROACH

A research paradigm or approach "is the perspective held by a community of researchers that is based on a set of shared assumptions, concepts, values and practices" (Johnson & Christensen, 2010: 31). One could distinguish between a qualitative, a quantitative, and a mixed approach. This research investigated a PD programme through the use of rich descriptive data which qualified it as a qualitative study, insofar as a component of the first and second research questions. Qualitative research could describe persons and events pertaining to this PD programme scientifically, without using numerical data (Best & Kahn, 1998: 73). Qualitative research also lends itself to the posing of different questions, being open to the possibility of change and following the direction in which the observation may lead the researcher, making the latter more open to the subject under investigation (ibid). A qualitative research approach was used in this study in an attempt to obtain comprehensive descriptions of the participants' and other stakeholders' experiences of the given PD programme, and to derive the significance of their interactions with both things and other people in their environment (Springer, 2010: 20). A qualitative approach is centred on understanding a social phenomenon from the perspective of the participants (McMillian & Schumacher, 2001:16). This principle was essential in this study, since the participating teachers' and their mentor's view of the programme was important to understand as to the possible change in teachers' competence and performance. Therefore, the focus of the study was on subjective experiences (Springer, 2010: 20) accessed through the lens of individuals' views, their behaviours, and their perceptions (Basit, 2010: 16). Qualitative researchers should be sensitive to the context in which the research is conducted, given that human activities are strongly influenced by the context in which they occur (McMillian & Schumacher, 2010: 16). Therefore, the context, relationships and situations were investigated, and the quality of activities was explored as sensitively as possible (Basit, 2010: 16). This allowed the researcher to understand the social world as it was experienced or lived by people in general, and how it was experienced by the participants in particular (ibid).

With regards to answering part of the first as well as the third research question, a quantitative approach was used for the analysis of the learners' results. In quantitative research, the type of information that the researcher obtained from the participants is expressed in numerical form (Cumberbatch, 2004: 2), and the analysis thereof would be largely statistical and would report on the size of the effects and the significance of the statistical relationships (Weiss, 1998: 82). The quantitative component of the study was small, compared to the qualitative constituent; hence, the study can be characterised as a qualitative study with a quantitative component.

The evaluated PD programme functions as a case study, in that this investigation could be viewed as "an in-depth study of interactions of a single instance in an enclosed system" (Opie, 2004: 74). Thus, this study focused on one specific PD programme; as such, the collection of information was intensive to ensure an in-depth understanding of the programme. Due to the nature of a case study, notably the fact that a significant amount of time and resources had to be spent on studying one programme, the researcher was able to acquire insight into the broader issue of mathematics professional teacher development (Springer, 2010: 406).

4.2.1 THE RESEARCH METHODS

In this research study, the researcher drew on a range of qualitative research methods that assisted in answering the first two research questions. Qualitative research has the tendency to allow researchers to develop their own research designs or strategies (De Vos et al, 2002: 276) in their endeavour to answer the research questions at hand. However, due to the peculiar nature of research question three, quantitative research methods were also used. The data collection method – which refers to the way in which the researcher physically obtains research data from the participants – can include test, questionnaire, interview, focus group, observations, and secondary data (Johnson & Christensen, 2010: 213). In this study, the data collection methods used were interviews, lesson observations, and secondary data.

Primary data are those that the researcher gathers directly from participants or organisations (Maree, 2012: 82). The primary sources of data that were included in this study were the interviews with the participants, the mentor/workshop coordinator and the programme executive manager, as well as the observations of the participants' lessons in the classroom. It must be noted that the researcher was not present when the investigated PD programme was implemented. Therefore, she relied on a number of secondary sources of data to gain an understanding of what transpired at that time. Secondary sources of data allude to such materials as articles, books, and reports produced by someone other than the researcher (Maree, 2012: 83). Given that this person might have had limited information, these records' authenticity and accuracy should be evaluated. The secondary data sources used in this study were the mentors' reports, the mentors' lesson observation reports, the pre- and post-test results of the participants – tests which were set and administered by the service provider – the grade 9 results of one school and the grade 12 results of the learners in the other three schools which were involved in the programme, as well as the project proposal document of the programme.

This study examined the Mathematics FET teachers' development. However, due to the small size of the participants, all the participants were used. One teacher who stopped attending the programme was excluded, reducing the number of participants to five. Sampling was done at the stage of choosing the schools as only the secondary school were selected due to the nature of this study's focus.

The data matrix below indicates the amount of data used, the instruments used, the methods of data collection used, the data provider, and the type of data used.

4.2.2 DATA MATRIX

As previously mentioned, a wide range of data was collected in order to assist with answering the research questions. The various tables below summarise – in relation to each research question – the types of data, data providers, methods of data collection, data collection instruments, the amounts of data, as well as the methods of analysing the respective data.

Research question 1: What was the effect of the identified Mathematics Professional Development Programme on the participating teachers' competence and performance, and on their learners' success, by implication?

Research sub-question 1: How did the workshops affect teachers' development in terms of their competence and performance?

Table 4.1 below indicates how the data relating to research sub-question 1 were collected, identifies the data providers, the methods and instruments of data collection, specifies the amount of data used, and indicates how the data were analysed.

Type of data	Data provider & numbers	Method of data collection	Data collection instrument	Amount of data	Method of data analysis
Transcripts of the teachers' teachings, assessments, progress with the syllabus, subject knowledge, lesson plans, and classroom conduct before intervention	5 teachers	Obtained from service provider	Mentor reports and lesson observation schedules	5 mentor reports and 1 mentor interview	Content analysis
	5 interviews	Interviews teachers	Teacher interview schedule	5 interviews	Content analysis
	1 interview	Interview mentor	Mentor interview schedule	1 interview	Content analysis

Transcripts of the observations of teachers' teachings, assessments, progress with the syllabus, subject knowledge, lesson plans, and classroom conduct during and after intervention	4 teachers	Observe teachers in class	Lesson observation schedule	4 lesson observations per teacher	Content analysis
	5 interviews	Interviews teachers	Teacher interview schedule	5 interviews	Content analysis
	1 interview	Interview mentor	Mentor interview schedule	1 interview	Content analysis
Accounts of the teachers' content knowledge before and after the intervention	5 teachers	Obtain pre- and post-tests of teachers administered by programme management	Teachers' test scripts	4 teachers' test results	Analyse results using the Wilcoxon Signed Rank Test of SPSS
Transcripts of the teachers' and mentor's views of their development in terms of their teachings, assessments, progress with the syllabus, subject knowledge, lesson plans, and classroom conduct through their involvement in the workshops	5 teachers	Interview teachers	Teacher interview schedule	5 interviews	Content analysis
	1 mentor	Interview mentor	Mentor interview schedule	1 interview	Content analysis
Workshop content, selector of workshop topics, and challenges faced	5 teachers	Interview teachers	Teacher interview schedule	5 interviews	Content analysis
	1 mentor	Interview mentor	Mentor interview schedule	1 interview	Content analysis

Table 4.1: Question1 Data Matrix

Research sub-question 2: How did the mentoring affect the teachers' development insofar as their competence and performance?

Table 4.2 below indicates how the data corresponding to research sub-question 2 was collected, identifies the data providers, the methods and instruments of data collection, specifies the amount of data used, and indicates the methods of data analysis.

Type of data	Data provider & numbers	Method of data collection	Data collection instrument	Amount of data	Method of data analysis
Transcripts of teachers' competence and performance in class before intervention	5 teachers	Mentor reports and lesson observation schedules obtained from service provider	Mentor reports and lesson observation schedule	4 mentor reports and 4 lesson observation schedules	Content analysis
	1 mentor	Interview mentor	Mentor interview schedule	1 mentor interview	Content analysis
	5 teachers	Interview teachers	Teacher interview schedule	5 interviews	Content analysis
Transcripts of teachers' performance in class during and after intervention	5 teachers	Mentor reports and lesson observation schedules obtained from service provider	Mentor reports and lesson observation schedule	4 mentor reports and 4 lesson observation schedules	Content analysis
	4 teachers	Observe teachers in class	Lesson observation schedule	Between 1-4 lesson observations per teachers	Content analysis

	5 teachers	Interview teachers	Teacher lesson observation schedule	5 interviews	Content analysis
	1 mentor	Interview mentor	Mentor interview schedule	1 interview	Content analysis

Table 4.2: Question 2 Data Matrix

Research sub-question 3: How did the participating teachers' competence and performance affect their learners' performance?

Table 4.3 below indicates how the data pertaining to research sub-question 3 was collected, identifies the data providers, the methods and instruments of data collection, specifies the amount of data, and indicates the methods of data analysis.

Type of data	Data provider & numbers	Method of data collection	Data collection Instrument	Amount of data	Method of data analysis
Learners' grade 12 results	2010-2013 grade 12 Mathematics results of the 4 different schools	Learners' comprehensive grade 12 results for 2010-2013	Learners grade 12 stats per school	All the learners who wrote in the period 2010-2013	Friedman Test of SPSS
Learners' grade 9 results	The 2011-2013 grade 9 Mathematics results of 1 school	Learners' comprehensive grade 9 results for 2011-2013	Learners grade 9 stats per school	All the learners who wrote in the period 2010-2013	Friedman Test of SPSS

Table 4.3: Question 3 Data Matrix

4.2.3 DATA COLLECTION INSTRUMENTS

The primary data were collected by means of both lesson observations of the participants and the respective semi-structured interview schedules for the participants, the mentor/ workshop coordinator and the executive manager of the programme.

4.2.3.1 LESSON OBSERVATIONS

Lesson observations were included as data collection method due to the nature of research questions one and two. In order to investigate the competence and performance of teachers involved in a PD programme, one needed to gain an insight into what was happening in the classroom. This is in line with the definition according to which "observation is the process of gathering open-ended, firsthand information by observing people and places at a research site" (Creswell, 2005: 211). By conducting lesson observations, the researcher was physically present in the research field and was thus relying on direct accounts of what was occurring in the classroom. Nevertheless, it must be borne in mind that the researcher could still be perceived as subjective, since every human being has her/his own lens through which s/he observes the world. One should also be mindful that when participants' respond to questions pertaining to their own practice, generally, their responses tend to conform to government's policy (Basit, 2010: 120). Lesson observations were conducted, using a lesson observation schedule, to elicit data pertaining to teachers' content knowledge of the topic at hand, their teaching skills, whether or not they cover the syllabus within the stipulated timeframes, learners' involvement in class, how teachers respond to the errors made by learners, whether or not homework is given and marked, the degree to which learners receive individual attention, and so on.

It must be emphasised that the data gathered through lesson observations could also be used to triangulate the data collected by means of interviews with the different participants (Basit, 2010: 120), as well as those obtained from all the other sources. The first lesson observations were conducted before the interviews with teachers. This gave the researcher the opportunity to use the data gained through

lesson observations to probe the topic further, or to clarify or gain more insight into ambiguous areas. After the interviews, the researcher conducted lesson observations again, which afforded further triangulation opportunities.

Lesson observations had a number of advantages. One of these was that the researcher had the opportunity to record data as it became available in the classroom setting, investigate individuals who had difficulty in verbalising their thoughts (maybe due to language barriers), and study their actual behaviour in context (Creswell, 2005: 211). Another advantage was that the researcher had access to information about the physical environment, this means that the data could be interpreted in their specific context (Opie, 2004: 122). It must be noted that the classrooms were closed, non-public settings – even to the researcher – as they were part of a school and fulfilled an overt role. As such, the researcher had to disclose her research interest to both the DoE and the schools – including the teachers – in order to gain access (Bryman, 2008: 295). However, lesson observations also had drawbacks. The first is that they were labour and time intensive. The second disadvantage is that teachers' and learners' behaviours could change because they were observed by an outsider. The third drawback is that the observations could be influenced by the lens through which the observer viewed the world (Opie, 2004: 122), especially given that the researcher was a middle class, black female academic who left high school teaching more than ten years ago, after teaching Mathematics in a rural school for ten years as a qualified specialist teacher. Indeed, any person's past experiences' strong impact on his/her objectivity can lead to his/her being sidetracked, and prone to stereotyping over-generalisation (De Vos et al., 2011: 11). The fourth disadvantage is that the observer was at the schools for a limited period and could thus not observe "everything"; instead, she got a glimpse of the full picture. It should be noted that some of the aspects investigated by the researcher might not have been included in the observed lessons, due to the structure of the teaching. For example, the application of a formula was only done after the formula had been explained to learners.

Lesson observations were thus conducted according to the lesson observation schedule in the attached Appendix 6. It must be stressed that the observations were not video-recorded as this might have disturbed the natural classroom setting, bearing in mind that the researcher's presence might already have had a

considerable effect on the behaviour of both teachers and the learners (Fraenkel & Wallen, 2003: 453). At least two lesson observations were conducted with each teacher. The researcher was a mere observer: she did not get involved in any classroom activities and did not interact with either the teacher or the learners (Bryman, 2008: 410; Fraenkel & Wallen, 2003: 450).

4.2.3.1.1 LESSON OBSERVATION SCHEDULE DESIGN

The core function of a teacher is to facilitate teaching and learning in the classroom. The broad definition of teaching, according to Moore (2007: 5), refers to "the action of someone who is trying to assist others to reach their fullest potential in all aspects of development". To assist all learners to fully reach their potential is a mammoth task. So, when designing a lesson observation schedule, the researcher needs to carefully decide which aspect of the teaching and learning should be focused on to achieve the aim of the research.

Direct observation is one of the simplest and most immediate means of gathering data on organisational support and change (Guskey, 2000: 167). The conduct of direct observations of lessons, to collect empirical data, requires an observation schedule. In the context of this research, the specific data that the researcher aimed to collect determined the components to be included in the observation schedule. The different components used in the observation schedule were 1) whether learners were involvement in active learning; 2) the way in which the teacher facilitates learning; 3) the teacher's content knowledge as reflected in class; 4) whether teachers draw on learners' living context in class; 5) the teacher's responses to learners' questions and the errors they make in their written work; 6) whether the theory taught in the lesson is applied; 7) whether homework is given to learners; and 8) whether the teacher prepares the lesson.

The observation of teachers in their natural setting was used to assist the researcher in answering research questions one and two which relate to the competence and performance of the participants involved in the PD programme. The intent was to gather data on the change in teachers' competence and performance in the classroom after they had received PD support in the form of workshops and

mentoring. It becomes important, at this stage, to explain why the aforementioned different components were included in the observation schedule.

Learners need to be actively involved in tasks for their learning to be enhanced. Therefore, it is of the utmost importance that teachers place learners at the centre of their teaching actions by planning their lessons to assist learners to construct knowledge, rather than to merely absorb it (Killen, 2010:8).

The skill used by teachers to facilitate learning is essential to students' enhancement of their learning in the classroom. The way teachers ask questions (open-ended) and how they connect ideas or investigate thinking in class determine whether most of the thinking and talking is done by the learners or the teacher (Brunn, 2010:20). Questioning has the potential to stimulate learning and thinking (Killen, 2010: 139). In the past, teachers tended to ask relatively low-level, close-ended questions (Siemon, Adendorff, Austin, Fransman, Hobden, Kaino, Luneta, Makonye, van der Walt, van Putten, Beswick, Brady, Clark, Faragher & Warren, 2013: 15). Nowadays, however, teachers need to be facilitators, that is, they need to ensure a more productive form of interaction in the classroom. Muij and Reynolds (2005: 42) characterise interactive ways of teaching as using a high frequency of questions, using open-ended questions, asking learners to explain their answers, and using academic questioning significantly. In this light, an effective teacher is one who ensures that learners engage actively with mathematics (Anthony & Walshaw, 2009: 149), and enhances the development of communities of practice in the classroom. These communities allow for the production, advancement, and sharing of individual and collective knowledge by means of active participation in the classroom (ibid). Thus, the teachers' facilitation skills were used as another component of the observation schedule to establish the extent learners' involvement in class activities were stimulated.

The observation schedule also used teachers' content knowledge as a component, because its use is at the center of teaching (Ball, 2000: 243). For teachers to be effective when working with learners, they ought to, among other things, be able to present ideas in multiple ways, select good tasks, and identify good assessment questions. Muir (2008) identifies other observable teacher actions that suggest

effective teaching, namely, the choice of examples (many different examples of the same idea assist in understanding a concept), teachable moments (using appropriate moments to make connections to enhance learning), and the use of representations. It is important, for the development of learners' conceptual understanding, to make connections across mathematical topics (Anthony & Walshaw, 2009: 156). This cannot be done without solid subject content knowledge. Luneta (2013: 8) adds that teachers should be regularly up-skilled in their content knowledge through professional development, in order to remain competent. Rogers, Abell, Lannin, Wang, Musikul, Barber and Dingman (2007: 525) consider science and mathematics PD as effective when it addresses the improvement of teachers' knowledge. Expertise in the subject content knowledge is essential, but it does not mean that a teacher with this expertise is de facto effective in ensuring that learning occurs in the classroom (Butt, 2008: 23). Clearly, it is not just a teacher's content knowledge that should improve, but also his/her pedagogical content knowledge (PCK) (Rogers et al., 2007: 526). This is because the content knowledge needs to be combined with appropriate pedagogical skills, to ensure effective teaching. PCK involves "subject-matter knowledge, pedagogical knowledge (how to teach in general), and knowledge about what makes the particular content easy/difficult to teach and learn (knowledge of learners)" (Siemon et al., 2013: 23). PCK assists teachers to make on-the-spot classroom decisions (Anthony & Walshaw, 2009: 158); this distinguishes an effective teacher from an ineffective one. So mathematics teachers ought to have the knowledge of key mathematical ideas to be taught and a general knowledge of how to incorporate appropriate strategies for managing and organising the classroom, have the ability to use various ways to present mathematical content and thus to assist learners in developing their understanding of it, as well as know the development of learners' understanding and their probable responses to mathematical tasks (Shulman, 1987). So, the PCK of the teachers was included in the observation schedule to explore their competence in that area.

Learning that occurs outside of the learners' context is less effective than that which takes place in their context (Killen, 2010: 4). Contextualised teaching and learning refers to the active commitments made by teachers to make meaningful connections between the aims of the school (curriculum) and learners' lives (Pugach, 2009: 216).

This is echoed by Luneta et al. (2013: 59). By contextualising teaching and learning, learners' motivation to learn the curriculum can be increased, as they can then establish the link between their schoolwork and their lives outside the classroom. Pugach's definition's emphasis on teachers' active commitments means that contextualised teaching and learning is not achieved automatically, it is a carefully-thought-through activity. Thus, when preparing a lesson, teachers should consciously consider how they will include the learners' world context into the lesson in order to promote learning. Hence, contextualised teaching and learning was included as the fourth component of the observation schedule.

The way in which teachers ask their questions and how they respond to those of the learners' or to the latter's work was also included in the observation schedule. The reason for including these aspects is that questioning and responding to learners' work can support, restrict, or enhance learning. Open-ended questions posed by teachers allow for further probing, where necessary, in order to elicit more thinking from learners (Hatch, 2002: 102). By repeating, expanding or rephrasing learners' responses, the teacher then highlights certain ideas, provokes more discussion and thinking around a topic, or even steers the thinking in another direction (Anthony & Walshaw, 2009: 153). However, to be able to know when to assist, when to intervene, when to allow learners to voice their understandings, or when to probe further, teachers need to be good listeners.

When teachers give learners feedback or respond to their work, opportunities arise for teachers to enhance or hinder learning. It is important to give learners feedback on their work (Burden & Byrd, 2003: 169), regardless of whether they did it correctly or not. Praising or acknowledging correct work gives learners the assurance that they are on the right track. This can only happen effectively when teachers gather sufficient information about learners by watching them during their engagement with tasks, whether individually or in a group setup, and by talking with them (Anthony & Walshaw, 2009: 154). However, when a teacher spots errors, it is vital not to just give learners the correct answers or to simply leave the errors uncorrected (Burden & Byrd, 2003: 169). The teacher needs to ask leading questions to probe the

learners in order to understand their thinking or why their work is incorrect, to be able to support them effectively. It is important that teachers respond to learners' work carefully, as teachers' words have a significant impact on learners; as such, teachers need to ensure that they remain non-judgemental in their actions (Brunn, 2010: 89). Thus, because questioning is such an important teaching strategy, it was included in the observation schedule, to collect data on teachers' questioning skills as well as their responses to errors made by learners.

In Mathematics, learners cannot be given recipes on how to answer questions; they need to develop a deep understanding of the "how" and the "why" of the questions. In order for learners to gain that deeper understanding of the questions, it is essential that teachers assist them to understand the application of the relevant theories by interweaving them in the lesson. Thus, theory application during the lesson was included as a component of the observation schedule.

It must be noted that Mathematics is a subject that requires significant practice for learners to acquire or enhance their skills and knowledge. Hence, giving learners homework regularly is an effective means of enhancing their mathematical abilities. In the investigated PD programme, teachers were encouraged by the mentor to regularly give well-planned homework to learners, hence the inclusion of this aspect in the observation schedule.

Teachers' lesson preparation and execution is another component of the observation schedule. Butt (2008: 2) emphasises that "learning does not occur by chance", planning is the key to effective teaching (Moore, 2007: 9). It is, therefore, very rare for an unprepared teacher to deliver a 'good lesson', since the lesson procedure was not clearly planned beforehand. A lesson should have an introduction where learners' prior knowledge is linked to the new information being introduced or where learners' existing proficiency is built on (Anthony & Walshaw, 2009: 151), a body, and a conclusion. These different sections of the lesson should flow into each other and complement each other to form a unit. Some of the important aspects to bear in mind, when preparing a lesson, are to have the learners in mind (not just the

content), to focus on the achievement of the objective of the lesson, to use facilitation techniques to probe learners' thinking, to ensure that learners talk more than the teacher, to encourage independent work as well as successful peer interactions in class (Brunn, 2010: 12). Careful consideration should be given to the selection of appropriate aims and learning objectives, teaching methods, the management of the lesson, classroom control, resources to be used in the lesson, and the concluding of the lesson (Butt, 2008: 109). The investigated PD programme flags lesson preparation as one of the crucial aspects in which teachers need to be developed. Its inclusion in the observation schedule helps to evaluate the extent to which teachers' plan their lessons and how these are executed in the classroom.

The designed observation schedule was piloted and changes were made accordingly. By examining the different components of the observation schedule during lesson observations, the researcher obtained data that were triangulated with those gained through the other data collection methods, one of which will now be discussed.

4.2.3.2 SEMI-STRUCTURED INTERVIEWS

Semi-structured, open-ended, face-to-face interviews were conducted with all the teachers at least once, as well as with both the programme executive manager and the mentor. Semi-structured interviews were selected because, though guided questions were used, the researcher was open to using the leads of the interviewees to probe further into areas that arose in the interviews (Hatch, 2002: 94). The challenge with interviews of this nature is to simultaneously balance structure and flexibility. All the teachers were thus asked the same questions on the same topics, to ensure that the different interviews could be compared (Best & Kahn, 1998: 256). Open-ended questions were used to allow the flexibility of probing, where necessary, in order to elicit the different participants' perspectives (Hatch, 2002: 102). The advantage of open-ended questions is that they allow the participants to create their own responses, without being "forced" into pre-established response possibilities (Creswell, 2010: 215). The interviews conducted in the context of this study helped

to gather information regarding teachers', the mentor's, and the programme executive manager's experiences as participants in the PD programme under investigation, as well as their opinions on certain aspects of the specific PD programme and their recommendations for a better implementation of future PD programmes (Best & Kahn, 1998: 255). It must be noted that different interview schedules were used for the teachers, the programme executive manager, and the mentor. All the interviews were voice-recorded, to ensure an accurate account of the conversations (Creswell, 2010: 217); they were then transcribed into words for their subsequent analysis.

Interviews in qualitative research have advantages and disadvantages. The advantages are that useful information can be elicited that cannot be gained through observations (Creswell, 2010: 215); the fact that the interviewer has control over the types of information received in interviews, compared to observations, since the interviewer chooses the questions to be asked (ibid); and the physical presence of the interviewee ensures that the interviewer gets responses, unlike questionnaires that are sent out. Furthermore, verbal and nonverbal behaviour could also be observed in face-to-face interviews which have a much higher response rate than questionnaires (McMillan & Schumacher, 2010: 205). Conversely, the disadvantages of interviews are the fact that they were time-consuming and costly, as they were done with one participant at a time; language barriers were also challenging, since English was not the teachers' first language. Consequently, the interviewer had to, at times, rephrase the questions, when it became obvious that the interviewees did not understand the questions. The language barrier also hindered the interviewees' ability to give detailed responses to questions. This prompted the interviewer to ask more probing questions, to get more information from the interviewees. With face-to-face interviews, it was sometimes difficult to find suitable times for both the interviewer and interviewee. This is mainly due to the nature of the settings – rural areas – where the participants use a common transport before and after work. The presence of the interviewer could also have affected how the interviewee responded to questions and should thus be added as a disadvantage. Social desirability, that is, the fact that the interviewees present themselves in the best possible way and provide socially-desirable responses – instead of the most honest ones, the

possibility that the data would reveal more about the social interaction processes between the interviewer and the interviewee instead of the interviewee's thought processes and attitudes, as well as the presence of the self-fulfilling prophecy – where the interviewer's expectations are fulfilled in the interview were also possible drawbacks that could arise during interviews (Cumberbatch, 2004: 4). Furthermore, the use of the recording equipment could pose challenges to the interviewer (Creswell, 2010: 215) and could ultimately lead to a lengthy interview not being recorded and valuable information being lost in the process. The lack of anonymity in interviews could also inhibit the honest sharing of views (McMillan & Schumacher, 2010: 205). Therefore, the interviewees were promised that pseudonyms would be used in the research to ensure their anonymity and, by implication, to elicit as much information from the interviewees as possible. This assurance was given to each participant in the written consent they signed as an indication of their agreement to be involved in the research. The ability of the interviewer to create a comfortable atmosphere during the interview, her/his ability to ask good probing questions, and her/his interpersonal skills (Opie, 2004: 111) could also constitute a challenge in eliciting quality responses from the participants. Opie (2004: 112) remarks that not every researcher possesses, or can develop, these much-needed interpersonal skills to conduct interviews which result in quality data.

4.2.4 QUALITATIVE DATA ANALYSIS

Qualitative researchers can use three main techniques to collect their data: analysing documents or other forms of communication (content analysis), observing people in their natural setting and recording the observation, or conducting in-depth interviews with people to gain insight into their opinions, ideas, and experiences (Fraenkel & Wallen, 2003: 450). Document analysis or content analysis (Springer, 2010: 21) could also include the interpretation and analysis of such materials as textbooks, e-mails, reports, or websites; thus, the focus is on the materials and not on people. Consequently, inferences can be made from the document analysis to describe events, people, or programmes.

It must be stressed that all three data collection techniques mentioned above were used in this research. The documents used in content analysis were the mentor's

reports, workshop reports, the project proposal, the programme executive manager's progress reports, and different websites that contain information on the service provider. All these documents were used to elicit information on the aims and objectives of the investigated PD programme, and how the interventions were planned and implemented, given that the researcher was not present at the launch of the programme. The mentor and workshop reports also enabled the researcher to acquire valuable information on the competence and performance of the participants before and during the implementation of the PD programme.

An advantage of documents is that they are ready for analysis, they do not need to be transcribed, as is the case with interviews and observations (Creswell, 2010: 219). Nevertheless, a disadvantage of document analysis is that such documents as reports were written by individuals with bias views which might have distorted the information. However, this biasness is not unique to documents; it is also present in interviews and observations, as mentioned earlier.

Due to the nature of this research, the researcher was relying on a significant amount of data ranging from interview transcripts, different reports of staff involved in the PD programme to observation schedules. This means that the researcher had data in textual form. Thus, a qualitative analysis was applied to the mentioned data gathered in this study because the data were in text form instead of numerical values. It is argued that qualitative research depends "on the presentation of solid descriptive data, so that the researcher leads the reader to an understanding of the meaning of the experience or phenomenon being studied" (de Vos et al., 2002: 339). Thus, data analysis is a process that involves the interpretation of these descriptive data. However, these data can accumulate into a significant amount which causes the data analysis to be perceived as a cumbersome process (Lichtman, 2009: 188). However, Lichtman (2009: 189) encourages a systematic approach to data analysis and interpretation, so that the process reflects order and understanding. It needs to be emphasised that data analysis is not a linear process; it can rather be regarded as a spiral process (Creswell, 1998).

In this study, the interviews were conducted as follows: two interviews with each of the five teachers, one interview with the programme executive manager, and one interview with the first of two mentors. The second mentor was not interviewed because she passed away before the data was collected. These interviews were audio-recorded and transcribed. Then, the analysis of the mentor's reports and lesson observation schedules was done. The interviews, the mentor's reports, and the lesson observation schedules done by both the mentor and the researcher were analysed to assess whether the participating teachers' competence and performance changed during and after their involvement in the PD programme. The analysis focused on the identified themes.

Indeed, the literature review on effective PD programmes and the analysis of the project proposal of the PD programme to establish its aims and objectives enabled the researcher to identify specific themes that were used to analyse the data. Thus, a thematic analysis was used to analyse the qualitative data in this study. Thematic analysis is defined by Gibson (2006: 1) as "an approach to dealing with data that involves the creation and application of 'codes' to data"; 'codes' refer to the "creation of categories in relation to data" (ibid). The categories used were completion of syllabus, subject content knowledge of teachers, written lesson preparations, teachers' support to learners and learners' participation in class, homework give to learners, and the involvement of the participants in the planning of the PD programme.

4.2.5 QUANTITATIVE DATA ANALYSIS

The analysis of quantitative data entails an effective presentation to ensure convenience and easy understanding of the findings (Cumberland, 2004: 14). The learners' results and teachers' pre- and post- PD programme tests were analysed by means of statistical tests aimed at getting a clearer understanding of the meaning of the findings.

4.2.5.1 LEARNERS' RESULTS

Grade 12 results relate to the final external examination written by learners in the FET band. It suffices to emphasise that a high premium is placed on these results, because they account for the grading of the academic status of schools and determine whether or not learners' are given access to Higher Education. These results also determine the courses for which learners qualify to enroll. In this light, grade 12 results are of the utmost importance to learners as these results influence their future possibilities and the country's economy at large. The improvement or lack thereof in the results of learners can also assist in evaluating the effectiveness of the teacher PD programme. Indeed, schools use teacher PD as a means to improve both learners' results and the educational standards in schools (King, 2014: 89). However, there is no de facto link between teacher PD and learners' results (Cumming, 2002), deep learning is required to ensure a change in learners' performance.

The grade 12 results of the three schools – over the period 2010-2013 – and the grade 9 results of one school were gathered and analysed, to assess whether the results of the learners whose teachers underwent PD changed significantly. One of the schools did not have grade 12 learners in the full 2010-2013 period. This was due to the moving of learners in the FET phase to a neighbouring school, because of a drop in learners' enrollment. Instead, the grade 9 results of learners of that school were used, given that these results also signify the end of the Senior Phase. Grade 9 is thus an exit level that enables students to venture into other educational avenues in South Africa.

However, to get a clearer idea of the meaning of quantitative findings, more statistical tests are necessary (Cumberbatch, 2004: 15). Thus, statistical tests were conducted to ascertain whether there was a significant change in the learners' results in the period under investigation. The Statistical Package for Social Sciences (SPSS) was used to analyse the data, particularly the Friedman Test. The latter was

selected because the data came from the same sample, and were measured at three points in time in the case of School A and at four stages in the context of the other three schools (Pallant, 2007: 228). This test was meant to assess the statistical significance levels of the data, with significance levels below 0.05 indicating a significant difference in the results. This would imply that the results of the different schools have either improved or worsened.

4.2.5.2 PARTICIPANTS' PRE- AND POST-TEST RESULTS

The participating teachers were given a pretest at the start of the PD programme; then, the intervention took place; and was followed by a posttest at the end of the programme. These tests were set by the first mathematics mentor and were administered by the service provider. This posed a challenge with regard to the validity of the results, since the service provider had an interest in showing that the intervention was successful. Ideally an outsider should have set and administered the pre- and post-tests. What is more, all the teachers did not write both tests, leaving the researcher with an attrition problem. The difference in percentage between the two tests, per teacher, was determined and analysed.

The analysis of the tests assisted in answering research question one, given that the workshops mostly dealt with strengthening the content knowledge of the participants. In other words, the pre- and post-tests assessed the content knowledge of participants. The pre- and post-test results were interval data; as such, the SPSS was used to analyse these results, by means of The Wilcoxon Signed Rank Test. This test has been designed to be used when "your subjects are measured on two occasions, or under two different conditions" (Pallant, 2007: 223). The two different occasions' scores were converted into ranks and were then compared.

4.3 RESEARCH PARTICIPANTS

Given that the purpose of this research was to investigate the professional development of FET Mathematics teachers involved in a PD programme, only participants that suited these particulars were selected. In clearer terms, the

participants were selected from the population of Mathematics teachers involved in the FET phase, in the district where the PD programme under investigation was rolled out.

It must be noted that five secondary schools were involved in the PD programme. However, one of these schools had major challenges which led to the FET Mathematics teacher not being willing to participate in the research. Furthermore, soon after the commencement of the research, this teacher was transferred to another school which was outside the ambits of the investigated PD programme. Another participating school (School A) experienced challenges relating to a drop in learners' numbers. This led to the FET phase of this school being moved to a neighboring school. Consequently, that teacher ended up teaching only Senior Phase learners. Nevertheless, due to this teacher's passionate involvement in almost all the aspects of the programme and the fact that he believed that his future professional trajectory was teaching in the FET phase again, he was included in the research. One teacher from each of the remaining three schools was included as participant in the research. In one of these three schools (School C), two teachers were involved in the Mathematics section of the PD programme. However, the one teacher – who was the head of the Mathematics and Science department of the school – was more involved in teaching Science, and more of his mentoring took place in the Science classes, although he continued to attend the Mathematics workshops. Table 4.4 below provides more details on each participating teacher, identified by means of a pseudonym.

Teacher	Gender	School	Subject Field of teaching
Teacher MK	Male	School C	Mathematics (Gr 10-12), Physical Sciences (Gr 10, 11, & 12), and Mathematical Literacy (Gr 12)
Teacher NK	Female	School C	Mathematics (Gr 10-12) and Mathematical Literacy (Gr 11-12)
Teacher RB	Male	School A	Mathematics (Gr 10-12), Mathematical Literacy (gr 11-12), and Science (Gr 10-12)
Teacher SB	Male	School B	Mathematics (Gr 10-12) and Mathematical Literacy (gr 11-12)
Teacher SR	Male	School D	Mathematics (Gr 10-12) and Science (Gr 10-12)

Table 4.4: Participants' biographical details

4.4 TRUSTWORTHINESS OF THE RESEARCH

In any research, there should be an earnest attempt to ensure rigor. In quantitative research, validity and reliability are seen as the result of rigor (Lietz, Langer & Furman, 2006: 442). In conducting this qualitative research, particular attention was given to the reliability and validity of the work. Validity refers to the accuracy with which the instruments used measure the concept in question (De Vos, Strydom, Fouche & Delport, 2002: 166). A research instrument is considered reliable if the results of a study can be reproduced under similar conditions (Joppe, 2000: 1). This highlights the notions of repeatability and replicability of observations or results (Golafshani, 2003:598). However, Lincoln and Guba (2000), and Graven (2002) question the applicability of reliability and validity in qualitative studies. In this regard, Lietz et al. (2006: 442) underscore that, in establishing rigor in qualitative research, these measures are not applicable standards to be used. In qualitative research, the assumption is that in the natural setting, there exist multiple realities which are constructed by individuals who are constantly in an interactive relationship with the social world (Graven, 2002). The use of the term reliability, which implies a test aimed at establishing consistency in measuring (Best & Kahn, 1998: 283), is thus contentious. Indeed, in qualitative research, the investigation is based on a range of experiences rather than the average experience (Krefting, 1991: 216). This implies that realities cannot be replicated and, by implication, similar results cannot be expected. In the absence of an objective reality, the focus should rather be on the co-construction of meaning between the participant and the researcher (Lietz et al, 2006: 443).

Therefore, qualitative researchers should rather strive to enhance trustworthiness in their endeavours. The term trustworthiness, which is now used instead of reliability and validity, relates to the need to ensure that the data are truthful and dependable in terms of the context under which data collection was done. It is also an attempt to ensure that findings, as much as possible, reflect the participants' meanings (Lietz et al, 2006: 444), as opposed to that of the researcher, since the "behavior goes beyond what is observed" (Krefting, 1991: 214) by the researcher. Researchers should thus attempt to find means to manage issues of reactivity and bias, which

could legitimise qualitative findings (Lietz et al, 2006: 444). The different strategies proposed by Lietz et al., (2006) and Krefting, (1991) to manage the threats to trustworthiness include prolonged engagements, triangulation, peer debriefing, member checking, negative case analysis, audit trial, and reflexivity. Thus, in this research, attempts were made to ensure trustworthiness – while accommodating both these multiple realities and participants' meanings (Krefting, 1991:215), that is, the meanings of the teachers, the mentor, and the programme executive manager– by means of triangulation. Triangulation is one of the strategies that can minimise such threats to trustworthiness as reactivity and biasness on the part of both the participants and the researcher (Lietz et al., 2006; Krefting, 1991).

The triangulation of data is defined by McMillan and Schumacher (2010: 379) as the "cross-validation amongst data sources, data collection strategies, time periods, and theoretical themes". In other words, it consists in comparing different sources, situations and methods so as to find regularities in the data and explore the recurring patterns (McMillan & Schumacher, 2006: 374). Thus, more than one information source or perspective was used to assist in the establishment of facts (Springer, 2010: 547). Triangulation can counteract the influence of the halo effect, a situation where the researcher's judgement – due to her/his knowledge of the participants or her/his knowledge of existing data about situations or the participants – can affect her/his data selection, how data are analysed, and how the findings are reported (Basit, 2010: 65).

By collecting data by means of interviews with different stakeholders, observations, and the analysis of the content of documents, this study used the triangulation of data collection methods; that is, the data collected by various means were then combined (Krefting, 1991; Patton, 2002). This is one of the strategies that could enhance trustworthiness in this study (Lietz et al, 2006). In practical terms, triangulation was done by cross-checking the data from the interviews with the different participating teachers, the mentor, and the programme executive manager so as to enhance the credibility of the research. The lesson observations conducted by the researcher were also cross-checked against the mentor's reports. The project reports (of the mentor, the workshop coordinator, and the programme executive

manager) were compared to the data supplied by the interview participants. This cross-checking is in line with Patton (2002) claim that “triangulation strengthens a study by combining methods”.

The triangulation of data sources is clearly another strategy to enhance the trustworthiness of qualitative research, as “it maximizes the range of data that might contribute to the complete understanding of the concept” (Krefting, 1991: 219). In this way, information sources are assessed against each other to cross-check the data and their interpretation (ibid) and, ultimately, to enhance the trustworthiness of the research. In this study, trustworthiness was ensured by cross-checking the interpretation of the data obtained from the interviews with the five teachers, the programme executive manager and one mentor, that of lesson observations conducted by both the mentor and the researcher, and the analysis of mentor and workshop reports. This not only maximised the range of data collected, but could also assist in gaining a better understanding of the concept of trustworthiness. The variety of the data, in terms of time (mentor-observed lessons during the programme, and researcher-observed lessons after the interventions), also contributed to an increased comparability of the data. This elicited similarities and differences in describing the different realities that existed, and allowed for more opportunities to investigate the multiple realities and views of different participants.

4.5 ETHICS AND THE RESEARCH PROCESS

When conducting research in social and educational spheres, researchers need to be mindful of the anticipated ethical issues, given that they conduct research on human beings who could be harmed (Opie, 2004: 24). Thus, respect for the audience and the use of nondiscriminatory language are aspects that researchers must uphold (Creswell, 2010: 11). Every researcher should, from the onset of a research project, consider how to ensure that the rights of the participants are respected, how to report the research findings fully and honestly, and how to honour research sites (Creswell, 2010: 11).

In seeking permission from the different stakeholders of the PD programme, the researcher first approached the service provider, JET, to obtain permission to do the research on this particular programme. After securing permission from the (Chief Executive Officer (CEO) of JET, the researcher then approached the North West Department of Education to request permission to conduct the research in that province. Given that the programme had a steering committee that included JET, the North West Department of Education district officials, and the unions that met on a regular basis, the researcher went through the JET representatives to seek permission. When the permission-seeking letter was tabled at the steering committee meeting, all the stakeholders were informed of the researcher's intention. Permission was ultimately granted by the Chief Director of the District (See Appendix 1).

To avoid a situation where the senior management of schools and the teachers of the relevant schools might feel that they were forced to partake in the research by district or provincial authorities, the researcher undertook to first explain her intention to the school principals. The latter were then informed that the North West Department of Education had granted the researcher permission to proceed with the research project. The researcher first approached the principals of the five schools selected telephonically and then in person, to explain the intended research project to them. They had no objection to the research being done in their schools and allowed the researcher to contact the Mathematics teachers. To maintain good relationships between the researcher and the possible participants, the researcher went to meet the teachers at their respective schools, after they had been individually contacted telephonically, to give each potential participant a brief explanation of the research project. This was done without first informing them that the North West Department of Education had granted permission for this research. This was in an attempt to ensure that the teachers feel that they themselves agreed to partake in the research, as opposed to being forced into it by some autocratic decision. The researcher believed that this could also enhance good relationships in the process, this is crucial to getting sensitive data from participants. What is more, these teachers' workload was already so heavy that partaking in this kind of research could demand extra time from their schedule. Thus, establishing good relationships

between the researcher and the participating teachers would probably lead to their agreeing to openly share information (data) with the researcher. The research methods to be used were explained to these teachers (interviews, observations, and document analysis). As a result, they all signed consent forms to partake in the research. In the consent forms (See Appendix 2), the option of voluntary withdrawal from the research – without any consequences on the participants – was stipulated. The clause on the anonymity of the participants was also included in the consent forms.

Furthermore, the researcher guaranteed the principals and teachers that the timetable of the schools will be respected and that the functioning of the school will be minimally affected by data collection. The interviews were scheduled in conjunction with the participants and their heads of department (which were also the participants), according to their availability as reflected by their respective timetables. The same principle was applied to the class visits. This was another attempt to consciously show the school management and the teachers that the researcher respects their schools' functioning and their time as professionals and will not interfere with the effective running of their respective schools. This undertaking meant that the researcher, some days, could only visit one school, due to the inability to synchronise the timetables of the different schools. An example is that two neighbouring schools' Mathematics teachers both teach their learners in the morning, on a particular day, and because of the extensive distances between these rural schools, the researcher was unable to visit both schools on the same day. This had a negative effect on the researcher's travelling budget and data collection time. Consent was also obtained from the Programme Executive Manager and the first mentor to have interviews with them (see Appendix 4).

The next two chapters analyse all the above mentioned data to draw conclusions pertaining to the research questions. The secondary data was first analysed and then the primary data. The reason for this sequence was that the secondary data set the background for what transpired before and during the implementation of the PD

programme and the primary data analysis the setting thereafter as well as analyse the reflection on the programme.

CHAPTER 5

ANALYSIS OF SECONDARY DATA

5.1 INTRODUCTION

This chapter analyses the secondary data pertaining to the Mathematics PD programme under investigation. The data sources on which the analysis is based include the lesson observations done by the mentor, the mentor's reports on school visits, reports on the workshops conducted in the programme, document pertaining to the PD programme, documents relating to the professional learning communities they tried to establish, the grade nine results of one of the schools for the 2011-2013 period, and the grade twelve end-of-year results of the other schools for the 2010-2013 period. The analysis also covered the participants' pre- and post-tests results. The data analysis sought to obtain answers to the following main research question:

What was the effect of the identified Mathematics Professional Teacher Development Programme on the participating teachers' competence and performance, and on their learners' success, by implication?

In addressing this research question, the researcher focused on the following sub-questions:

1. How did the workshops affect teachers' development in terms of their competence and performance?
2. How did the mentoring affect teachers' development insofar as their competence and performance?
3. How did the participating teachers' competence and performance affect their learners' performance?

An interpretive approach to the data analysis was adopted for the data relating to sub-questions (1) and (2), this is due to the qualitative nature of the data used. The data pertaining to sub-question (3) was quantitative, this is because the imperative to

establish whether or not the participants' involvement in the PD programme affected their learners' performance.

The mentor's reports and lesson observation schedules were first analysed in an attempt to answer the second research question. This is because the PD programme used mentoring and lesson observations as an on-site or classroom-based intervention. Initially, the plan was for the mentor to visit the involved schools three times a year; workshops were to be scheduled four times a year; and self-directed learning was to occur three times a year. The workshops were conducted either during the holidays, or from a Thursday evening to a Saturday. These workshops were to be residential to minimise outside disturbances. In 2012, the number of school visits by the mentor increased to three per month, because the project-steering committee deemed that the teacher development progress was not on par. Thus, substantial reference will be made to information from these mentor visit reports and lesson observation reports, as well as workshop reports, notably their dates.

The teachers were also tested before and after the intervention by means of pre- and post-tests, to assess their subject content competence. These pre- and post-tests were set and conducted by the service provider, in an attempt to establish whether there was a change in the participants' content knowledge after the PD interventions. The tests consisted of two papers that were similar to those that form part of the grade 12 examinations. The topics included the core grade 12 NCS curriculum (pre-test), and the 2012 curriculum (post-test). It must be noted that these tests did not assess exactly the same topics, as they were set according to different curricula. Nevertheless, one should bear in mind that South African public schools underwent a curriculum change during the period under investigation. It must be emphasised that although the new curriculum was introduced in 2012, teacher were trained on it in the PD programme since 2011. Workshops covered topics on both the previous and new curricula; hence, the newly included topics also formed part of the post-test.

It must be noted that the researcher could not access all the lesson observation schedules and mentor reports. She worked with approximately seven documents on each teacher. Most of the 2011 intervention reports were not available; this created a gap in the information regarding the interventions. The same headings, as in the abovementioned documents, were used for the analysis which included topics that surfaced in the literature review. As was the case with protecting the real identity of the schools, pseudonyms were also used for the different teachers who are known as Teacher MK, Teacher NK, Teacher RB, Teacher SB, and Teacher SR.

5.2 ANALYSIS OF MENTOR'S LESSON OBSERVATIONS AND REPORTS

The mentor's lesson observation analyses below were done using the following headings: completion of syllabus, subject knowledge, lesson plan, support provided to learners and learner participation in class, homework given, critique, and observations that did not fall in any heading. These analyses are documented below, under the abovementioned headings, after a brief description of the teaching load and position of each teacher.

Teacher MK

Teacher MK is the HOD for Mathematics, Mathematical Literacy (ML), Physical Science (PS), Life Sciences, and Agriculture. The school had an enrolment of 314 learners in 2012. In 2010, this teacher taught five different groups of learners, namely, Mathematics for grade 12, Physical Sciences for grades 10, 11 and 12, and ML for grade 12. This was quite a heavy teaching load, especially considering that he also had to fulfil the HOD duties and responsibilities.

Teacher NK

Teacher NK is a post level one teacher. She joined the school staff in 2009, as a Mathematics teacher. She was on maternity leave between April and August 2010; thus, the HOD taught her Mathematics classes for that period. In 2013, Teacher NK taught five groups, namely, Mathematics for grades 10, 11 and 12, and ML for grades 10 and 12. This was a heavy workload, as she had to prepare five different

lessons. At the same time, she was also involved in another PD programme that ran concurrently with the one under investigation. This took her out of the classroom at times, as she had to travel far to attend workshops. The other PD programme ran only workshops which took place on Thursdays between 12h00 and 15h00 and whose tasks were tackled in groups. She only attended that programme for a year, because the travelling and the missing of classes became too taxing for her.

Teacher RB

Teacher RB is a post level one teacher who taught Mathematics and Science for all the FET groups. The numerous classes he taught caused him to spend almost the entire school day in class. Subsequently, the school's FET learners were moved to a neighbouring school by the District; this left him with only grade 8 and 9 learners. This was a frustrating situation for Teacher RB, as he was passionate about teaching the FET grades. He grappled with a lot of questions as to why this situation happened to the school. In his opinion, the District did not consult the school enough. His involvement in the PD programme under investigation related mostly to FET Mathematics, which also caused a strain on his ability to apply what he had learnt. He passionately attended the workshops and enthusiastically engaged in the different aspects of the PD programme. The classes he taught in 2011 were Mathematics for grades 10, 11 and 12, Physical Science for grades 10, 11 and 12, and Mathematics Literacy for grades 11 and 12.

Teacher SB

Teacher SB is the HOD for Mathematics, and the acting principal of the school. Therefore, he had the mammoth task of teaching the FET learners alongside managing the school. He found it difficult to attend all the workshop sessions. Nevertheless, class visits and mentoring took place. The classes he taught in 2011 were Mathematics for grades 10, 11 and 12, and Mathematics Literacy for grade 12.

Teacher SR

Teacher SR is the Head of Department (HOD) for Mathematics at his school. He assisted the principal on a regular basis, because the latter sometimes arrived late at school, as indicated in the mentor's reports (Lesson observation grade 10, 16 March 2012; Lesson observation grade 12, 21 May 2012). Teacher SR received an award for the best improved teacher in the PD programme and received both money and a laptop, for his efforts. He has been using this laptop in class and for other work-related purposes. The classes he taught in 2011 were Mathematics for grades 11 and 12, Mathematics Literacy for grade 12, and Physical Science for grades 10, 11 and 12. This implies that he has six different lessons to prepare per group, which is quite demanding.

5.2.1 Completion of syllabus

In certain schools, learners' poor performance is strongly linked to teachers' failure to complete the syllabus for the particular year (Makgato & Mji, 2006: 261). The non-completion of the syllabus/work schedule leads to learners moving to the next grade without the necessary knowledge and skills which were supposed to serve as their prior knowledge and abilities in the new grade. This is one of the contributing factors to learners' poor performance. Therefore, the completion of the syllabus was investigated. The teachers were expected to tick and sign off the topics in their teacher-files after completing them so that, when the subject advisor or mentor visited the school, these files would serve as tools for the monitoring of the progress with the syllabus.

Teacher MK

In all the observation schedules, the mentor critiqued Teacher MK's tendency to neglect to date and sign off the topics that were covered in the teacher-file. This hindered the ability to assess whether or not this teacher was on or behind schedule with regard to the year planner.

Teacher NK

In the March 2012 mentor report, the mentor indicated that Teacher NK was two weeks behind with the grade 11 work schedule, and that this teacher had promised to cover the remaining work during the coming vacation classes.

Teacher RB

Teacher RB did not update his teacher-file in terms of dates and signatures. Therefore, it was unclear as to when he finished the different sections of the syllabus, based on his teacher-file. Consequently, the researcher could not comment on the rate of his completion of the syllabus. Interviews conducted with him shed more light on this situation.

Teacher SB

Teacher SB's mentor's reports and classroom observation schedules (Lesson observation for grade 10, 13 March 2012; Lesson observation for grade 11, 13 March 2012; Lesson observation for grade 12, 13 March 2012; Lesson observation for grade 11, 22 May 2012; Lesson observation for grade 12, 22 May 2012) did not indicate if this teacher completed the syllabus or not. What is more, he did not date or sign the work schedule in the teacher-file (Lesson observation for grade 12, 13 March 2012). This issue was addressed by the mentor on several occasions.

Teacher SR

In the lesson observation schedules of 16 March 2012 and 18 May 2012, the mentor indicated that Teacher SR covered all the work according to the work schedule. The fact that he conducted extra classes throughout the year might have contributed to his covering the syllabus as per the schedule. At the end of May 2012, he was even ahead of the work schedule; this allowed him to do revision before the June examination.

5.2.2 Subject knowledge

According to Kanyongo and Brown (2013: 107), "teachers' content knowledge of mathematics is one good measure of teacher quality". Studies have found that

teachers' content knowledge is important in three main ways: (1) it influences how teachers engage students in terms of the subject matter, (2) it affects how teachers evaluate and use instructional materials, and (3) it determines what students learn in the classroom (Kanyongo & Brown, 2013: 108). Research conducted by Bansilal, Brijlal and Mkhwanazi (2014: 34) has shown that South African teachers are incompetent in the Mathematical content that they teach. This is perceived as one of the many reasons for learners' poor performance in this country (CDE, 2011; Mji & Makgato, 2006)). Through the analysis of the observation schedules and mentor reports, the participants' content knowledge competence in class was assessed to ascertain their competence levels before and during the PD programme was running. This could assist in establishing whether or not the participants' content knowledge developed. However, it must be noted that observing a lesson does not enable one really determine a teacher's content knowledge, especially if more advanced exercises and explanations are not part of the particular lesson. Clearly, this way of assessing teachers' content knowledge competences had limitations.

Teacher MK

All the observation schedules and mentor reports indicated that Teacher MK's subject knowledge was adequate.

Teacher NK

The different lesson observation and mentor reports revealed that Teacher NK's subject knowledge was adequate during the different lessons observed. However, in the 31 October 2012 report, the mentor indicated that the teacher needed to pay special attention to the development of her content knowledge. This implied that this teacher still needed to develop her content knowledge.

Teacher RB

In different lesson observation schedules and mentor reports, the mentor indicated that Teacher RB was well-versed in his subject knowledge (Lesson observation for grade 10, 12 March 2012; Lesson observation for grade 11, 26 March 2012; First semester mentor report, 2012). This allowed him to use appropriate examples and build on previous sections. This is confirmed by the following excerpt: "Various approaches to the answers were discussed" (Lesson observation for grade 11, 12

Mar 2012). The incorporation of various approaches could only be done comfortably when the teacher's content knowledge is extensive. Another excerpt indicated that the teacher's good content knowledge assisted him to facilitate the lesson adequately: "The teacher has good understanding of trigonometric graphs and is able to communicate it to the learners" (Lesson observation for grade 11, 26 March 2012). These are clear indications of Teacher RB's competence with regards to his content knowledge and ability to facilitate learning.

Teacher SB

In different observation schedules (for grade 10, 13 March 2012; grade 11, 22 May 2012; grade 11, 22 July 2012), the mentor described Teacher SB's content knowledge as "good". Grade 11 learners were given questions on the interpretation of trigonometric graphs (13 March 2012). The mentor remarked that "most of the time was used to help the learners understand how to read answers from the graphs" (13 March 2012). This section of the work is generally challenging. Thus, Teacher SB' ability to effectively assist the learners to interpret graphs (application questions) revealed his mastery of the content of this section.

Teacher SR

The mentor report of 16 March 2012 indicated that Teacher SR's content knowledge was "good", and the progress report for the first term 2012 qualified his subject knowledge as "correct". This teacher also highlighted common mistakes related to the topic at hand and explained to the learners how to prevent them (First semester mentor report, 2012). This flags his internalisation of the content knowledge and his ability to assist learners to understand the subject even better.

5.2.3 Lesson plan

Planning what one has to do every day is a means to ensure that time is managed effectively. Thus, what a teacher intends to teach in the classroom must also be planned in advance, to ensure a timeous completion of the syllabus. Consequently, written lesson plans are needed for all lessons to be conducted as they describe what the teacher plans to cover in the classroom (McKay, 2010: 1). When the

subject advisor or mentor visits the school, the lesson plan serves as a tool for the monitoring of what happens in the classroom. The focus on the lesson plans was to ascertain if the participants planned their lessons and if they were developed, through the PD programme, to the point of planning their lessons to the best of their abilities.

Teacher MK

Teacher MK did not submit any written lesson plan to the mentor. He was, according to the observation schedule, constantly encouraged to do so, to ensure a smooth lesson and was also made aware that lesson preparation is part of effective teaching. In one of the lesson observations, the mentor reported that the particular lesson did not flow and suspected that this was because of poor or lack of preparation. Despite this, the mentor reported that most of the lessons went well. In one instance, the mentor reported that, despite the absence of a lesson plan, it was evident from the delivery of the lesson that the teacher was prepared.

Teacher NK

Teacher NK did not produce any written lesson plans. In this regard, the mentor repeatedly indicated that she had advised this teacher to do so, as this would enhance her lesson presentations. The lack of lesson preparation also played a role in her lagging behind with the syllabus. There were indications, in the mentor reports, that a summary of the lesson was given to the learners at the end of the lesson and that Teacher NK told the learners what to expect in the following lesson. This implied some mental planning on the teacher's part.

Teacher RB

The mentor's visits to the school revealed that Teacher RB did not have any written lesson preparation (Lesson observation for grade 10, 12 March 2012; Lesson observation for grade 11, 12 March 2012; Lesson observation for grade 11, 26 March 2012; First semester mentor report, 2012). The mentor addressed the lack of lesson preparation with Teacher RB on more than one occasion. However, the mentor mentioned that, although this teacher did not have a written lesson plan, it was evident in the way the lesson was structured that Teacher RB was prepared for the observed lessons. This is evidenced in the following excerpt: "His lessons flow

with ease from introduction to conclusion and within the allocated time". His passion for teaching was also revealed: "Teacher RB delivers his lessons with zeal and passion".

Teacher SB

Teacher SB did not have written lesson plans until the end of term one 2012, although the mentor noticed that this teacher was prepared for the lessons. However, after the mentor's intervention, Teacher SB started to produce written lesson plans. This is regarded as a significant improvement. Nonetheless, the mentor indicated areas of the lesson plan that still needed to be improved after mid-2012, namely, "detailed worked out solutions for problems given in class and … homework" (Progress report on first semester 2012). So, although improvement occurred – from no written lesson plans to all being written out – the write-up of some areas could still be refined.

Teacher SR

Like many of the other participants, Teacher SR did not produce any written lesson plans, when the mentor visited the school. This is documented in the mentor report of 16 March 2012, for instance. However, a shift occurred later in 2012 (second term), as he wrote lesson plans for all his lessons, including those that were not observed by the mentor. This happened after a discussion with the mentor, which revealed that Teacher SR was simply confused by the many lesson plan templates and was unsure which ones to use. After clarification on the part of the mentor, this teacher was able to clearly write his lesson plans. Nevertheless, the mentor indicated, in the term two 2012 report, that even without the written lesson plans, she could gather that Teacher SR was prepared for all his observed lessons, as "was evident in the way the lessons were structured". According to the mentor, it was easy to identify the introduction, the body, and the conclusion of the lesson, as it was being delivered. The mentor noted that Teacher SR was even "vocal about how a written lesson plan helps him stay focussed during his lesson presentations". The mentor report of 18 May 2012 indicates that the "lesson plans for all the lessons have been written with completion dates and signatures. This is an improvement!" So the improvement was not just the writing-up of all the lesson plans, but also their being dated and signed by Teacher SR. This clearly indicates that this teacher

developed in terms of lesson preparations, due to his interaction with the mentor. Ultimately, this interaction improved his competence and performance as a professional.

5.2.4 Support to learners and learner participation in class

The teacher acts as the more knowledgeable other who is expected to facilitate learning in the classroom. It is important to stress the potential of learners' participation to contribute to their learning. There are different forms of learner participation; however, during lesson observations, only explicit and visible participation could be accounted for. It included learners offering their ideas and thoughts spontaneously, answering questions when called on, volunteering to answer questions, demonstrating at the chalkboard, completing written work, and talking to peers or the teacher about tasks (Turner & Patrick, 2004: 1760). Learner participation in the classroom creates an avenue that enables teachers to have glimpses of their learners' thinking processes and learning. It also provides opportunities for teachers to identify problems with learning or evaluate their learners' progress (ibid). Teachers' failure to effectively utilise these opportunities to support learning results in missed learner support opportunities. Examples of learner support include scaffolding learning, or providing cognitive and affective support to learners to ensure a better understanding. Investigations in this aspect of the research sought to establish the extent of learners' participation in the classroom, and whether or not learners were supported by the teachers in the learning process.

Teacher MK

During the lesson on exponents, the mentor observed that Teacher MK's learners confused the use of a comma and a full stop between numbers; for example, they wrote $3{,}2^5$ instead of 3.2^5. The report further stated that this was corrected through co-facilitation. This suggested that the teacher was unaware that his learners made such an error to which the mentor alerted him. This was a possible indication that Teacher MK was not checking what the learners had been doing in their books in class. Indeed, Lanhart's (2010) research has found a relationship between pedagogical content knowledge (PCK) and instruction in the classroom. Therefore,

the teachers' pedagogical knowledge and, ultimately, their pedagogical content knowledge have to be further developed. This will help to sufficiently transform their own knowledge into the content of instruction and, in this case, to support learners whose written work displays errors. Misconceptions could arise or increase, if interventions to correct errors were neglected. Thus, the mentor encouraged Teacher MK to do his self-directed learning tasks, which were given to all the participants, as this would assist him with his own development.

Initially, the mentor noticed and reported that very few learners participated in the lesson joined in. Through co-facilitation, the teacher and his mentor were able to get more learners involved in the lesson. This indicated that the mentoring assisted the teacher to develop facilitation skills that enable him to involve more learners. The subsequent reports did indicate that the learners participated massively, that the learners worked in groups, and that the teacher gave them feedback on the work done. Some reports (Lesson observation for grade 10B, 7 May 2012; Lesson observation for grade 10A, 24 October 2012) also indicated that the learners received "immediate" feedback.

Teacher NK

Teacher NK used the group work strategy effectively, in that homework or classwork was marked immediately after the learners had completed it in groups and then present their answers. The mentor regarded this as a good method, especially because the teacher moved around the groups to support them. It must be stressed that this method also increased learner involvement in class. However, this method was very time-consuming and contributed to the teacher lagging behind with the syllabus. Indeed, at times, an entire period was spent on correcting the homework alone. The mentor encouraged Teacher NK to do the provided self-directed learning tasks, to assist with her professional development so as to alleviate this time issue. However, the report acknowledged that this teacher dissipated learners' difficulties by moving around the class when classwork was in progress, and that learner participation in class was generally good. It was also reported that the learners were comfortable to ask Teacher NK clarification questions, because she availed herself during group work.

Teacher RB

The mentor report indicated that Teacher RB gave learners class exercises and provided them with feedback in the same period (First semester mentor report, 2012). This gave the learners an indication of how they were performing in that aspect of the curriculum. Nevertheless, the mentor report indicated that the learners' participation in class was generally unsatisfactory, despite Teacher RB's attempt to involve passive learners. At the end of the grade 10 learners' lesson on linear equations, the teacher re-emphasised the steps to be followed when solving equations (Lesson observation for grade 10, 12 March 2012). Re-emphasising the steps affords the learners the opportunity to revise and internalise the content.

Teacher SB

The mentor reports indicated that Teacher SB gave learners individual attention and tried to involve passive learners by using the question and answer method (First semester 2012 progress report). It was even mentioned that "he was able to reach the learners" (Lesson observation, 22 July 2012).

Teacher SR

Teacher SR assisted his learners in developing the important skill of working independently as a class, especially in his absence or when he was delayed and could not arrive in class on time. This is confirmed by the following excerpt:

> The learners are so disciplined that even when the teacher is not in the class they continue to do their work in an organised manner, usually discussing tutorials (First semester 2012 mentor report).

Learners would thus continue to work in his absence as if they were being supervised by their teacher. This was noticed by both the mentor and the researcher. On 16 March 2012, the mentor observed that the teacher was delayed in the principal's office; yet, upon arriving in his class, "we found the learners already discussing the homework with one of them writing the correction(s) on the board. That was impressive. There was order". This was an indication that the learners did not sit idle in class, they worked as a collective to check the solutions to their homework.

It was noted that Teacher SR started with the revision of aspects that were already covered, but which had to be used in new sections, to ensure that learners were not hindered by a lack of prior knowledge. This approach warranted that prior knowledge was refreshed in time. For example, the theorem of Pythagoras was revised before learners were expected to incorporate it in the trigonometry questions. Feedback on classwork was also provided immediately, as a form of support to learners. As stated by the mentor, “A lot of worksheets and classwork were used to ensure that learners get enough practice on topics done” (First semester 2012 mentor report). Teacher SR also tried to involve passive learners. The mentor also reported that the learners asked clarification questions (Lesson observation for grade 10, 16 March 2012). This was an indication that the teacher created a conducive environment in which learners felt safe enough to ask clarification questions, which has the potential to promote learning.

Teacher SR also taught Saturday classes to support learners so as to better their performance and to ensure that the syllabus was completed on time. He kept attendance registers as evidence that the interventions occurred and to document the attendees.

Furthermore, the layout of this teacher’s work on the board was well-organised and promoted teaching and learning.

5.2.5 Homework given

Mathematics is perceived as a subject that requires that learners practice their skills so as to master the content. As such, mere classwork practice is insufficient to ensure learners’ competence in Mathematics. Therefore, guided homework and the correction thereof are crucial in ensuring that learners grow their Mathematics competence. Thus, this section endeavoured to establish whether or not teachers gave leaners homework as a means of continuing to develop their Mathematical skills and knowledge, after the lesson.

Teacher MK

Another constant critique by the mentor was that Teacher MK hardly gave his learners homework at the end of the lesson. The mentor discussed this with the teacher on numerous occasions, but the latter generally failed to address this issue. However, in the report on the latest observation schedule indicated that homework was eventually given after the lesson.

Teacher NK

Some of the reports (Lesson observation for grade 11, 24 October 2011; First semester 2012 mentor report) revealed that Teacher NK gave homework to his learners. Other reports (Lesson observation for grade 11, 3 August 2012; Lesson observation for grade 11, 30 October 2012) indicate that no homework was given to learners. It thus be concluded that this teacher gave learners homework sporadically.

Teacher RB

Reports indicated that Teacher RB gave learners homework (Lesson observation for grade 10, 12 March 2012; Lesson observation for grade 11, 12 March 2012; Lesson observation for grade 11, 26 March 2012). It can be concluded that this teacher gave learners homework on a regular basis.

Teacher SB

All the available lesson observation schedules indicated that Teacher SB gave learners homework after every lesson (Lesson observation for grade 10, 13 March 2012; Lesson observation for grade 11, 13 March 2012; Lesson observation for grade 12, 13 March 2012; Lesson observation for grade 11, 22 May 2012; Lesson observation for grade 12, 22 May 2012). Lesson observation reports also indicated that homework was marked in class, but did not consume a lot of time; hence, other work was given immediately thereafter.

Teacher SR

All the lesson observation reports indicated that Teacher SR gave learners homework (Lesson observation for grade 10, 16 March 2012; First semester 2012 mentor report; Lesson observation for grade 10, 21 May 2012; Lesson observation for grade 12, 21 May 2012). Homework was marked within the time constraints to ensure that prompt interventions were undertaken once errors were detected.

5.2.6 Critique

This section analysed aspects or areas that the mentor or workshop facilitator flagged as not falling under the previous headings, and in which the participants still needed development. The researcher further scrutinised sections which referred to follow-up comments on this, in order to trace possible development.

Teacher MK

According to the mentor report, Teacher MK's use of the chalkboard was unconducive to teaching and learning. Indeed, the mentor reported that "Initially his work on the board was a mess …" (First term 2012 mentor report). Through mentoring and classroom observation sessions, this was addressed. It was only through observing Teacher MK's lessons that this was identified as a classroom challenge. After receiving assistance from the mentor in more than two classroom observation schedules, it was reported that his writing on the board had improved significantly. These reports (First term 2012 mentor report; Lesson observation for grade 10C, 19 April 2012) revealed that "…there's a marked improvement…" in that "[t]he layout of the work on the board was well organised".

Teacher NK

It transpired that Teacher NK had good facilitation skills. She handled group work exceptionally well and was hands-on when learners were doing classwork. However, when the height of a triangle was covered in class, under the measurement section– with the mentor acting as co-facilitator – it became apparent that the learners struggled to understand that concept. Subsequently, Teacher NK was mentored to ensure that she was able to teach the relevant section more efficiently, after the mentor had diagnosed her weakness with regard to teaching the height of a triangle. Co-facilitation also took place when the mentor noticed an incorrect writing of $\left(\frac{-12}{13}\right)\left(\frac{-5}{13}\right)$ or $\frac{-12}{13}.\frac{-5}{13}$. Indeed, when multiplying two fractions with negative signs, as is the case in the above example, Teacher NK would write $\left(\frac{-12}{13}\right)-\frac{5}{13}$. The possible explanation for this could be that this teacher did not detect this situation or

did not identify it as an error. However, when the mentor addressed this error, Teacher NK made an effort to rectify it.

The absence of a written lesson preparation was also critiqued, and the mentor stressed that the production of this document could improve Teacher NK's lesson. The lesson preparation could also assist this teacher not to use the entire period to mark homework; this would enable her to make appropriate progress with the syllabus.

Another concern was the poor performance of grade 12 learners in the June 2012 examination. Indeed, only 20% of the 15 learners passed this examination. Thus, the mentor advised Teacher NK to analyse each learner's results per question and use this analysis to direct her revision plan. The mentor assisted this teacher to start the analysis process. This highlights the support that the mentor provided to the teacher with regard to the use of data analysis to direct her interventions aimed at improving learner performance.

After the grade 11 lesson on trigonometric graphs, the mentor advised Teacher NK to include strategies other than the trial and error method and the table method, to draw trigonometric graphs. This is after it became evident that the learners did not understand that section. The teacher agreed to repeat the lesson the next day and to do what the mentor advised. This clearly indicates that the teacher was open-minded and took the mentor's advice seriously.

Once again, the trial and error method was used by Teacher NK during the lesson on solving trigonometric identities. The mentor made this teacher aware that, when this method is used in this section, it would not guarantee the attainment of all the solutions. Hence, co-facilitation was undertaken once again to assist the class to get to a general solution for the equation. This was to ensure that all the possible solutions could be determined. Through co-teaching, Teacher NK was practically mentored so as to improve her competence in the classroom.

The mentor observed that this teacher also lagged behind with the marking of assessments (Grade 11 mentor report, 23 March 2012).

Teacher RB

One of the mentor's main concerns with regard to Teacher RB was the lack of written lesson plans (First semester 2012 mentor report). Another key concern was this teacher's tendency to neglect the ticking of the completed sections of the syllabus in the teacher-file. Another critique by the mentor was that learners were not given sufficient practice activities.

Although extra lessons were offered to the learners in 2012, this intervention was not effective (Lesson observation for grade 11, 12 March 2012). This is because these learners rely on the school bus for transport; yet, the latter left right after school. As a result, the attendance of these extra lessons was poor. The mentor's recommendation was for the school to fund these learners' transport. Unfortunately, the school lacked the required funds. This left Teacher RB with only his class time as sole opportunity to support his learners. However, the mentor advised additional exercises instead of the extra classes.

Teacher SB

Lesson observation for grade 11 (22 July 2012) indicates that the progress of the lesson was hampered, at some point, by the fact that the majority of learners lacked calculators when they were working on a trigonometry section. However, the school had spare calculators that Teacher SB could give lent to the learners. The mentor advised this teacher to avail those calculators to the learners whenever the need arose. Learners' lack of calculators was not a strange situation in the South African context where schools do have resources in their possession but do not allow their learners to use them (Draper, 2010: 149). This is because school staff feared that the resources might get lost or damaged. Thus, teachers under-use the resources at their disposal (Graven, 2002: 175).

At times, the mentor observed that learners were too passive in the class, to the extent that the lesson resembled a lecture. The advice was for Teacher SB to use other teaching strategies, like group work and discussions which are followed by questions, to allow for more active learner participation.

Teacher SR

Teacher SR was behind with the self-directed learning given to the participating teachers by the mentor. This was addressed by the mentor and the teacher "promised to complete it before the next workshop" (Mentor report, 18 May 2012). Another concern relating to Teacher SR was that the dates and signatures against the completed topics in the teacher-file were not filled. The mentor addressed this neglect of the updating of the administrative file. The mentor also recommended that this teacher include the corrections of assessments in the learners' filed-portfolios.

5.2.7 Observations that did not fit in any headings

This section differed from the previous headings in that it did not necessarily relate to the participants' development areas per se. It dealt with general observations which could shed some light on the individual participants' development or lack thereof, as the programme progressed.

Teacher MK

Initially Teacher MK seemed to find it difficult to ask for assistance, but towards the middle of the year 2012, he opened up and was more comfortable with the idea of asking for help.

Teacher NK

Teacher NK would walk around, from one group to another, during group work sessions, to listen to the learners' discussions and mark their work. She was able to use the discussion method effectively in that learners participated and gained more knowledge through this method.

Teacher RB

Teacher RB delivered his lessons with “zeal and passion (First semester 2012 progress report). The mentor observed that this teacher’s layout of the work on the board was well organised (First semester 2012 mentor report).

Teacher SB

The fact that Teacher SB revised the previous work with the learners, instead of assuming their prior knowledge before moving to the next section, was a commendable approach (Lesson observation for grade 11, 22 July 2012). In most of the reports, the mentor mentioned that this teacher had developed strong subject knowledge, which is a pre-requisite to being a competent teacher. In relation to the lesson with the grade 11 learners, on quadratic sequences and series, the mentor commented that “the presentation of this lesson was excellent” (Lesson observation for grade 11, 22 May 2012). This signified that it was almost flawless, according to her understanding. In more than one instance, mention was also made of Teacher SB’s organised writing on the board.

Teacher SR

Teacher SRs administrative work was up-to-date, since the control test was already done and the investigations were marked and recorded in the files. This teacher instructed learners to use two different books: one for the sections relating to Paper 1 and the other for the sections pertaining to Paper 2. This assisted learners to know which topics fell under which examination paper, as failure to make this distinction could confuse learners during the examinations. These marked and recorded assessments were perceived by the mentor as sufficient.

Discussion

Teachers MK, RB, and SB neglected to indicate the sections that they had completed, in their files. In other words, they did not tick off and sign in the files, after completing syllabus topics. Thus, it could not be ascertained whether they were on par with their work schedules. Teacher NK was, at some stage in 2012, behind with the grade 11 work schedule and she indicated to the mentor that she would use the

holidays to get back on schedule. Teacher SR was on par with his syllabus, because he used Saturdays for extra classes. Just before the June 2012 examinations, he was even ahead of the work schedule.

The comments on teachers' content knowledge, based on the mentor's lesson observations, indicated that Teacher MK did not make mistakes with regard to his content knowledge. In relation to Teacher NK, the mentor identified areas where her content knowledge needed development. The mentor indicated that Teacher RB was well versed in terms of his content knowledge, as displayed in class. He used appropriate examples and built on previous sections during his lessons. He displayed more than one approach to solving Mathematical problems, due to his extended content knowledge. Therefore, it could be concluded that strong content knowledge could impact positively on a teacher's competence and performance in class. Teacher SB's content knowledge could be described as adequate, which allowed him to facilitate the challenging section on reading and interpreting trigonometric graphs. Teacher SR also displayed adequate content knowledge in class where he could even highlight commonly made errors to learners so that they could avoid them. This was an indication that a well-laid content knowledge could assist a teacher to better facilitate learning.

There were no accounts that Teachers MK and RB produce any written lesson preparations, despite the fact that the mentor constantly encouraged them to do so. Nonetheless, the mentor reported, in one instance, that although Teacher MK did not have a written lesson plan, it was evident that this teacher was prepared. Conversely, the mentor stressed that thorough lesson preparations would assist Teacher NK to keep abreast with the syllabus. Similarly, Teacher SB did not have any written lesson plans until the end of the first term of 2012; however, the mentor observed that this teacher was prepared for the lesson. As a result of the mentor's intervention, Teacher SB started to do written lesson preparations. The mentor highlighted areas in which this teacher's lesson plans could be improved. In the same vein, Teacher SR did not do any written lesson preparations; but, this changed by the middle of 2012. This change resulted from discussions that this teacher had

with the subject advisor in a workshop and the motivation provided by the mentor. These factors helped Teacher SR to acknowledge the importance of written lesson plans which eventually assisted him to stay focused during the lessons. It must be emphasised that he was the only teacher who filed all his written lesson plans – including those that were not observed – dated and signed. This was an indication of Teacher SR's improved competence and performance in class. It could be concluded that the participants started producing written lesson plans as a result of mentoring and workshop interventions that formed part of the PD programme. These lesson plans contributed to some of the teachers' improved competence and performance in class.

On the issue of teachers providing support to learners and learner participation in class, Teacher MK was initially unable to notice errors that learners made in their classwork. This was corrected by the mentor who intervened through the co-facilitation of the lesson. This revealed that this teacher did not check the learners' classwork and, therefore, a lack of the necessary PCK to support learners when their written work contained errors. Following the mentor's intervention, Teacher MK developed in terms of the acquisition of facilitation skills that ensure that more learners were involved in lessons. It was also indicated, at a later stage, that he facilitated group work and gave learners feedback on work done in their respective groups. Clearly, this teacher had successfully incorporated other teaching strategies in his lessons; this evidences his improved competence and performance. It must be noted that Teacher NK used group work substantially, because learners' seating arrangement in class was favourable to this. However, this teacher spent too much time on assisting learners to correct homework. This implied her inability to support learners within limited timeframes. In other words, although other teaching strategies were implemented, they were hindered by poor time management. This means that more support is needed to improve her competence and performance in class. On his part, Teacher RB incorporated giving his learners classwork, in every period, on which they received immediate feedback. He made an effort to involve the passive learners and supported all his learners in terms of revising the work done at the end of the lesson. Teacher SB also encouraged passive learners to be more involved and gave learners individual attention. As for Teacher SR, he assisted learners to

develop the ability to work independently, even when he is absence from the classroom. He also supported his learners by ascertaining their prior knowledge before moving on to new sections. Furthermore, his learners received immediate feedback on classwork, and consented efforts to involve the passive learners. Teacher SR created an environment that was conducive to learners asking questions freely.

Teacher MK did not give learners homework at the beginning of the PD programme. He only started giving homework to his learners much later in the lifespan of the programme, after numerous discussions with the mentor in that regard. Teacher NK gave homework sporadically; while Teachers RB, SB and SR gave homework on a regular basis. Teachers SB and SR marked the homework in class, before they started with the following sections.

Possible areas where development is still needed

Teacher MK's use of the chalkboard was not conducive to teaching and learning. Through the mentor's lesson observations, this was identified and addressed. This resulted in an improvement in his layout on the board and his becoming more organised. Teacher NK showed weaknesses in her teaching of heights of triangles. Another area of development for this teacher was her monitoring of the errors that learners made in terms of how they wrote negative fractions in multiplication sums. The mentor assisted Teacher NK in analysing the poor results of her grade 12 learners in June 2012, so that she could identify the common areas in which the learners performed poorly. This identification of problem-areas would enable her to structure revision plans to address those specific areas. This teacher was also assisted, through mentoring, to use more problem-solving methods besides the trial and error method which helps to deduce answers. It was also noted that her marking of assessments lagged behind, which could be as associated with a lack of time management skills. Insofar as Teacher RB, he gave his learners insufficient practice activities. One of Teacher SB's classes on trigonometry was hampered by his learners' lack of calculators, despite the fact that the school had spare calculators in

the storeroom and which could have been lent to the learners. One of his lessons turned into a lecture, because the learners were too passive. Consequently, discussions and group work were recommended by the mentor, to ensure more learner participation. Observations were also made regarding Teacher SB's neglect of his administrative work and his failure to include the corrections of assessments in the learners' filed portfolios. These issues were also discussed between the teacher and the mentor.

5.3 WORKSHOPS

The workshop reports were analysed in a deductive manner; in the process, the themes were obtained. These reports were accessed from the service provider and were compiled by the mentor and/or the workshop facilitator.

The workshop reports available to the researcher, which reflected the dates and topics covered are listed in Table 5.1 below.

Nr	Date	Topics Covered	Attendees
1.	10-11 Jan 2011	• Sequences and series • Financial Mathematics • Interpretation of nature of roots • Analytical Geometry • Compound angles • Inequalities • Functions, Inverses & Logarithmic functions	• 5/5
2.	10 Feb 2011	• Financial Mathematics • Linear programming	• Open workshop
3.	5-6 April 2011	• Grade 11: Inequalities using graphs & Algebraic solutions • Straight line, hyperbola, parabola & exponential graphs	• 4/5

4.	21-22 June 2011	• Financial Mathematics • Calculus • Linear programming • Trigonometry	• -
5.	21-23 Nov 2011	• Exam papers of the 3 accredited exam bodies in South Africa were worked through	• -
6.	16-18 Feb 2012	• Sequences and series • Euclidian Geometry • Financial Mathematics	• 4/5
7.	1 June 2012	• Meeting – Included were lesson plans, work schedules & assessments	• 5/5
8.	6-7 July 2012	• Trig identities and trig equations • Circle Geometry for grades10 & 11	• 3/5
9.	24-25 Aug 2012	• Lesson preparation for grade 12 • New topics of CAPS • Finance • Geometry • Probability	• 4/5
10.	12 Oct 2012	• Number patterns • Financial Mathematics • Euclidean Geometry riders • Probability	• 5/5

Table 5.1: Workshop reports

It is evident from Table 5.1 that the most of the workshops focused on content knowledge, as only one (workshop 7) out of 10 workshops was not about content knowledge.

It must be stressed that the curriculum for South African public schools had been changed several times in the past, and the latest change was from the National Curriculum Statement (NCS) to the Curriculum Assessment Policy Statement (CAPS). The CAPS curriculum was first implemented in 2012 in the Foundation

Phase and in grade 10; then, in the next consecutive years, it was implemented in grades 11 and 12 (DBE, 2011: 16). Indeed, complaints and comments regarding the NCS curriculum had been received by the Minister of Basic Education. These included the overburdening of teachers with administrative tasks, differences in the interpretations of the curriculum countywide and across schools, as well as the growing level of learners' underperformance in numeracy and literacy (Olivier, 2013: 15). Coetzee (2012) contends that the CAPS was not a new curriculum, but rather an amendment to the NCS and whose aim was to ensure that the curriculum was more accessible to teachers. The approach was more detail on what content to teach per grade and per subject, to make recommendations on the number and type of assessments per term, and to change the outcomes and assessment standards to topics and learning areas and themes to subjects respectively (Olivier, 2013: 16).

The most important change to the Mathematics FET curriculum was that "most of the work covered previously in the optional Paper 3 … is now included in the core Maths curriculum" (Olivier, 2013: 17); this optional work includes Euclidean geometry and Probability. In the process, the following sections had been removed from the curriculum: Linear Programming, Recursive sequences, and Transformational Geometry (ibid). Consequently, the Department of Education devised a five-year plan to train and support teachers with regard to the CAPS curriculum (Coetzee, 2012). This included, first, the training of district and provincial subject advisors for the Grade 10 CAPS, in May 2011; and, then, a grade 10 teacher training in the June and September 2011 holidays (DBE, 2011: 17). An important aspect of this grade 10 teacher training was the provision of learner and teacher support materials.

The PD programme under investigation was implemented in the midst of the change to the CAPS curriculum. Thus, the assumption was that this PD programme would enhance the DBE's teacher preparation to ensure that teachers were adequately equipped to teach the new curriculum. This research sought to establish if this was indeed the case. Thus, the workshop reports were investigated under the following headings: content selection, lesson preparation, teaching strategies, work schedule, attendance of workshops by participants, topics covered, and challenges faced. These headings were mostly aligned with those of the lesson observation schedule.

The information below was acquired by analysing both the workshop reports produced by the facilitator/mentor and the mentor reports on school visits.

5.3.1 Content selection

As indicated in section 2.3 of Chapter 2, involving participants in as many processes of the PD programme as possible (Kgalema, 2001: 25-31; Luneta, 2013: 80; Lee, 2005: 46) is crucial for their optimal development. Hence, this heading was incorporated to ascertain who selected what was covered in the different workshops.

Workshop 1's content was selected by the teachers themselves, after the assessment of their pre-programme test. Workshop 2's content on linear programming and financial mathematics was selected by the Mathematics subject advisor. The workshop coordinator chose the contents of workshops 3 and 4. The selection was based on the weaknesses in the teachers' content knowledge identified in the pre-test. The weaknesses exposed in the diagnostic of the post-test (written after the workshop) – which were not evident in the pre-test – were selected as the content of workshop 5. These were addressed in an attempt to strengthen the teachers' ability to tackle the more cognitively demanding questions set by the three Umalusi accredited examination bodies. The first part of workshop 6's content was chosen by the workshop coordinator, since she had identified the weaknesses exposed in the previous post-workshop test. Number patterns were identified as a focus-area in this regard. Teacher SR brought a term test that he had prepared and which was analysed by the workshop coordinator and the teachers. This was an unplanned exercise; however, the interrogation of the test was converted into a professional development activity which required teachers to make comments on the coverage of the curriculum and the cognitive demands of each subsection of the broader question. Adjustments were suggested and the group was expected to reach a consensus on the cognitive levels. This interaction was regarded as an exemplification of how the professional learning cluster ought to function. In workshop 6, time was spent on Euclidean geometry and financial mathematics. Workshop 7's content was selected by both the Mathematics subject advisor and the participants; this workshop had an element of a meeting where attendees could put

points on the agenda. The researcher was unable to determine who selected the content of workshop 8.

In workshop 9, the workshop coordinator prepared grade 12 revision exercises for the weaker learners. It was hoped that, through practising these questions, these learners' confidence in answering similar questions might improve. The participants had to ascertain that these exercises were suitable. The necessary changes were made, after consultation. The second day of this workshop was spent on topics covered in previous workshops, but which were still not well understood. These topics were financial mathematics, geometry, and probability. This was the fifth time that financial mathematics was covered in a workshop.

Number patterns, financial mathematics, circle geometry, and probability were covered in workshop 10. It was not possible to gather how or by whom these topics were selected. Financial mathematics was discussed once again, even though the report revealed that all the planned activities on this topic were not covered in the workshop. The same situation occurred with circle geometry and probability, in workshop 10.

5.3.2 Lesson preparation

The preparation of lessons is central to teaching and learning, in that teachers need to outline what they would do in the classroom, daily, and how it would be done (McKay, 2010: 1). Lesson preparation would assist teachers in planning how they would complete the year's work schedule.

Workshops 1 and 7 dealt with the importance of written lesson preparation. In workshop 1, the participants were informed that it is a provincial requirement that written lesson plans be done for each lesson. It was also communicated to participants that a topic should be subdivided into many daily lessons. It was

emphasised that care should be taken to ensure the selection of both appropriate examples to be done on the board and appropriate class activities to ensure that class time is used optimally. Participants were also cautioned against using an entire period to mark homework. Teachers were also advised to do class exercises and homework in advance, to avoid the embarrassment that comes with being unable to answer learners' questions regarding the solutions to the homework.

Workshop 6 addressed the importance of not setting tasks for learners without knowing exactly how these activities need to be done, as well as the need to grade them in a manner that helps to build learners' confidence (instead of destroying it). Therefore, proper preparation of classes was identified as the key to ensure this confidence-building. Gradual progression with the given exercises should also be borne in mind, as it requires carefully selected problems.

In workshop 7, there was a lengthy discussion and explanation on written lesson plans. Teacher SB raised his concern about the many different lesson plan templates and the resulting uncertainty about which one to use. The subject advisor responded that a lesson preparation should have the following: the topic, the date on which the lesson would be conducted, an introduction, the presentation of the lesson where the examples and detailed solutions would be written out, as well as class exercises and homework with detailed solutions. Teachers were made aware of the fact that the daily lesson plan should be in line with the work schedule. The subject advisor also emphasised "that a lesson plan is a priority at each class visit and the teacher should also have a record (of) lesson plans for all the lessons delivered but not (necessarily) observed" (Workshop 7, June 2012). This clearly conveyed the Department of Education's stance on lesson preparations. However, it is regrettable that this message was sent towards the end of the PD programme. Therefore, it would be difficult to guarantee that teachers would abide by this regulation once the mentor's class visits have ended. Put differently, the mentor or subject advisor should have emphasised written lesson plans from the onset of the PD programme. This would have given them the opportunity to monitor the refinement of the teachers' skill with regard to written lesson preparations, as this forms an integral

part of the development of an effective teacher. Indeed, the written daily lesson preparation outlines the strategies and methods that teachers will employ to assist their learners – in a systematic way – to achieve their learning outcomes (Adedeji & Olaniyan, 2011: 52). The more organised a teacher is, the more effective the teaching; therefore, a lesson plan is an essential aspect of being organised (ibid).

Workshop 8 had a slot where teachers had to do lesson preparation on trigonometry equations and identities. Material was provided to assist the participants with their lesson preparations. In workshop 9, written lesson preparation was addressed once again and teachers were asked to share their lesson plans with the group. Unfortunately, none of the teachers were prepared to share their work with the group. Participants also prepared examples to be used in actual class teaching forming part of revision sessions for grade 12 learners. These examples were later consolidated into revision material available for use by all the teachers. These preparations occurred in pairs; this was so as to create an environment where the participants could share knowledge and skills, and ask questions to their peers.

It was beneficial that the Mathematics subject advisor was present in some of the workshops on lesson plans; this afforded him the opportunity to highlight the departmental requirements for this aspect of teacher. He could also assist in dissipating the uncertainty regarding which lesson plan template to use. The scheduling of the sessions on lesson preparation late in the programme was regrettable, as participants did not have sufficient opportunities to practise the writing out of lesson plans very early in the programme.

5.3.3 Teaching strategies

The classroom is a space where learning is expected to occur. The teacher's responsibility is to endeavour to make every lesson a productive and positive learning experience for all learners by selecting the most appropriate teaching

strategies (Killen, 2010: 84). The latter include, among others, direct instruction, using small-group work, case study, and so forth.

The teaching strategy relating to how to teach inverse functions was discussed in workshop 1. This is because the mentor's classroom observations revealed that teachers moved straight into the swopping of *x* and *y* in the equation, without explaining why this is done. This became more of a recipe than a mathematical reasoning. As a result, an approach was shared by the mentor in an attempt to rectify the incorrect teaching of this section.

Time was also spent on the teaching of functions, inverses, and logarithmic functions, in workshop 1. The teachers were reminded to adapt these lessons to suit their learners' needs.

In workshop 5, the teachers worked in pairs on a worksheet; they had to present their solutions to the group. This was done in an attempt to simulate a classroom practice method which could encourage more learner involvement in the classroom. When the participants presented their solutions, the workshop coordinator just gave them tips and identified errors sporadically, without telling the participants how to solve those problems. This was a way of showing the participants how to allow for more learner involvement in the classroom.

In workshop 5, time was also devoted to grappling with the view that it was not always necessary to first find the n-th term of a number pattern with a quadratic general term. In other words, a diagram can also be used, which saves time and can develop learners' problem-solving skills.

Workshop 6 also focused on the quest for a general formula for number patterns. At first, the teachers struggled to answer the questions on this section. They were tired given that this was on a Thursday evening, after they had completed a day's work. Indeed, when they resumed the next morning, these teachers were more susceptible to understanding the section in question. The workshop coordinator explained to the

participants that, when teaching this section, they need to get across to learners the value of pattern work. That is, this section is about more than just finding the first few terms or the general term, it is about a deeper understanding of the concept of number patterns. The workshop coordinator also reiterated the need for learners to understand how shortcuts, in answering questions on this section, were derived and the fact that several general terms for quadratic sequences needed to be determined before shortcuts would be introduced.

With regard to Euclidean Geometry, some paper-folding activities were discussed and tried out to determine the properties of the sides, angles and diagonals of special quadrilaterals. This was in an attempt to support teachers on how to effectively teach this section to grade 9 classes.

In workshop 8, the teachers had to practise explaining riders of circle geometry by presenting in front of the peers. This exercise was valuable in that teachers had to demonstrate their understanding of a section that was not in the syllabus when they were in school. Teachers' presentations revealed their growth in terms of their understanding of proofs and the use of appropriate reasons. The discussions on these topics sparked a lot of debate and contributed to the participants' understanding of this section.

In short, the workshops were used to assist the participants on how to teach the specific Mathematics sections that the mentor identified as problem-areas during classroom observations. Participants were taught how to replace procedural explanations with conceptual ones in certain sections. The modelling of lessons was also used to demonstrate to the participants how to teach. Subsequently, the participants conducted lessons for their peers to observe and critique. In the process, best practices were shared; these include fewer recipes, the use of diagrams, paper folding in geometry, and how to identify patterns instead of focusing on procedural practices. Modelling lessons also occurred in relation to sections which were not covered when the participants were still in school.

5.3.4 Work schedule

It was indicated in Section 2.5 of Chapter 2 that there was evidence linking certain schools' underperformance to some teachers' failure to complete the syllabus for the particular year (Makgato & Mji, 2006: 261). Thus, the participants in the evaluated PD programme were provided with possible ways to finish the syllabus timeously.

The subject advisor made the grade 12 provincial work schedule of the first term available to teachers, and the content was discussed in detail (Workshop 1, 10 Jan 2011). As it becomes apparent, the workshops were used to disseminate resources that teachers needed to assist them to finish the syllabus timeously. Teacher SB informed the meeting of the omission of revision time on the work schedule, which was immediately addressed by the subject advisor. This is an indication of this teacher's thorough perusal of the work schedule. Clearly, this PD programme created opportunities to discuss the concerns of the participants and to enable them to change the work schedule accordingly. This indicated that the programme accommodated the views of participants and took them seriously.

Workshop 7, which was more of a meeting chaired by the subject advisor, took place just before the start of the June 2012 examinations. In the workshop, the subject advisor enquired as to how far each teacher was with regards to the work schedule for grade 12. It transpired that Teacher SR was ahead of the work schedule, he was busy with revision in preparation for the upcoming examinations. Teacher SB was left with a small section to cover, which he would be able to cover before the examinations. Teacher RB was behind with the work schedule and was conducting morning, afternoon and Saturday classes, in order to cover the necessary sections. Teachers MK and NK were behind with the work schedule, due to unrest in the village where the school was situated. They did not have a plan on how to catch up with the missed time, as the unrest was still unresolved. This painted a clear picture of the different levels at which the participants were regarding the work schedule, as well as their unique and common challenges and associated coping/catch up mechanisms. It was established that teachers whose content knowledge was firmly established were the ones who could also keep up with the work schedule, and vice versa.

5.3.5 Attendance of workshops by participants

Assessing whether participants in a PD programme have benefitted from it necessitates the verification of their attendance of the interventions. It must be noted that the researcher could not access all the information on the participants' attendance of workshops, but she was able to gather that, generally, the five participants' attendance of workshops was quite regular. Some isolated instances where teachers were absent – due to personal commitments or health issues (illness) or clashes between this workshop and another that forms part of a different programme – were recorded.

Workshop 8 was only attended by three participants. This was disappointing given that the absent participants also struggled with the topic under discussion, namely, Euclidean geometry for grade 10 (Workshop 8, 6-7 July 2012). The teachers who attended this workshop admitted that the abovementioned topic was not taught well by their own high school teachers, and that it was not part of their tertiary syllabus (ibid).

5.3.6 Topics covered

This section investigated the topics or aspects that were covered in the different workshops. The purpose of this investigation was to link what was covered in the workshops with the participants' and mentor's responses in the interviews, in an attempt to answer the first research question.

At the start of the programme, all the participants wrote a pre-test which consisted of two papers of a standard equivalent to the grade 12 examination. After marking the scripts, the workshop coordinator identified the main weaknesses which related to the application of differential calculus, financial mathematics, algebraic inequalities, and trigonometry (Mentor 1's end-2012 report). The areas where the participants performed reasonably well were topics that were included in the previous standard grade syllabus (the South African public school system previously had a higher and a standard grade syllabus), as well as sections that required routine algorithmic

approaches (Mentor 1's end-2012 report). However, it was later discovered by the workshop coordinator that not all the problem-areas could be identified in the pre-tests, possibly due to the limited number of questions that can be included in a test, or due to the uneven distribution of topics in the test paper. The section on contextualised quadratic number patterns was later identified as another problem-area for the participants, especially when more than the identification of a common second difference and the determination of the general formula were required. These aspects were kept in mind when the topics for the different workshops had to be selected.

Workshop 1 covered the section on financial mathematics, inequalities, and the interpretation of the number of roots of a cubic equation from a graph. Workshop 1 was also devoted to working on such grade 12 topics as sequences and series and coordinates of analytical geometry, as well as compound angles.

Workshop 3 covered grade 11 sections on inequalities, using graphs and algebraic solutions, in the first day. This is because of the lack of improvement in these sections between the pre- and post-test in the first workshop in 2012. The possible reasons provided by the workshop coordinator, to account for the lack of improvement in teachers' knowledge in these sections, were that they might have been rushed through these sections and that serious misconceptions were still evident among participants. On the second day, the linear graph, parabola, hyperbola, and exponential graphs were covered. Financial Mathematics was dealt with, for the third time in 2011. The workshop focused on compound interest, nominal and effective interest, future and present values annuities and problems where formulae had to be modified like deferred annuities and outstanding balances on loans. Part of the next day was used to complete this section; then, the workshop looked at calculus, linear programming (for the second time in 2011), and trigonometry.

Workshop 5 focused on challenging questions on sequences and series, solving trigonometric equations, and another way of determining the general solution of trigonometric equations. This is because the workshop coordinator felt that a "modern" method she presented was simpler and linked better with tertiary work. Number patterns were also dealt with in workshop 5.

Workshop 8 covered trigonometric equations and identities, as in workshop 5. Circle geometry was also done in this workshop. The teachers requested that more time be spent on grade 10 Euclidean geometry before moving on to grade 11 circle geometry, as they were not taught that section when they were in school. As a result, they lack background knowledge on and experience in this section. This highlighted some of the teachers' inability to study an unfamiliar work section on their own.

It must be emphasised that Financial Mathematics was new to the curriculum. A mathematical investigation on this section, as part of continuous assessment, was also designed by the workshop coordinator, at the request of the participants; however, it did not work well. The workshop coordinator suspected that this assessment failed because not all the participants understood this section very well, possibly because not enough time was devoted to this section. However, it must be noted that this topic was covered in many workshops. This discredits any argument grounded on insufficient time, or the way in which this topic was dealt with.

5.3.7 Challenges faced

The challenges faced by the workshop coordinator/mentor regarding the participants or any other aspect of the workshops are highlighted in this section. This information might be useful in attempts to clarity certain aspects of the research, or when drawing conclusions after the interviews have been analysed.

In workshop 1, the teachers had to report back after they worked through the lesson preparations, using grade 12 topics. However, the report back session on what they did in their groups did not go well. The mentor suspects that these teachers did not select appropriate examples. This could be due to the fact that they did not understand how to do the lesson preparation properly, or it might also be that not enough time was allocated to this exercise. To remedy this situation, more examples of these sections were handed out to teachers. These examples were from past Independent Examination Board (IEB) and Department of Basic Education (DBE) question papers.

Workshop 2 (which was open to all the Mathematics teachers in the district) experienced challenges of teachers arriving late for the workshop and wanting to

leave earlier. This made it difficult to continue with the workshop, since all the participating teachers were not present during the introduction. The lunch-break timeframes were also not adhered to in that some of the teachers took longer lunch breaks. This caused time constraints that resulted in the partial completion of the planned topics. This forced the workshop organiser to schedule another workshop to cover the remaining sections.

Another time management issue was the slower pace at which workshops progressed, compared to what was planned. This led to a situation where the workshop presenter could not cover all the sections of the workshop as planned (Workshop 2, 10 Feb 2011; Workshop 3, 5-6 Apr 2011). The slower pace of workshop 2 was due to the fact that the teachers' knowledge was not at the level where they were teaching, or due to the workshop being "pitched" at a too high level for the participants (Workshop 2, 10 Feb 2011). Furthermore, in workshop 3, all the sections were not covered as planned (Workshop 3, 5-6 Apr 2011). No reason for this was given. Giving the outstanding sections to the participants as homework was not always an ideal situation, because not all the teachers have the time or desire to work on their own after workshops. Again, workshop 5 experienced challenges in that in the first day only the first eight questions prepared were covered, a number which was far lower than anticipated (Workshop 5, 21-23 Nov 2011). The participants were asked to complete more sections in the evening and present them the next day. In the workshop 10 report, the workshop coordinator admitted that she experienced time management challenges when planning workshops (Workshop 10, 12 Oct 2012).

It must be stressed that the participants were at different competence levels when the PD programme started, as evidenced by the pre-test analysis, further in this thesis. These differences resulted in the participants' differing needs. This made it almost impossible to have an effective workshop in which all the participants could be catered for. An example was the fact that some of the attendees "do not know how to use their own calculators effectively whilst others are very well equipped to teach even some of the more demanding work on finance" (Workshop 2 report, 10 Feb 2011). Some of the teachers were also reluctant to admit that there were areas

that they did not understand. They opted to rather ask their colleagues to assist them. This might have particularly been the case with teachers who were not used to the workshop presenter, that is, a trust-based relationship was not built yet. Another reason could have been language barrier, since the first workshop facilitator was an English-home-language speaker, unlike the participants.

Another challenge derived from the fact that some teachers only taught up to grade 10 level whereas others went until grade 12 level (Workshop 9 report, 24-25 Aug 2012). In other words, some of the teachers did not teach some of the topics covered in the workshop; thus, they might have felt that these topics were irrelevant to their teaching needs at the time. These teachers' lack of interest is captured by the coordinator's hope that "Perhaps they will make time when the situation becomes urgent next year and the topics need to be taught at the grade 11 level" (Workshop 9 report, 24-25 Aug 2012). Clearly, there was a difference among the participants in that way as well, although the ideal situation would have been that all teachers be skilled to teach up to grade 12 level. Thus, a possible recommendation would be that PD programmes first start with basic workshops on topics that are relevant to the teachers of grade 10 learners, before moving to more advanced workshops that focus on the other two FET levels. This might accommodate the difference in the levels of competence and the teaching levels, and could alleviate the duplication of workshops on the same topic. Simply put, the workshop coordinator realised that workshop 9 did not cater for participants who did not teach grade 12 learners. However, all teachers need to be well versed in the content and assessments of all the FET grades. A teacher's job in planning is not complete until the learners' assessment results show that the anticipated objectives have been reached successfully (Adedeji & Olaniyan, 2011: 53). Therefore, assessment is an important attribute of an effective teacher.

In workshop 2, the material prepared mainly focused on cognitive levels 3 and 4 questions (Workshop 2, 10 Feb 2011), extracted from previous examination papers. This was done to sharpen the cognitive abilities of the participants. However, it was difficult for some teachers to manage these questions, especially those who did not yet master work for grades 10 and 11 (Workshop 2, 10 Feb 2011). Thus, a challenge

for the facilitator of the workshops was to pitch at the appropriate level for a diverse audience.

A further challenge resulted from the fact that some of the teachers had to attend workshops forming part of other PD programmes offered in the district. On days when there were timetable clashes, they were forced to choose which workshops to attend. This could have negatively affected both their ability to attend all the workshops on the different topics covered, and their completion of the syllabus, since they missed classes frequently (Workshop 2, 10 Feb 2011). Indeed, teachers needed to leave the school early because they had to travel long distances to the workshops. It must be noted that the issue relating to the fact that some of the teachers had to attend workshops forming part of other PD programmes particularly affected workshop 8 of the PD programme under investigation.

Financial Mathematics was addressed for the third time in workshop 4; nevertheless, the post-test revealed that the majority of teachers "still struggle with the more demanding questions" (Workshop 4, 21-22 June 2011). This was surprising to the researcher. Thus, it became important to determine whether this was due to the workshop coordinator's lack of a progression plan with regard to this particular section, in the light of the different events or challenges mentioned above. The other possibility was that the teachers were just very weak in this section, because they did not have much prior exposure to this topic. The probability topic was done in workshops 2 and 9. However, to "a large extent, gains from workshop 2 had been lost as no work had been done in the intervening months on the prepared exercises". The question remained whether these workshops were conducted effectively, given that repeating exactly the same topics cannot be tolerated and time was of the essence. Indeed, a topic was expected to be done thoroughly once and for all. However, 'probability' was a new topic in the Curriculum and Assessment Policy Statement (CAPS). This curriculum was implemented in grade 10 in 2012, and cascaded to grades 11 and 12 in the consecutive years. The 'probability' topic – which replaced linear programming – together with Euclidean Geometry lend themselves to cognitively demanding questions. 'Probability' had never been in the

compulsory South African public schools' curriculum before. In other words, it was included in the optional third paper, which only a limited number of candidates opted for. So the participants in the PD programme did not teach these sections before, given that the optional third paper was not done by most of the students in rural schools, including those from which the participating teachers are. In a way, this explained why participants struggled to understand these sections even after the first workshop.

The proof that one diagonal of a kite bisects the other at right angle was tackled in workshop 6. However, some of the participants made mistakes as they underestimated the complexity of using congruency to proof this. Misconceptions also existed with the converse of the midpoint theorem of circles. Given that this had to be discussed and clarified, it took up some time. Nevertheless, most of the workshop (which was on a Saturday) was spent on revisiting the six formulae associated with financial mathematics, after this topic was dealt with for the fourth time in workshops. A regular workshop attendee acknowledged that he had difficulty in using the calculator correctly when applying annuity formulae, for instance. The interesting part of this revelation was that this topic was repeatedly covered in workshops. However, this particular workshop did not cover deferred annuity in depth, nor did it tackle balance of a loan and other less straightforward application of this section, due to time constraints. This implied that, even after financial mathematics had been covered for the fourth time, all its challenging sections had not still been discussed. The researcher interpreted this fragmented approach to the topics as an indication that not enough preparation went into selecting the topics for the workshops and that "more time will need to be found to strengthen the teachers' grasp of this topic" (Workshop 6, 16-18 Feb 2012). Again, in workshop 10, the participants experienced challenges with regard to questions on deferred payments and missed instalments, which fall under Financial Mathematics. The workshop coordinator identified Teacher RB as the participant whose Financial Mathematics ability had improved drastically in the course of the PD programme to the extent that he could conduct workshops to assist colleagues on that topic (Workshop coordinator's report, 2012). Nonetheless, while one teacher improved significantly in

terms of his understanding of financial mathematics topics, the question remained how to bring the other teachers to his comprehension level?

In relation to workshop 6, the workshop coordinator still felt that there was “a lack [of] in-depth understanding of the four cognitive levels referred to in curriculum” (Workshop report, Feb 2012). This reflection also revealed the need for most of the participants to improve their own ability on cognitive levels 3 and 4 questions. Another challenge is how to deal with those teachers whose content knowledge was still weak without embarrassing them in front of their peers. A possible solution devised by the workshop coordinator was to work with the relevant teachers alone, on the first day of the workshop series.

The teachers argued the fact that they had not been consulted in the scheduling of the workshops, although the project officials claimed that the workshop dates were chosen consultatively with participants. It might, however, be that some of the participants were not present when these dates were agreed upon.

The answering of questions on grade 11 circle geometry was unsatisfactory. The workshop coordinator suspected that the questions were pitched at a too high level and, in retrospect, thought that she should have started with more “straight forward numerical examples until more confidence had been gained” (Workshop 8, July 2012). The same sentiments were expressed in workshop 10 by the participants. The researcher had difficulty understanding this, as she expected that towards the end of the programme, the participants should have gained more confidence in self-studying unfamiliar sections, even beyond the level of the school syllabus. Generally, the participants did not do the self-study exercises that they were given. This created time delays, as these exercises were then done in the next workshop (Workshop 10; Oct 2012).

It seemed that some of the topics were covered with the intention to improve the results of the post-test and not necessary to enhance the competence and performance of the participants. This deduction was based on the following remark: "… general revision of the new topics in the curriculum would be tackled in preparation for the year end test" (Workshop 10, Oct 2012). This can be detrimental to the teachers' PD, since measuring the improvement (or lack thereof) of the participants' abilities does not seem to be the ultimate aim of this particular PD programme.

Discussion

It could be concluded that the selection of the topics covered in the different workshops was done by the workshop coordinator, the subject advisor and the participants. This highlighted the programme's flexibility in that it allowed the different stakeholders to make contributions to what was covered in the workshops. This was in line with effective means of implementing a PD programme, since the participants and the district official were consulted insofar as the content of the programme.

Lesson preparations were also discussed and practised in workshops. The provincial requirements of the DoE, notably the one according to which lesson preparation plans should be done by teachers for each lesson, were communicated to the participants in the presence of the Mathematics subject advisor. The presence of the subject advisor in these discussions emphasised that what was done in the PD programme was in line with the DoE's requirements and mandate. This could be perceived as an attempt to implement this programme as a type of reform. Participants were also reminded to keep records of their lesson plans, for every lesson delivered. In a subsequent workshop, opportunities were created to enable the participants to practise the writing out and showcasing of lesson plans. However, the showcasing was unsuccessful. Furthermore, it is regrettable that these discussions on lesson plans came so late in the programme, as this left very little time to refine individual's lesson plan skills and to monitor whether or not the participants implemented this requirement.

Workshop time was also spent on introducing and practising different teaching styles, so as to familiarise the participants with a variety of teaching strategies. This could be perceived as another way of bringing theory and practice together in order to make the implementation of new strategies manageable to participants. More learner involvement, through selecting appropriate strategies, was also promoted.

Workshops were also used to distribute documents/teaching resources from the district. The subject advisor made the grade 12 provincial Mathematics work schedule available to the participants, in Workshop 1. This also created an opportunity for the teachers to engage the district official, as one teacher noticed that revision time was omitted from the schedule. The latter was then adjusted to cater for the noted omission. Later, a slot in the workshop was also used by the subject advisor to enquire about the teachers' progress with the work schedule. The participants whose content knowledge was firmly established were the ones who could keep up with the work schedule and vice versa.

The participants' attendance of the workshops could not be accurately measured, because the researcher was unable to access the attendance registers. However, it seemed that absenteeism was minimal, with the main reasons for missing workshops being the imperative to attend another workshop that forms part of a different PD programme, illness, and family commitments.

After the pre-tests were written by the participants, the workshop coordinator identified challenging topics based on the analysis of the results. The topics covered included sequences and series, financial mathematics, interpretation of the nature of roots, analytical geometry, compound angles, inequalities, functions, inverses and logarithmic functions, linear programming, inequalities using graphs, trigonometric identities, number patterns, geometry, probability, circle geometry, Euclidean riders, calculus, hyperbola, parabola, and exponential graphs. These topics combined the

previous NCS curriculum and the new CAPS document topics. Participants requested more time on trigonometry, although it was already dealt with in a previous workshop. Financial Mathematics, probability, and geometry were the other topics that were discussed in more than one workshop, with financial mathematics reappearing the most. The reason for the recurrence of these topics in several workshops might be that they were dealt with in a fragmented manner. This created the impression that there was no clear plan as to how these topics would be covered. Another reason could be that the workshop coordinator underestimated the extent of the gaps in the participants' content knowledge. Thus, she pitched the first workshops on the abovementioned topics too high and had to, later, come back to them. However, such a repetition could hinder the effectiveness of the PD programme.

Numerous challenges were faced in relation to the use of workshops as intervention for the professional development of the participants. These challenges ranged from participants arriving late at the workshops and excusing themselves early, time management issues on the part of both the workshop coordinator and the participants, and teachers' differing needs, abilities and teaching levels to clashes between workshops pertaining to the investigated PD programme and those forming part of other PD programmes that some of the teachers had to attend in the district. Nevertheless, the main aim of the workshops was to strengthen the content knowledge of the participants. It must be noted that the content knowledge of the participants improved in Financial Mathematics and in inclination angles, which is a section of trigonometry. The main issue here was whether this small improvement justified the time spent on these topics in the workshops. What is more, the interviews sketched a different picture of how the teachers experienced the workshops.

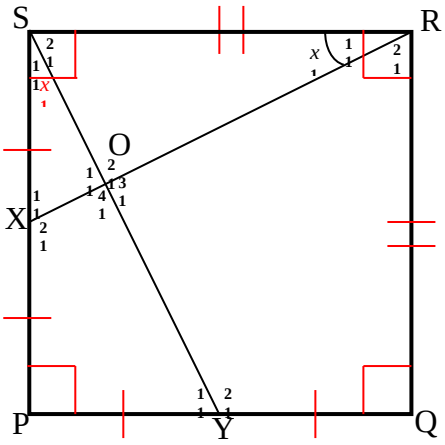
5.4 PROFESSIONAL LEARNING CLUSTERS

Professional learning clusters offered teachers in the same vicinity the opportunity to meet, in an attempt to create spaces where communities of practice could be

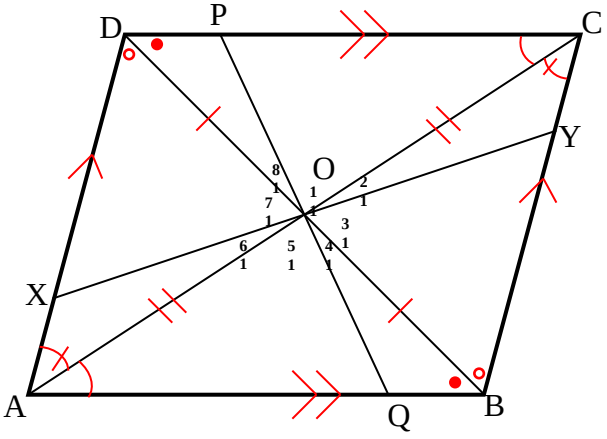
formed. These spaces could enable teachers to learn from each other. The PD programme under investigation also had cluster meetings which were regarded as vehicles for professional development. The reports on these meetings were analysed by the researcher.

The researcher had two professional learning cluster (PLC) reports at her disposal, one dated 6 July 2012 and the other 25 August 2012. Both the corresponding cluster meetings were facilitated by the second mentor. The first one was attended by 3 participants, as one of them was sick and the other attended a workshop relating to another PD programme. It must be noted that the subject advisor was also on sick leave. This PLC covered grade 10 Euclidean Geometry; the discussion focused on the analysis of nine different geometric problems. Below are two examples of these problems.

3) PQRS is a square. X is the midpoint of PS, and Y is the midpoint of PO.
   a) If $\hat{R}_1 = x$ show that $\hat{S}_1 = x$
   b) Determine 4 angles each equal to $90^o - x$
   c) Prove that SY⊥XR



4) ABCD is a parallelogram. PQ and XY are any straight lines through O, the point of intersection of the diagonals.
   a) Prove that XO = OY
   b) Then prove that PYQX is a parallelogram



The focus of these problems was on quadrilaterals. Participants were assisted on how to write down the solutions to the riders, and alternative solutions were also included. On the PLC meeting held in August 2012, only one participant was absent. However, the meeting did not cover what was planned for that day, because participants had a different agenda in mind. They wanted a meeting with the project manager to discuss their views on the implementation of the PD programme. This request was forwarded to the relevant people; but, the gathering was unproductive, given the distances that they had to travel to attend the meeting.

Discussion

Only two professional learning cluster reports were accessed. The second PLC meeting was unproductive as it did not cover what was planned. It could, therefore, be concluded that PLC meetings did not happen regularly; as such, they could not be viewed as an influential factor in the professional development of the participants.

5.5 RESULTS OF THE PRE- AND POST-TESTS WRITTEN BY THE PARTICIPANTS

The results of the pre- and post-tests were analysed to assist the researcher in answering the first research question pertaining to the content that was covered in the workshops, among other things. As mentioned in section 5.1, pre- and post- PD programme tests were taken by the participants. These tests related to the following topics: inequalities, convergence, sequences and series, non-routine annuity, calculus application, linear programming, compound angles equations, trigonometry graphs, and three-dimensional trigonometry. Understandably, all the FET topics could not be included, because of the limitations associated with a three-hour test.

The results of these tests were analysed using the SPSS, particularly the Wilcoxon Signed Rank Test of the SPSS. The choice of this test for the analysis of these data was motivated by the fact that it is designed to be used when “your subjects are measured on two occasions, or under two different conditions” (Pallant, 2007: 223).

The teachers' scores were converted to ranks; then, the two different occasions' scores were compared. This was to assess whether or not the population mean ranks differed. The sample size was 5, as this was the number of teachers who participated in the PD programme. However, this small sample size could be seen as a limitation for this test in that significant changes cannot be noticed (Pallant, 2007: 207). In other words, if one wants to see significant patterns using this test, larger groups of participants are needed.

Thus, in assessing whether there was a change between the pre- and post-tests, the *p*-score (significant level) and the *z*-score are important values. When the significance level (*p*-score) of a set of data is equal or less than 0.05, there is a statistically-significant change between the two scores (Pallant, 2007: 225). If that had been assessed, one would have needed to consider the size of the effect (*r*-score). The *r*-score is determined by the formula $r = \frac{z}{\sqrt{n}}$, where *n* is the number of observations over the two tests. The *r*-value can be interpreted as follows: *r* = 0.1 as having a small effect; *r* = 0.3 as having a medium effect; and *r* = 0.5 as having a large effect.

Based on the investigation of the previously-mentioned topics, which formed part of the pre- and post-tests, the following statistical information was obtained:

	Pre-Test Inequality	Post-Test Inequality	Pre-Test Patterns, sequences and series	Post-Test Patterns, sequences & series	Pre-Test Logs & Exponents	Post-Test Logs & Exponents	Pre-Test Financial Mathematics	Post-Test Financial Mathematics	Pre-Test Calculus application	Post-Test Calculus application	Pre-Test Linear programming	Post-Test Linear programming	Pre-Test Inclination	Post-Test Inclination	Pre-Test Compound angles equations	Post-Test Compound angles equations	Pre-Test Trig graphs & int	Post-Test Trig graphs & int	Pre-Test 3D trigonometry	Post-Test 3D Trigonometry
Mean	40.00	40.00	63.33	80.00	56.00	36.00	26.66	53.33	0.00	20.00	45.33	56.25	11.42	56.66	44.00	32.50	58.66	72.22	22.00	36.00
Std dev	28.28	0.00	41.5	28.28	35.77	38.47	25.27	29.81	0.00	44.72	15.91	6.25	25.55	14.90	30.47	30.10	35.08	16.19	27.74	20.73
Minimum	0	40	0.00	40	20	0	0	16.67	0	0	20	50	0	33.33	0	0	0	50	0	10
Maximum	80	40	100	100	100	100	66.67	100	0	100	60	62.50	57.14	66.67	100	62.50	93.33	88.89	70	60

Table 5.2: Pre- & post-test statistics of teachers

	Equations & Inequalities	Patterns, sequences & series	Logs & Exponents	Financial Maths	Calculus application	Linear programming	Inclination Angles	Compound angles equations	Trig graphs & intercepts	3D trigonometry
z-score	0.00	-0.73	-1.134	-2.07	-1.0	-0.677	-1.786	-1.289	-0.944	-1.298
p-score/Asymp Sig	1.000	0.465	0.257	0.038	0.317	0.498	0.074	0.197	0.345	0.179
Effect Size (r)	0	0.23	0.359	0.655	0.316	0.214	0.565	0.408	0.299	0.408

Table 5.3: Pre- & post-test scores of teachers' statistics

Below are examples of questions that fall under some of the headings of topics contained in Table 5.3:

Topics	**Examples**
Equations & inequalities	Find x where $\frac{(x-3)(x+3)}{3x} < 0$
Patterns, sequences & series	Find the general term of: 5; 12; 29; 48; 77.
Financial Maths	A computer is purchased for R16 000. It depreciates at 15% per annum. Determine the book value of it after 3 years if depreciation is calculated according to the straight-line method.
Calculus application	Determine the maximum volume of a rectangular prism with $Volume(x) = (5x)(x)(9-2x)$
Inclination angles	Determine the angle of inclination between points A and B.
Compound angles equations	Prove that $\cos(3A) = 4\cos^3 A - 3\cos A$
Trig graphs & intercepts	Draw the graph of $y = \cos(x + 30°)$. Show all the turning points and the point where the graph intersects with the axis.

Table 5.4: Examples of headings in pre- and post-tests.

In Table 5.3, the inequality topic's results show no statistical significance, as the *p*-score (also called the significance level) was 1.00, this is higher than 0.05 which is the benchmark figure for the *p*-score. The only two topics that indicated statistical significance levels were Financial Mathematics and Inclination (trigonometry section), with *p*-scores of 0.038 and 0.074, respectively. The Inclination topic's *p*-score is more than 0.05 but also the closest to it, since all the other *p*-scores were more than 0.1. The positive sign of the *z*-score indicated that the pre-test scores were more than those of the post-test, and the negative sign is assigned when the post-test scores were more than to those of the pre-test (Pallant, 2007: 222). The negative *z*-scores of these two topics indicated that the participants' knowledge improved in relation to these two topics. This improvement was significantly large, as the effect sizes (*r*-value) for both the Financial Mathematics and Inclination topics were respectively 0.655 and 0.565, which are values associated with a large effect. With regard to the Financial Mathematics topic, all five participants' results improved from the pre- to the post-test. In relation to the Inclination topic, four participants' results improved after the pre-test whereas one participant's marks decreased after

the pre-test. The improvement in Financial Mathematics could be due to the significant amount of time spent on this topic in the workshops, as described in section 5.3.6 and Table 5.1.

This section did not indicate that a significant amount of workshop time was spent on Inclination. These statistics also revealed a lack of significant changes in the pre- and post-test scores of the teachers in the remaining eight topics. In other words, after the teachers' involvement in the PD programme for more than two years, during which time workshops and class visits were conducted, their competence in terms of the content did not improve, as revealed by the tests.

Teacher	Pre-Test P 1	Pre-Test P 2	Pre-Test Ave	Post-Test P 1	Post-Test P 2	Post-Test Ave
SR	60.6	59.3	60	66.6	61.3	64
RB	62	50	56	72	77.3	74.6
SB	84.6	79.3	82			
NK	51.3	56.6	54	54.6		
MK	47.3	45.3	46.3	42	50	46
Average	61.2	58.1	59.6	58.8	62.8	61.5

Table 5.5: Overall pre- & post-test marks of the teachers in %

Table 5.5 represents the overall performance of the teachers in the pre- and post-tests. The open spaces relating to Teachers SB and NK imply that they had some missing scores for the post-test(s), due to Teacher SB not writing the test and Teacher NK's test script getting lost in the process of its being couriered from the marker. It is important to note that Teacher SB's pre-test results were the highest for both papers and that his pre-test marks' average was 82%, that is 22% higher than the average of the participant with the second highest marks. It could be assumed that his post-test results would have been as high as those of his pre-tests, or even better, if he had managed to write the latter. Thus, their incomplete scores made the

analysis of these two teachers' results a challenge. However, the overall changes in the scores were not significant, except for Teacher RB. Teacher MK's scores dropped, based on a comparison of his pre-test and post-test. It can thus be concluded that there was no significant change in the content knowledge of the participants, with the exception of Financial Mathematics and Inclination.

5.6 ANALYSIS OF THE FOUR SCHOOLS' GRADE 12 LEARNERS' EXAMINATION RESULTS FOR THE PERIOD 2010-2013 AND ONE SCHOOL'S GRADE 9 LEARNERS' EXAMINATION RESULTS FOR THE PERIOD 2011-2013

Kelleher (2003: 752) stresses that the evaluation of the effectiveness of a PD programme should be based on the effect of the teachers' professional development on learners' learning. Hence, the participating teachers' learners' results were analysed to assess the possible effect of the teachers' involvement in the PD programme on their learners' performance.

Thus, the 2010-2013 grade 12 results of School B, School C and School D, as well as the 2011-2013 grade 9 results of School A' were analysed. The aim of this analysis was to investigate whether the teachers' involvement in the Mathematics PD programme had an effect on the results of the learners. It suffices to observe that many countries conduct PD programmes as a way of enhancing learner outcomes (King, 2014: 89), based on the view that "the only way to improve outcomes is to improve instruction" (McKinsey & Company, 2007: 26). In the South African context, grade 9 and grade 12 represent exit levels for the Senior Phase and the FET Phase, respectively, although learners only write national examinations in grade 12. These grades are therefore important in the lives of learners and have implications for the rating of schools. Thus the decision to use the grade 12 results of School B, School C and School D as well as the grade 9 results of School A which did not have grade 12 learners at the time.

Results per school

The tables and graphs below present the results of the four schools. The different schools were given pseudonyms, namely, School A, School B, School C, and School D, respectively. The tables and bar charts presenting the data were compiled or drawn – as a means to analyse the data – by comparing the different years. The details on each school are provided below.

School A's Mathematics results 2011-2013

School A did not have grade12 learners for the 2010-2013 period. Consequently, its grade 9 end-of-year examination results were used, since grade 9 signals the end of the Senior Phase in South Africa. It must be noted that grade 9 learners also write the Annual National Assessments (ANA) which could also have been used. However, only the 2012 and 2013 results were available; hence, the researcher decided to only use the-end-of-year results of three consecutive years as these were available and ready for comparison. Nevertheless, it must be noted that only the 2011-2013 results of School A could be obtained, its 2010 results were not included, unlike the other schools. The grade 9 results of School A – for the 2011-2013 period – were as follows:

	2011	**2012**	**2013**
0 – 29	7 = 53.8%	5 = 41.7%	0
30 – 39	1 = 7.7%	6 = 50.0%	4 = 50.0%
40 – 49	4 = 30.8%	1 = 8.3%	3 = 37.5%
50 – 59	1 = 7.7%	0	1 = 12.5%
Total	**13**	**12**	**8**

Table 5.6: School A's Mathematics results 2011 - 2013

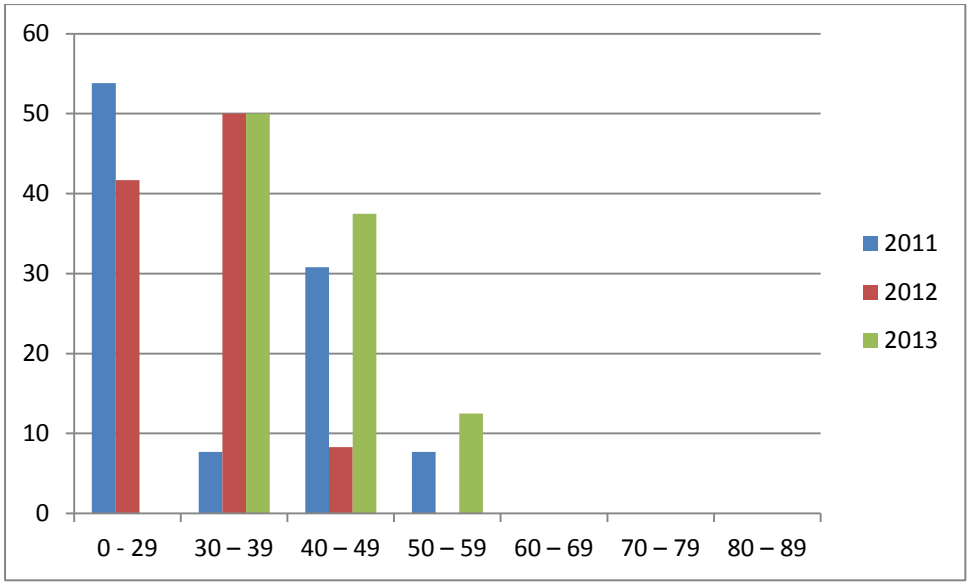


Figure 5.1: Graph of School A's Mathematics results 2011 - 2013

The number of grade 9 learners in School A between 2011 and 2013 was generally small, with 2013 registering the lowest number – eight – of learners writing the examination. Nonetheless, there seems to be an improvement in School A's grade 9 results between 2011 and 2013. However, in 2012, no learner got a score above 50%, which was an indication that the learners in that year were quite weak. In none of the years did any learner obtain a score within and above the 60% range. Overall, it seems that 2013 was the best year for School A in terms of its grade 9 learners' results.

School B's Mathematics results 2010-2013

	2010	2011	2012	2013
0 – 29	5 = 29.4%	1 = 16.7%	3 = 21.4%	4 = 40%
30 – 39	7 = 41.2%	2 = 33.3%	4 = 28.6%	3 = 30%
40 – 49	3 = 17.6%	3 = 50.0%	1 = 7.1%	1 = 10%
50 – 59	0	0	0	1 = 10%
60 – 69	1 = 5.9%	0	3 = 21.4%	1 = 10%
70 – 79	1 = 5.9%	0	1 = 7.1%	0
80 – 89	0	0	2 = 14.3%	0
Total	**17**	**6**	**14**	**10**

Table 5.7: School B's Mathematics results 2010 - 2013

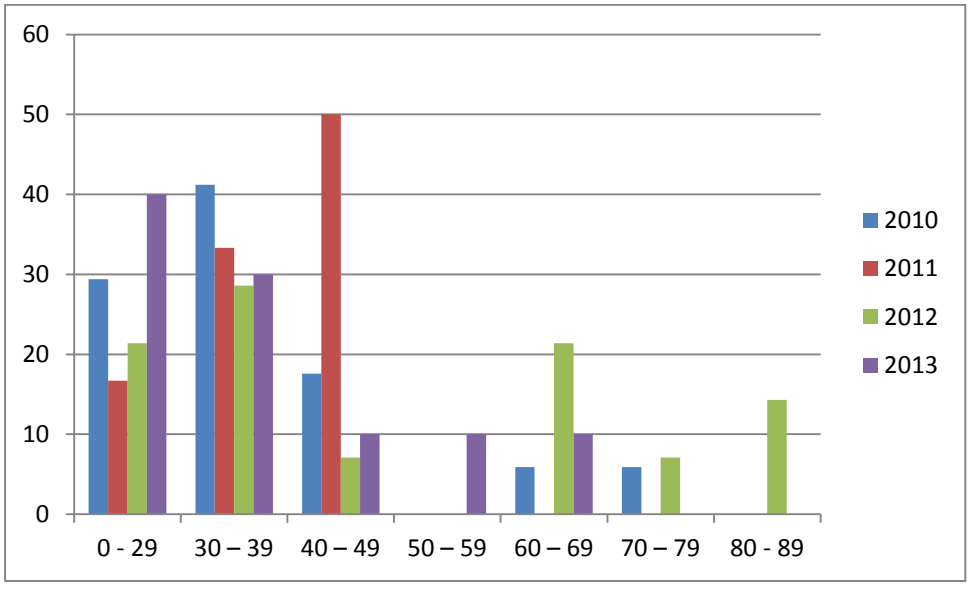


Figure 5.2: Graph of School B's Mathematics results 2010 - 2013

The number of learners who wrote grade 12 Mathematics examinations in School B was fairly small, with 2011 having the lowest count – six learners. There seems to be an improvement in the grade 12 examination results of School B between 2010 and 2012. Nonetheless, the 2011 results reveal that no learner obtained marks above 50%, which indicates poorer results compared to those registered in 2010, 2012, and 2013. In 2010, one learner obtained a mark within the range of 60% and another within the 70% range. In 2012, 57.1% of the learners scored below 50%, and two learners obtained distinctions (above 80%). This is a significant improvement, given that the total number of learners in 2012 was higher than that of 2011. In 2013, 80% of the learners obtained marks below 50%, and only 2 learners obtained results above 50% but not exceeding 70%. This was School B's worse performing year, compared to 2012. Overall, it seems that 2012 was the best year for School B, although more or less half of its learners performed below the 50% mark and the other half above. The grade 12 results of School B fluctuated from year to year.

School C's Mathematics results 2010-2013

	2010	**2011**	**2012**	**2013**
0 – 29	15 = 62.5%	26 = 74.3%	4 = 26.7%	16 = 80%
30 – 39	5 = 20.8%	6 = 17.1%	6 = 40.0%	0
40 – 49	4 = 16.7%	1 = 2.9%	2 = 13.3%	2 = 10%
50 – 59	0	1 = 2.9%	1 = 6.7%	2 = 10%
60 – 69	0	1 = 2.9%	1 = 6.7%	0
70 – 79	0	0	0	0
80 – 89	0	0	1 = 6.7%	0
Total	**24**	**35**	**15**	**20**

Table 5.8: School C's Mathematics results 2010 - 2013

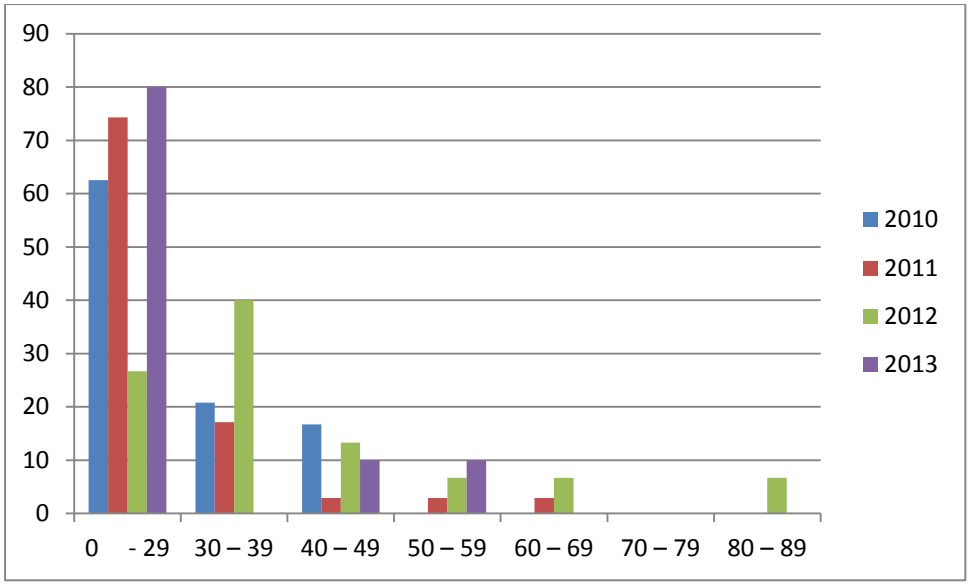


Figure 5.3: Graph of School C's Mathematics results 2010 - 2013

The number of learners who wrote the grade 12 Mathematics examination in School C was slightly higher than that of School B. In 2010, none of the learners obtained marks above 50%, and 62.5% of the learners' marks were below 30%. In 2011, (the following year) 74.3% of the learners obtained marks below 30%. This is higher than the previous year. In contrast, only one learner got within the 60% and 70% range. In 2012, the number of learners with marks below 30% decreased to 26.7%, which is significant improvement, compared to the previous two years. However, 80% of School C's learners obtained marks below 50%. This was also the only year, in the period considered, that one learner from this school obtained a distinction in Mathematics. This is an exploit, considering that no learner from School C has ever achieved a mark within the 70% band. However, in 2013, the grade 12 marks of School C dropped significantly, as 80% of its learners' scores fell in the below 30% band. Only two learners (10%) obtained marks above 50%.

School D's Mathematics results 2010-2013

	2010	2011	2012	2013
0 – 29	10 = 45.5%	2 = 25.0%	5 = 38.4%	11 = 61.1%
30 – 39	7 = 31.8%	1 = 12.5%	5 = 38.4%	2 = 11.1%
40 – 49	4 = 18.1%	2 = 25%	2 = 15.4%	3 = 16.6 %
50 – 59	1 = 4.5%	1 = 12.5%	1 = 7.7%	1 = 5.6%
60 – 69	0	1 = 12.5%	0	1 = 5.6%
70 – 79	0	1 = 12.5%	0	0
80 – 89	0	0	0	0
Total	**22**	**8**	**13**	**18**

Table 5.9: School D's Mathematics results 2010 - 2013

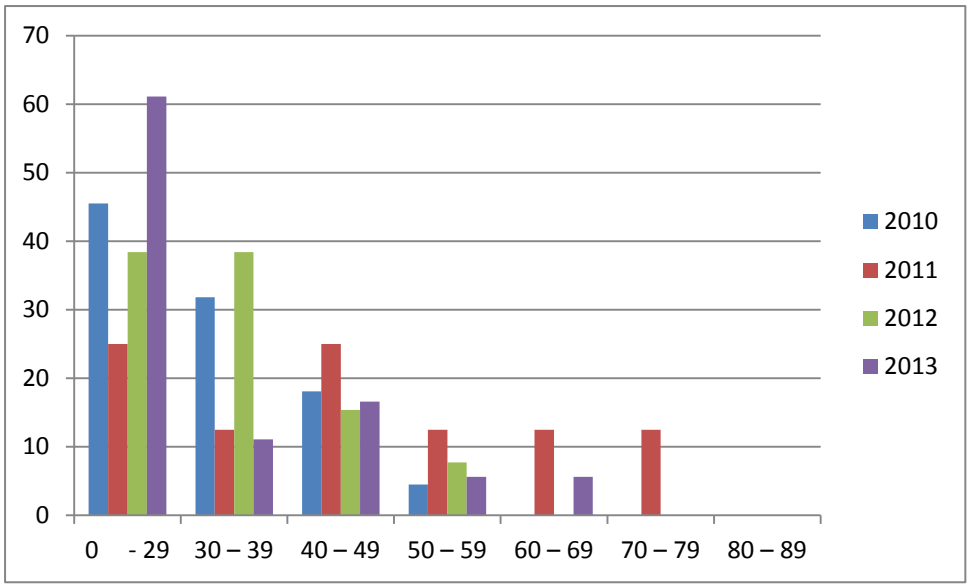


Figure 5.4: Graph of School D's Mathematics results 2010 - 2013

The number of learners in School D who wrote Mathematics in grade 12 in the 2010-2013 period fluctuated significantly, with 2010 having the most grade 12 learners. Interestingly, 2010 was the year with the second highest percentage of learners (45.5%) who scored below 30% in the examination. Only one learner obtained marks above 50%, leaving 95.5% of the other leaners with marks below 50%. In 2011, the spread of marks was relatively even. Indeed, this year registered the smallest number of learners with marks in the lowest band. Just more than half of the learners obtained marks below 50%, while only one learner's marks were in the 50%, 60%, and 70% bands. Thus, 2011 can be regarded as the year with the best results, compared to the other three years. The analysis of the 2012 results reveals that a significant number of learners scored in the lowest band (38.4% of the learners). Only one learner obtained a mark above 50% in the examination. The Mathematics results of 61.1% of the 2013 cohort of School D learners were clustered in the lowest band. This is the year with the most learners in the lowest band. Indeed, 88.8% of the learners obtained marks below 50% in that year, leaving only two of the 18 learners (11.2%) above the 50% mark.

The results were analysed using the SPSS, in particular the Friedman Test. This test was used because it is appropriate when analysing data derived from the same sample cases which are measured at three or more points in time, or under three different conditions (Pallant, 2007: 228). As the data were collected over three years (for School A) and four years (for the other schools) and suited other descriptions, it was appropriate to use this test. If there were significant positive or negative changes to the learners' performance, the tests' significance levels (Sig. level) would have been less than 0.005 (Pallant, 2007: 230). The significance levels for the different schools were as follows:

Schools	Significance levels	
School A	Between 2011 & 2012	0.574
	Between 2011 & 2013	0.104
	Between 2012 & 2013	0.001
School B	0.746	
School C	0.484	
School D	0.504	

Table 5.10 Significance levels of learners' results per schools

These results indicate the lack of significant differences in the learners' results in the period 2010-2013 for School B, School C and School D, since their significance levels were above 0.005. It could also be noted that these significance levels were far above the threshold figure of 0.005. This implied that there was no improvement in the learners' performance at the mentioned schools where the PD programme was rolled out. However, in the case of school A, the analysis of grade 9 results showed a significant change in the learners' performance in the period 2012-2013, as the significance level was 0.001, which was less than 0.005. Although a significant change was evident, its scale was small scale in terms of the significance level's magnitude. However, the small numbers of the schools' cohorts could have had a negative influence on the test. Nonetheless, it can be concluded that the PD programme did not achieve its goal of improving the learners' results. This answered research question 3.

It suffices to reiterate that learners' performance is directly related to their teachers' competence and performance. The researcher agreed with Adler and Davis (2006: 279) that, due to limited human resources, the competing goals of reforming could account for the fact that these learners' results did not improve in the timespan under investigation. The majority of the participants had very heavy teaching loads, as described in section 5.6; this resulted in limited time for professional development initiatives to be reflected upon. A significant amount of PD interventions was spent on improving the participants' content knowledge, especially in the workshops.

However, in the mentoring sessions, the mentor claimed that the focus was on the areas of the lesson that could be improved, the choice of examples used in the lesson, and whether learners' books were monitored by the teacher. This signified that participants were exposed to sessions where they had more practice on content issues, but did not get much support on their pedagogy and innovative practices. So it is unlikely that these teachers' classroom practice improved, despite the fact that it is an important aspect of the effort to improve learners' performance. The fact that the participating teachers had a limited initial content knowledge, as reflected in the pre-test results, limited the development of their competence and performance in areas others than understanding the content of sections mentioned in 5.3. It also became evident that teachers only started working on improving their written lesson preparations in the last year of the programme (2012). This indicated that for the better part of the programme, the participants did not focus on lesson preparation. This is in line with Killen's (2010: 84) claim that one "cannot expect individual lessons to be successful if they have not been planned thoroughly and integrated carefully into medium and long term plans". Clearly, the classroom practices might not have been adequately planned for the majority of the programme's duration; as a result, they might not have been effective. This could explain the lack of improvement in learners' performance.

The next chapter focuses on the analysis of the primary data sources, namely, the interviews that the researcher conducted with the participants, the mentor and the programme executive manager, as well as the lesson observations done by the researcher.

CHAPTER 6

ANALYSIS OF PRIMARY DOCUMENTS

6.1 INTRODUCTION

This chapter analyses and discusses the primary data pertaining to the Mathematics PD programme under investigation. The data sources included the interviews with the teachers, the programme executive manager and the first mentor, as well as the lesson observations done by the researcher. This data analysis sought to obtain answers to the first and second research questions.

6.2 INTERVIEWS WITH THE PARTICIPANTS, THE FIRST MENTOR, AND THE PROGRAMME EXECUTIVE MANAGER

Interviews were conducted with the five participants in the PD programme, the first mentor who was also the workshop facilitator for two years, and the programme executive manager. These interviews – together with the class observations done by the researcher – were the only primary data sources. These data collection methods were deemed appropriate, especially considering that the researcher was not present during the running of the investigated PD programme.

6.2.1 Analysis of interviews with the participants

Open-ended interviews were conducted with the five participants (see Appendix 5 for the interview schedule that was used). Two interviews were done with Teachers NK, RB, and SR. The second interview was necessary because, after the first interview, the researcher identified areas that needed to be clarified. It must be noted that Teacher MK was only interviewed once; this is because he did not teach Mathematics at the time and therefore was one interview sufficient. Similarly, Teacher SB, who was acting principal, was only available for one interview. These interviews were conducted to elicit the participants' view on their involvement in the investigated PD programme, that is, how they experienced the workshops and

mentoring session, and to establish whether this programme has had an effect on their development as teachers. The participants were also requested to make recommendations as to how the subsequent roll-out of this PD programme could be improved.

The data obtained from these interviews were also used for triangulation purposes in that they were related to those gathered from the mentor's lesson observation reports and the researcher's own lesson observations. This is in line with the view that combining different methods of data collection could strengthen a study (Patton, 2002: 247). The richness of the data collected would become evident during the integrative analysis (Joubert, 2005: 38).

Each participant's interviews were analysed using the categories identified through the literature review. These categories were almost the same as those used to analyse both the mentor's lesson observations and reports. This was so as to enable the triangulation of the data. These categories corresponded to possible areas of development in terms of preparing and conducting lessons, year work scheduling, assessment-related development, the role of both the workshops and mentoring, as well as other areas of development through the PD programme. Some of the questions related to possible recommendations on how the future implementation of this PD programme in another district could be improved. The data acquired could assist in answering the first two research questions. Both background information on each participant and the headings were provided in section 5.2 of Chapter 5; hence, they were not repeated in the sections below.

Nevertheless, it must be added that Teacher MK was the Mathematics HOD at School C. He continued to be involved in the investigated PD programme, despite the fact that he predominantly taught PS when the school received a new staff member who mostly taught Mathematics. Generally, he was very pleased with his involvement in the PD programme and manifested his willingness to partake in the programme from its introduction. This is evident when he states that: "… I was willing

to be involved in the project" (Interview with MK, 17 April 2013: 2). It must be emphasised that this teacher came from an intermediate school in 1996; as such, he did not teach Mathematics in higher grade before joining School C. This means that, before, he did not teach such topics as probability. This might account for his having the lowest score in both the pre- and post-tests. His inability to fluently speak English was also evident in the interview.

6.2.2.1 Possible development in terms of preparing and conducting lessons

Killen (2010: 84) observed that "you cannot expect individual lessons to be successful if they have not been planned thoroughly and integrated carefully into medium and long term plans". Therefore, this study explored the degree to which lesson preparations were done by the participants. In a lesson plan, a teacher should indicate the intended outcomes of the lesson, and identify the teaching strategies to be applied, the assessment to be incorporated, activities to be done by the learners, and the selected content (ibid). For a teacher with strong learners, decisions on the above aspects would be easier than one with weak learners. Given that the investigated PD programme was implemented in schools where learner performance was generally poor in Mathematics, as the study sought to establish whether development took place in terms of lesson preparation and delivery.

Teacher MK

Teacher MK was convinced that his lesson preparation was appropriate until guidelines were provided in the PD programme:

> …you know the way we use to do some lesson plans … it's just only things that maybe we think is right to do. But when the project now came in, we (were taught): For a lesson preparation you must do one, two, three. That is how a lesson plan must look like (Interview with MK, 17 April 2013: 13).

The participants were also made aware of the need to include the solutions to the classwork in the lesson preparation, to prevent them from being embarrassed in class:

If the learners … don't understand how to solve the problems, you have the solutions … (Don't go) to your class saying that I will just find the solutions in the class. Then it will be embarrassing you see? (Interview with MK, 17 Apr 2013: 13)

When asked whether he was still doing his lesson plans as taught in the PD programme, Teacher MK replied: "Ja, the way (the workshop facilitator) taught us" (Interview with TMK, 17 April 2013: 14). Based on the fact that Teacher MK was the HOD, the researcher asked him whether he checked the lesson plans of the teachers on his team. His response was as follows:

Not so much. I just look at them because you even can see I have to do everything here and then have five classes to teach and then I have to check everything and then I have to moderate and I have to mark my learners books and it is a lot of things (Interview with MK, 17 April 2013: 14).

It could, therefore, be concluded that the HOD did not regularly monitor whether his team was doing lesson preparations. He did not even check or assess the standard of the lesson preparations that he had the opportunity to look at. This was a major concern, since it is the HOD's responsibility to check whether staff were doing lesson preparations and to guide and support those whose lesson preparations were substandard. The monitoring and evaluation of teachers' work is an important way of ensuring good results in schools (Adedeji & Alaniyan, 2011: 78). However, one must also sensitive to Teacher MK's huge teaching load. It should be noted that the Mathematics team taught the entire school's learners, because it was compulsory for all learners to take either Mathematics or Mathematical Literacy as a subject. This was different from the past when, in South Africa, Mathematics was optional. This interview did not reveal anything regarding Teacher MK's lesson delivery. This is because the researcher did not do lesson observations with him, given that Teacher MK only taught ML and not pure Mathematics.

Teacher NK

In the workshops, the participants received guidance on how to do lesson preparations. This is evidenced by Teacher NK who recognises that:

(The workshop facilitator) showed us how we prepare the lessons. So we did it at the workshop and used them in the class (Interview with NK, 17 April 2013: 2).

The interview revealed that Teacher NK learnt more on how to prepare a lesson and how to conduct learner-centred lessons, instead of teacher-centred ones, through mentoring:

I've learnt most of the things how to prepare a lesson, well I don't have to talk too much in class. These learners need to write; I have to give them something to write so that they know. So if I can talk every day throughout the lesson, they will be empty (Interview with NK, 17 April 2013: 5).

The PD programme interventions assisted this teacher to move away from being the centre of the class and allow the learners to play a more prominent role in class, and taught her to allow the learners to write more and participate more in the lesson. As a result, she gave her learners more classwork. This implied that Teacher NK's role changed to that of a facilitator in the class, due to her involvement in the investigated PD programme. As a matter of fact, she moved around in class instead of merely standing at the front, as she used to do. This is evident when she states that:

[I] move around, checking whether they are doing their work because if I can give them work and just sit down there, some of them are not going to write … Talking less and giving them work to do and moving around, checking whether they are writing or are they just... So they have to do most of the work (Interview with NK, 17 April 2013: 5).

Clearly, the PD programme has not only enabled Teacher NK to increase her visibility in class, but it has also helped her to enhance her learners' involvement with class activities.

Teacher RB

Teacher RB described how his lesson preparation had changed as a result of his involvement in the PD programme. He acknowledged that he did lesson preparation before the implementation of the programme, but added that he was doing it differently now:

You know before JET came in I was using textbook ... In the textbook, you find that you want to do a sum like that one that I was writing on the board … quadratic (function patterns). You find that the textbooks have got only 2 quadratic (function patterns). Now in order to formulate your own thing: The textbook sometimes cannot help you reach your objective. You ought to know what you want to do so that you can formulate your own similar sequences. Only one was from text book. The rest I had to formulate it because the textbook is only managing to give me 2 (examples). Then I took from

that… It move you away from the schedule … It can take you away because textbook is not formulated in a way that it is structured according to the work schedule. And again the textbook add other aspects that sometimes are not in line with the work schedule. Now following the textbook, the textbook can mislead you. Make sure that you know the document by heart before you follow the textbook. You can know heya - this one- I am not gonna use that. Learners must know this. Skip this one, and this one (Interview with RB, 17 April 2013: 3).

An example of a quadratic function pattern that was on the board is provided below:

$3;6;11;18;...$ and the general formula is $T_n = n^2 + 2$.

It has been revealed that 71% of the South African Mathematics teachers use of the textbook as basis for instruction (Mullis, 2012: 395) in contrast to using worksheets or the use of other sources to improve the understanding of concepts. Teacher RB discovered that the "textbook" method of teaching or preparing a lesson was not the ideal way and that it presented some challenges. One of these challenges was the fact that textbooks were not necessarily written according to the work schedule. This resulted in him wasting class time on work that was not stipulated in the work schedule. The "textbook" also failed to offer examples that allowed for a gradual progression from lower order to higher order aspects, neither did it have enough examples that would enable the learners to thoroughly understand the content. Thus, the PD programme assisted him in preparing lessons that were on par with the work schedule and that allowed for a gradual progression in the different difficulty levels. Teacher RB indicated that the programme had also assisted teachers to formulate their own examples in cases where the textbooks did not have enough examples that would ensure a smooth progression through the different levels of difficulty. The fact that teachers were able to choose or formulate appropriate examples ensured a logical progression from one level to the next and made their lessons more effective.

Teacher RB also explained that the PD programme empowered teachers by equipping them with lesson preparation resources that they could use. As he puts it:

… JET has really helped us with so many things. We've got lesson plans that we have planned, we've got resources – lots of resources in terms of grade 12 if you want to do whatever – everything is at your disposal (Interview with RB, 17 April 2013: 4).

It becomes evident that the workshops helped Teacher RB to develop or write more appropriate lesson preparations and provided him with useful class resources.

In the workshops, Teacher RB also learnt new ways of introducing a lesson. As a result of the development of his computer skills through the PD programme, he was able to use the multimedia tool to put pictures on the screen to help learners to better understand the concepts at the centre of the lesson:

… you can also bring in the pictures so that they can formulate terms sequence using pictures. It is nice if you also bring in again in picture, after they managed to see what is a sequence – like tomorrow I can ask them to bring pictures then they formulate sequences to see whether they can (interpret) the picture. When you start a lesson, you can start in that way. Throwing the pictures, they formulate the sequences and then from there, they now say: Ok what will be the nth term there? (Interview with RB; 17 April 2013: 6)

With regard to the question on whether he can still develop in terms of teaching strategies, Teacher RB acknowledged that there was still room for improvement. He further explained how his approach to the presentation of his lesson had changed:

Ja I can say that the way that I was teaching before was teacher-centred mostly because you will never be aware that you are teacher-centred until someone tell you or show you – no (Teacher RB) look here – you are preaching too much. Let the kids do this themselves. Be free in the class – do whatever. Make sure that the kids are involved; that's the first thing; the very very first thing. They are involved; you come after the kids. And then you will see their mistakes if you come after them. But if you move before, you give them all the information … They will just say yes, yes, yes and nothing will be grasped for the whole lesson (Interview with RB, 17 April 2013: 2).

Teacher RB acknowledged that the mentor's actual presence in the classroom and her observation of his presentation of lessons made him aware of his mistakes. His attention was drawn to possible areas of improvement that he would not have been aware of otherwise.

Teacher RB further described his shift from a teacher-centred to a learner-centred approach to teaching. This was as a result of the fact that the mentor made him aware that he was talking alone in class, not allowing the learners to participate in the lesson. Previously, the learners simply said 'yes' to what he conveyed to them, as he did not afford them an opportunity to give their inputs in class. Fortunately, that changed to a situation where he allowed the learners to be more involved in the

lesson. He made significant efforts to involve even the learners who were passive, and listened to all his learners' contributions more attentively:

Spoke less yes, spoke less and involve the learners. Take even the one that is not concentrating … He was sitting and watching me like this and you just call that learner so that every time he knows that even if he may be looking into and thinking out, he will know that you are looking at him or her. That thing that you use every one; use every one in the class and try to also listen when you are writing … (with) more activities in class … (Interview with RB, 17 April 2013: 9).

Teacher RB was also able to spot the mistakes that his learners made in classwork after changing his teaching approach; this allowed him to support those learners by assisting them in correcting their mistakes. He also acknowledged that previously he was not patient when learners did not grasp concepts the first time:

… previously, I was moving on top of problems; on top of problems like tomorrow I will end up here, and then I will say that no: This learner is stubborn – I am done with that one. I will continue … (Interview with RB, 17 April 2013: 8).

However, through mentoring, he learnt to wait for learners to respond to what he was teaching and before he moved to the next section, he ensured that the learners had understood the work.

Teacher SB

Teacher SB mentioned that he had been exposed to other PD programmes before. He indicated that he had learnt the following from this specific PD programme:

Like something I pick up from JET is that, after presenting, maybe at the end, you need to just have a wrap up of what you were doing you know because usually in the phase before they (the programme) come, though I have been exposed to a number of projects before JET, I mean I used to leave things like just teach, give learners work; at some stage not even correcting it you see, correcting it the following day. But I have learned that I must just give little … try to correct it within the timeframes of the period and then you can give an extra work in the form of homework (Interview with SB, 7 May 2013: 2).

Clearly, the investigated PD programme assisted Teacher SB in giving learners, in the same period, the opportunity to not only practise the section that was presented to them, but also to correct that classwork the same day. This would enable teachers to assess whether the learners understood the covered section. Teacher SB was

also made aware of the need to give learners homework thereafter. He felt that this way of concluding the period "helped learners to grasp whatever concepts (they covered)" (Interview with SB, 7 May 2013: 2).

Teacher SR

Teacher SR confided that he did not do lesson preparations before the investigated PD programme started. He indicated that the programme had shown him how to prepare for a lesson:

> Before the project I did not have lesson preparation, but now during the project, they showed us how to prepare maths and PS. So it's more advisable for any teacher that whenever you go to the class, you must have a lesson, you must have a plan for the particular lesson (Interview with SR, 15 April 2013: 3).

Teacher SR added that:

> In the past … the knowledge that I had was not enough. So after this project I got more knowledge in such a way that whenever you prepare, you must prepare a certain topic at a time and give learners assessment on that topic so that you see to it that this learner understood you or not (Interview with SR, 15 April 2013: 3).

What could be gathered was that Teacher SR learnt how to do lesson preparation, keeping in mind that he had been in teaching for more than 20 years. He was also taught to only cover a selected section of work per day, to give exercises on it, and then to assess learners on that particular section. In the past, he taught for the entire period, without giving learners the opportunity to do classwork on the covered section. He also did not give them homework or any assessment in class:

> [Previously] I just taught the whole 50 minutes then I give them homework and then leave them, not knowing whether they did understand or not. So those people from the project they said no, it is wrong. Teach them a certain period, give them a chance to work, mark, go around the learners within the class, check whether they are doing the work correctly or not, and it works a lot. Because you cannot teach and leave the learners not knowing if they did understand or not, give them a chance to write and mark (the written work) (Interview with SR, 15 April 2013: 4).

It becomes evident that Teacher SR's classroom practice changed, following his involvement in the PD programme. He started giving classroom exercises to learners and marked them in class, and/or gave learners assessments that afforded them

opportunities to practice the covered section and enabled him to check if they had understood the work.

6.2.1.2 Progress with the year-work schedule

Every grade has an outlined curriculum that should then be managed by teachers, to ensure that they cover it timeously. However, in rural schools, the monitoring of the progress with the curriculum is not always happening. This is due to the remote locations of the schools (Adedeji & Olaniyan, 2011: 49). Nonetheless, proper planning, whether it is medium or short term, is vital to the completion of the curriculum (Killen, 2010: 84). It has been established that schools with poor performance do not complete their curriculum on time or not at all. Hence, this section investigates whether the participants manage their planning effectively.

Teacher MK

Teacher MK was unable to complete the work schedule before the PD programme was rolled out.

> …sometimes we have problems with completing the syllabus but now the syllabus is not much a problem to be completed … Because we have some good knowledge of the subject and we can just teach those topics maybe that may take long, maybe two weeks or maybe three weeks. Even three days then we are ok and then that is why the syllabus now … we can complete – even in grade 12 – then we complete the syllabus in May/June (Interview with MK, 17 April 2013: 7).

Teacher MK indicated that he became able to cover the syllabus in record time, because his subject knowledge had improved through the PD programme. Indeed, when asked whether the syllabus was now finished earlier, Teacher MK replied “ja earlier than before …” (Interview with MK, 17 April 2013: 7). This implied that prior to the PD programme, the syllabus was completed late in the year; whereas after the programme, it was covered earlier, even before the June holidays.

Teacher NK

To Teacher MK, completing the work schedule was a problem in the past, in that, she was unable to complete it in the prescribed timeframe. Her pace had increased following her involvement in the PD programme; however, more improvement still needed to be made:

[The pace] was [a problem] – even now. It was worse in the past. Now it is better (Interview with NK, 17 April 2013: 3).

When asked why she was struggling to keep up with the work schedule, Teacher NK responded:

Sometimes we cannot move to another topic if the learner doesn't understand the topic … So that one delays the process. That's why the other weeks we lag behind (Interview with MK, 17 April 2013: 3).

Teacher NK managed the situation by using extra time, outside the normal class time, to try and compensate for the fact that she was behind the work schedule:

… in order to finish it in time, we use our holidays. We sometimes can come to the school during the holidays; even on Saturday if we don't have things to attend (Interview with NK, 17 April 2013: 3).

Although Teacher NK did not manage the class time effectively, extra time was used outside the normal school hours to finish the work schedule for the year. Nonetheless, class time should be managed more effectively. In other words, a PD programme needs to equip teachers with time management skills that would enable them to complete the work schedule within the allocated school hours.

Teacher RB

Teacher RB did not always manage to stick to the work schedule and, at times, he had to rush through the syllabus. This is due to the fact that his classes had been suspended as a result of circumstances beyond his control:

I managed but at some stage I was a little bit rushing because you know what causes this rushing sometimes like you see this … last week I was off for 3 days (workshop); today you can see that SADTU has taken some of the teachers. Because of the shortage maybe next week there will be something taking up my time. Sometimes when we see that time is now closing; you are anxious in terms of teaching, you then start to panic. You're starting to increase your pace of moving now. Even

as you started … your kids start to see you as someone who is little bit now starting to do what? Starting to be a little bit harsh because they know that this is not your style. What is making you a little bit rushed? This is my weakness. When time is now catching up because something that had happened … not because of me … (Interview with RB, 17 April 2013: 3).

As it becomes apparent, different circumstances affected the smooth running of classes throughout the school year. The SADTU meeting and Teacher RB's attendance of workshops forming part of the investigated PD programme were among the factors that disrupted the normal running of his classes. This caused him to fall behind the work schedule and resulted in him rushing through the syllabus later on, in an attempt to catch up. This situation was unconducive to effective teaching and learning. As a matter of fact Teacher RB confessed that he started to panic and began to be "harsh" with the learners.

Teacher SB

Teacher SB stated that he "never had such a problem" (Interview with SB, 7 May 2013: 2) as not finishing the year's work schedule. However, he admitted that he missed valuable class time when he attended workshops or when he was occupied with his work as acting principal. He made up for that time by having classes over the weekends:

… you normally go like ask learners to come on weekends; like on some Saturdays. And I try to push them (Interview with SB, 7 May 2013: 5).

Teacher SR

Teacher SR was initially unable to complete the work schedule within the prescribed timeframe. The PD programme provided him with new approaches that enabled him to conduct and complete lessons timeously:

It is a problem to finish the work plan because I am having a lot of classes here. I mean 6 classes per day is too much, but I try by all means to finish up the plan. But in the past it was very very difficult ... Ja, after JET chipped in, then I managed to finish everything. But before, it was so difficult. Ja because they just showed us how to teach this topic, the skill of teaching this topic because before we were dwelling much, before JET we were dwelling much on the same topic. This

took up a lot of time. But now they have just given us the direction that we just do this, concentrate on this and that and that. So that is how we can cover the syllabus. You see those skills are very very important from those 2 people (the two mentors). They just give you the overall plan, how to attack it (Interview with SR, 15 April 2013: 4-5).

When the researcher mentioned that she observed that he only dealt with three specific aspects of the section that was in progress, namely, distance, the midpoint, and the gradient in circle geometry, Teacher SR added that:

Because they link, you cannot just take one by one. You are going to waste a lot of time. Group them because you are talking about almost one and the same thing (Interview with SR, 15 April 2013: 5).

Applying this strategy, together with conducting Saturday classes, enabled him to finish the work schedule. These Saturday classes ran between eight in the morning and one in the afternoon. They assisted him to revise grade 11 work slowly with grade 12 learners, to finish the work schedule, and to conduct tests that he could not administer during the regular period due to limited class time:

Saturday class – I usually do it because it is more advantageous: 1) I teach learners the previous work from the previous grade. Grade 11, I revise with them grade 11 very slowly; have enough time and 2) sometimes I use Saturday classes if I am behind with the syllabus so that I can cover it. Sometimes I use the time to write tests because during the period's time, I don't have enough time to let them write tests. So I teach them Saturdays. They will start from 8 to 1 o'clock. Then we go home (Interview with SR, 6 May 2013: 1).

It must be noted that Teacher SR conducted these Saturday classes for all the FET grades.

6.2.1.3 Development in terms of the setting of assessments

Teacher professional development aim at developing teachers and one of these aspects to consider for development is their assessment strategies (Hatting, 2009: 343). Hence, the participants' possible development in terms of their assessment skills was investigated. It should be noted that the teachers were not directly asked about this aspect; they indirectly addressed it as they described their involvement in the PD programme. The intention was to triangulate this information with the other data acquired, with the aim of answering research questions one and two.

Teacher MK

Teacher MK did not expressed anything regarding this aspect, because he did not teach pure Mathematics at the time.

Teacher NK

The investigated PD programme assisted Teacher NK in assignment setting and investigations. This is evident in the two extracts below:

…they also helped us with the investigations, drafting the investigations for the learners and the assignments (Interview with NK, 17 April 2013: 1).

And:

I also developed in how to set an assignment myself, taking the question papers, and then sorting out the questions from different question papers. They have shown us how to develop an assignment question paper, not to take one question and make it raw as it is and you just give it to the learners … (Interview with NK, 17 April 2013: 6).

What Teacher NK referred to regarding the raw question was that she developed in terms of how to take a question from a past examination paper and adapt it so that learners, who already worked on this question, will not necessary get full marks as the question would have been adapted. The answer would then have to be the product of the learner's own logical thinking.

Teacher RB

Teacher RB did not mention anything regarding his development in terms of assessments.

Teacher SB

The team of participants compiled common assessments which they conducted in their schools. In the process, Teacher SB developed his assessment skills:

Ja it did (develop my skill in setting assessments). I mean like usually I never looked at the cognitive levels of questions, to try to balance that that you know. So I think I did improve in that regards to do that when setting a question, you must try to balance across the cognitive levels (Interview with SB, 7 May 2013: 3).

Teacher SB developed his ability to consider the different cognitive levels at which questions are pitched and then balance these levels in an assessment.

Teacher SR

Teacher SR also felt that he developed in terms of the setting of assessments. This is as a result of the fact that the participants worked as a collective to compile a bank of items to use in tests:

We formulate questions there at the workshop … So we just combine them to make a sort of a class test. So we make those questions and the memorandum ... Then we take that exercises, make sort of a book. So now time to time we just photo copy and just give the learners particular exercises. Most of them they come from the workshop. We have formulated those particular exercises. Even the JET – we have the file from JET. The big one. All the material are there, normally we have them in the classroom. They are very very effective (Interview with SR, 15 April 2013: 5).

Besides these questions which were collectively formulated by the participants, the programme also supplied them with resources that they could use in class assessments.

6.2.1.4 The role played by the workshops

Workshops formed part of the strategies adopted in the PD programme to strengthen the participating teachers' content knowledge and lesson preparation, and to model good lessons and other classroom practices. This section provides an account of the

participants' perspectives on the role played by the workshops in their development as teachers.

Teacher MK

Teacher MK indicated that some of the topics covered in the workshops were proposed by the participants; whereas other were selected by the workshop presenter, after assessing the gaps in the previous test written by the participants. This is evident in the two extracts below:

…sometimes we would say to ma'am (presenter): Some of the topics now, we don't like know… Then she will say: Ok, because the topic is new and you have to teach it at school, then I will just start with those topics (Interview with MK, 17 April 2013: 9).

And:

Maybe after we have just written some tests …. (she) say[s]: Ok I have realized that's some of you have a problem with this and that … Let's just go and do that (Interview with MK, 17 April 2013: 9).

This was a very effective way of deciding on the topics to be covered in the workshops. Indeed, this approach ensured that the needs of the teachers were effectively addressed, given that the intervention was guided by the analyses of the pre-test which indicated the participants' challenge areas (topics).

However, whether the participants or the workshop presenter chose the topics, Teacher MK felt that the topics were relevant to the needs of the participants (Interview with MK, 17 April 2013: 10). The relevance of the selected topic is further reinforced by the interview extract below:

Researcher: So can you agree with me that the topics that you've covered in the workshop were very relevant to your needs?

Teacher MK: Ja, to our needs …

Teacher MK's elaborate response to the question regarding his experience of the workshops, were the following:

(The workshop presenter) taught us different methods of getting those problems' (solutions) …how to solve those problems … they have been giving us some material and then work out solutions for those problems (Interview with MK, 17 April 2013: 7).

Teacher MK stressed the fact that they were provided different strategies that enabled them to solve problems, not just those that he was used to. He also acknowledged that they were given both materials (resources) and memoranda of the sections covered in the workshops. These resources and memoranda could then be used by the participants in class or during lesson preparation.

In the workshops, participants were also given exercises that were pitched at different cognitive levels:

In trigonometry she can just give us maybe some equations … how to solve the trig problems and then she will just give you a simple one and then middle ones and then the difficult ones … (Interview with MK, 17 April 2013: 8).

A possible reason for learners' underperformance might be the fact that the teachers did not expose them to higher order problems. This could have been because the teachers themselves were not well versed in those higher order exercises. Hence, the workshop facilitator's structuring of the workshops so as to include higher order exercises might have encouraged the participating teachers to expose their own learners to these kinds of exercises.

The workshop facilitator created a conducive environment that encouraged teachers to ask for assistance when they struggled in answering the questions in workshops:

…we get stuck somewhere. Then we just call her and say: Can you just help me? And then she will say: Ok, you are stuck here and this is the way … Even the difficult ones. We can maybe just get zero for that and she will say: Ok, let us just work this out; and she can just work 2 or 3 difficult problems just to show us how easily to get the answer …((Interview with MK, 17 April 2013: 8).

Teacher MK also enjoyed the workshop experience of working in pairs for given exercises:

Yes to feel free and to feel comfortable there because I can just ask you – you are my peer … The way I understand it is this way. You see another (way and) one would come again like Teacher RB was coming again to present the same problem and say: Now I have just tackled the problem this way

and then I say: Ok this one is the same as that one… That is (how) we are working in Mathematics together (Interview with MK, 17 April 2013; 8).

Working in pairs in the workshops created opportunities for the participants to learn from each other, especially when the partner used a different method to solve the same problem. The participants' use of their home languages when working in pairs might also have contributed to bettering their understanding of the work, if one recalls the fact that the researcher earlier mentioned that the English language was identified as a barrier for this particular teacher.

The specific workshop topics that Teacher MK mentioned that were helpful to him were probability and financial mathematics. These two topic formed part of the "new" topics of the CAPS curriculum, as was mentioned previously in section 5.3:

I was stuck now and then in probabilities … Probabilities can be very challenging... even financial Mathematics, we had some problems … (Interview with MK, 17 April 2013: 10).

Teacher NK

In the workshops, the participants were assisted to set assessments which were also used with their learners. Teacher NK found the workshops useful, because what teachers learnt was also applicable to their learners:

(The workshops) were very useful. They also would set the test for us and the tests that we write there; we also use them to assess the learners. We take some of the questions from that test paper, and then we give the learners (Interview with NK, 17 Apr 2013: 1).

Trigonometry and probability were topics that the participants needed assistance with; hence, they were covered in the workshops:

They (the topics) were all relevant. Even this new one – the probability one. (Laugh). I was having difficulty on how to introduce (it). So first when I see it, I thought that maybe it was meant for university. They just put it there, but now I don't have a problem of introducing it to the learners (Interview with NK, 17 April 2013: 2).

She found all the topics relevant to the needs of the participating teachers and became more confident in presenting these topics, after the workshops. So this

teacher's competence in the content improved due to her involvement in the workshops.

Teacher RB

Relating his experience of the workshops, Teacher RB noted that:

> The workshops were fascinating because in terms of new syllabus for NCS, we were struggling with finance to an extent that we were regrouping as teachers … (laugh) (Interview with RB, 17 April 2013: 5).

The researcher then asked him what regrouping meant and he replied:

> Sitting together, taking all the finance questions in front of us and trying to take pen and solve the questions … (Interview with RB, 17 April 2013: 5).

Teacher RB's use of the word "fascinating" to describe the workshops showed that he thoroughly enjoyed them and may suggest that he developed in terms of his content knowledge. It also came to light that the new topic, financial mathematics, was covered to the benefit of this teacher who initially struggled with this topic. Financial mathematics was dealt with by working out different questions, in groups, to ensure that teachers were comfortable with this section, before presenting it to learners. Other topics that were also covered in the workshops and that Teacher RB felt that he benefitted from were functions, linear programming, and probability:

> … in linear programming, functions and finance and then the new … Even probabilities … (Interview with RB, 17 April 2013: 5).

In the workshops, the participants formed a community of practice and interacted in such a way that they learnt from one another, as they felt free to express themselves or ask for assistance. Each of these teachers presented lessons in front of the group and got valuable feedback. In this regard, Teacher RB confides:

> Ja, you know what I like about it (the workshop): We are open. We criticize so that someone can see whether his or her lesson was good or not. We talk. You go there and present your lesson. We bombard it with questions. Sir, you could have started this lesson in this way. Why are you starting that way? You're supposed to explain why, but not in a negative way; in a way that will help you see it ... because some (participants) are experienced, some are new so that you know how the learners are thinking if you do this. Where will be the mistake? If the mistake will be in this way, avoid doing this and that, come along this style ... Ja, that was helpful (Interview with RB, 17 April 2013: 5).

The presentation of lessons was a learning experience, as it afforded teachers the opportunity to critique each other. Thus, the group's feedback helped the presenting colleague to improve his/her lesson presentation and, in that way, growth could occur. What was also helpful in the situation was that the participants had varied levels of experience and expertise, and the critique was expressed ina constructive manner. This contributed to its being well-received. Hence, Teacher RB mentioned that they were "… learning from each other!" (Interview with RB, 17 April 2013: 7). One could also sense the strengthening of the community of practice among the participants.

Teacher SB

Teacher RB found the workshop to be of value as the participants learnt from each other, despite being on different levels of development as teachers:

> … I mean they (the workshops) were fruitful, you know. Ja they were fruitful. Though, like we taught with other colleagues, you might find that 2 of us are moving at a faster rate, some are lacking behind you know. But those who were faster, they were … asked to help others so that …just to try to explain to other colleagues. So I think they were very good (Interview with RB, 7 May 2013: 3).

This was further evidence that the group formed a community of practice where the teachers learnt from one another. Teacher SB appreciated the fact of working with the other participants. This was particularly useful when they deliberated on issues of teaching and learning. His appreciation of the assistance they provided one another suggested that he worked in isolation before:

> … they give us an opportunity that we met as colleagues. In the cluster (workshops) we discussed about work you see; something we lacked before ... Ja, we're working together … it helped during that time … Because they provided that platform; we never met before; we only met … I mean we never met being 6 at one time talking about our experiences at work you know or helping each other, but it did give us that opportunity that we can interact with each other (Interview with SB, 7 May 2013: 1).

So Teacher SB's need to be part of a group and to share experiences was fulfilled in the in the workshops. When asked why he thought there was a need to work together, his response was:

Probably you might find that some concepts I have easier ways of explaining – passing it onto the learners which I can share with other colleagues you know and also for the spirit – maybe helping each other because we are not on the same level as far as the teaching Mathematics are concerned; the confidence we have with the subject. So it helped in the sense that we share it with some colleagues (Interview with SB, 7 May 2013: 2).

Teachers from rural area schools expressed the need to work together in order to exchange ideas, achieve a sense of belonging, and break teachers' isolation (De Clercq & Phiri, 2013:79). The additional positive factor was the presence of the workshop coordinator who would guide where necessary. (Maistry, 2008) also referred to the importance of having non-school-based experts present in clusters/workshops to facilitate learning. Teacher SB described the workshop coordinator as "excellent" (Interview with SB, 7 May 2013: 3).

The topics covered in the workshops contributed to Teacher SB's development:

Ja even like this new CAPS topics you know. Ja she helped us a lot with regards to things like probabilities. We also reviewed this thing circle geometry you know is coming back with. Ja we had a look at them (Interview with SB, 7 May 2013: 4).

When asked who selected the workshop topics, he responded:

… she wanted to hear from us which topic we want her to do . I mean if we are in a workshop, she'll ask us what to prepare for the next workshop, you see ... we were part of her planning (Interview with SB, 7 May 2013: 4).

This signified that the workshop coordinator involved the participants in deciding on the topics to cover in the workshops. Participants were able to feel part of the planning of the workshops, and an environment where participants could feel that their input was valued was created.

Teacher SR

When asked how he experienced the workshops, Teacher SR responded:

Well one can say the workshops was nice, the arrangement of the workshop was fine, the accommodation –fine, the facilitators they have good skill in totality. And the way they assessed us – it was very very convincing indeed. We managed to write tests there, we managed to write classwork's there, we managed to present lessons in front of them (Interview with SR, 15 April 2013: 5-6).

Teacher SR had full confidence in the expertise of the workshop facilitator, based on the skills the latter had displayed.

In relation to the lesson presentations done in the workshop, Teacher SR mentioned that:

> We presented lessons in front of the facilitator assuming the teachers are learners. Ja then the facilitators will show us whether the lesson was successful or not. But most of them, my lesson, were successful indeed because I managed to bring along the apparatus and other things in the workshop so that I must demonstrate in front of educators (Interview with SR, 15 April 2013: 6).

He further conceded:

> Ja I learned a lot from them because I still remember that when we were presenting how they present their lessons. A lot in deed … How they approach us; the relationship between the teacher and the learners ... (Interview with SR, 15 April 2013: 8).

In the workshops, the teachers presented lessons and received critiques. Teacher SR indicated that the feedback assisted him in terms of his ability to relate to his learners.

The researcher than asked him about how the participants reacted to the comments made about their lesson presentations. He responded that:

> I just accept my mistake. The comments were constructive … (Interview with SR, 15 April 2013: 6).

Participants thus learnt from the comments they received and built on them. The critique created a learning opportunity for the participants.

With regard to the question on how the topics covered in the workshops were selected, Teacher SR responded:

> No actually they decide on the topics after writing the assessment. They can identify: This teacher have a problem with this topic, this on that and that. They didn't come and agree on the topic; they just detect our problem from those assessments - Here's a problem there and there ... It was very good – the workshop (Interview with SR, 15 April 2013: 6).

The analysis of the pre-tests directed the workshop facilitator in terms of the topics to choose. Teacher SR was very satisfied with the selected topics:

Ja they were appropriate and actually those are the topics that we had a problem with. They managed to detect the problems well (Interview with SR, 15 April 2013: 7).

It becomes imperative to determine the role played by mentoring in the development of the participating teachers.

6.2.1.5 The role played by mentoring

Mentoring is defined as "a relationship between two people [,] with learning and development as its purpose" (Megginson & Garvey, 2004: 2). One of the challenges associated with professional development relates to the need to ensure that what is learnt is implemented in the classroom. Therefore, effective PD interventions would require teacher training to be moved to the classroom (McKinsey & Company, 2007: 26; De Clercq & Phiri, 2013: 78), the place in which it would be most relevant. Indeed, mentoring can enable teachers to implement new ways of doing, because regular discussions and classroom observations can foster the willingness to incorporate new ideas (Harrison, 2005: 262). Mentoring could be the link between the knowledge and skills that the participants acquired and how these could be incorporated in their classroom context, since the mentor would be lending classroom support to in-service teachers (Jawahar, 2012: 260). Mentoring was incorporated in this PD programme as another intervention strategy which the second research question focused on. In answering this research question, participants were interviewed to investigate how they experienced the mentoring process. Below are the analyses of those interviews.

Teacher MK:

Teacher MK found the first mentor's assistance beneficial and used the word "interesting" (Interview with MK, 17 April 2013: 10) to describe their interaction. However, he did not receive the second mentor very well, as he found the latter to be a faultfinder who did not know what transpired in the workshop. As a result, there was no link between what was to implement in class, in the workshop, and during

class visits. Because this teacher predominantly taught PS, he did not elaborate on the issue of mentoring. This is because he was visited more by the PS mentor, an aspect that the researcher felt was not part of the study.

Teacher NK

Teacher NK had a very positive view of the mentoring that took place. This is corroborated by the following utterances:

> They came to school, observed the lesson; they even teach … It was very nice because there were some of the aspects that I was having a problem with. So … but after their visit, I was just fine. (She felt) very comfortable (with the mentor). Even if we go together to the class, I give them (mentors) chance to say something or do something on the board. It was very nice and maybe even with these learners. If they see a different person talking with them, they become better (Interview with NK, 17 April 2013: 4-5).

It is evident that Teacher NK perceived the assistance provided by the mentor in class as a help, and not as someone looking for opportunities to correct her. Thus, she was comfortable in allowing the mentor to co-teach with her. Even the learners welcomed the mentor's assistance, so much so that Teacher NK felt that the learners understood the work better with the mentor's support. She also perceived the mentor's visits as learning opportunities for herself. She indicated that she felt "fine", after the mentor's visit; in other words, she felt that her competence had increased.

The mentor also extended her support beyond the classroom, as she was accessible to the participants even after hours:

> Because even if we were having a problem, (the mentor) has given us her address to contact so that whenever I may come across a problem, I can call her or email her. Then she will come back to me and help me how to solve the problem. She even emailed me the previous questions for revision last year; even for Maths Literacy (Interview with NK, 17 April 2013: 7).

Teacher RB

When asked how he experienced mentoring, Teacher RB responded that:

> What I've learnt about mentoring is that for every lesson that you do, there is a correction for it; there is an improvement – every lesson. There is no 100% lesson. There is an improvement for every

lesson because someone who is sitting and watching can improve on your lesson. Ok, I can push it there and push it there. You can also add this, because she or he knows something in a different way and then that different way, either it can add something to your lesson like, especially, if it is a – we would prefer it if it was our lecturer – if they are coming to our classes because they can see that: No Teacher RB, you are not relaxing if you are teaching. Relax. Look, you are doing something nice if you wait for the learner's response. Don't rush, leave it. Then because – you copy the style and then you find it easier; you don't sweat, you learn the learners move at their own pace and then from there; once they grasp, the pace will be covered. Don't be afraid to waste the period for today, tomorrow it will be better than if you could have rushed it. Ja, mentoring was good … (Interview with RB, 17 April 2013: 7).

This long quote highlights the support that Teacher RB received through mentoring. He was advised on how and where to improve the lesson, how to reduce his pace, and wait for learners to respond to the question put to them. He learnt to be more patient in class, both with himself and with the learners. He realised that there was always room for improvement with every lesson.

Teacher SB

Teacher SB felt that he had gained a lot from the feedback that the first mentor gave him, when visiting his class. This is evident when he affirms that:

Ja I gained a lot when you know the feedback I received from Alison after observing me … (Interview with SB, 7 May 2013: 3).

However, when the second mentor started, he felt that things started to go wrong:

The problem started …I didn't feel any gains after the change, you know because the lady (the second mentor) to me, she couldn't fit into the shoes of Alison (the first mentor), you know … (Interview with SB, 7 May 2013: 3).

Teacher SB felt that the second mentor had displayed a "lack of experience" and was "more of a fault finder than like a mentor" (Interview with SB, 7 May 2013: 3-4). In that regard, Wessels and Nieuwoudt (2011: 7) argued that PD specialists should have classroom experience in what they present, to ensure the training is effective. The second mentor also did not schedule school visits timeously, unlike the first mentor. This frustrated Teacher SB who stopped participating in the programme, due to this and another issue.

Teacher SR

According to Teacher SR, the mentor did the following:

She was checking whether we had the classwork and whether we have this and that and that. She was going with us to the classroom to observe the lessons. So it was … what I can say was it was effective because when we come from the classroom, we sit down and we discuss the shortcomings of the lesson and other things … (Interview with SR, 15 April 2013: 7).

When this teacher was asked what she had learnt through the mentoring process, she replied that:

Actually the thing I've learned there is how to formulate a lesson plan. That lady helped me how to formula a lesson plans. Ja, how to communicate with the learners in the classroom that: No you must not communicate alone. Just ask learners one by one so that you can understand whether they understand or not. That was the mentoring I got from … even the lady was fine actually (Interview with SR, 15 April 2013: 7).

Clearly, mentoring enabled Teacher SR to be more learner-centred and to allow learners to express themselves, unlike in the past where he talked alone in class. Teacher SR also received assistance with the formulation of a lesson plan. The mentoring also included helping him to develop his ability to draw up assessments.

The mentor also assisted Teacher SR by means of co-teaching, when class visits occurred:

Many times come here, just take a chalk and present and I was so happy. And those particular chapters she presented, even a single learner got it ... because the way she presents, she will do it in such a way that each and every one here understand the chapter and it was very, very good indeed. I cannot say this person must not present. He must do that for the benefit of the learner. If I don't have that knowledge, I must accept my mistakes and go and work on that mistake. That's that! That's learning (Interview with SR, 6 May 2013: 4).

The mentor was invited to assist Teacher SR through co-teaching. He expressed his appreciation of this assistance which enabled him to learn from the mentor. It must also be emphasised that this teacher had an eagerness to learn from others, to the benefit of his learners. He accepted advice and saw it as a learning experience.

6.2.1.6 Other areas of development through the PD programme

This section highlights other aspects which were mentioned in the interviews with the participants as having contributed to their development, although they did not fall under the previous sections.

Teacher MK

Teacher MK was also part of the school's leadership, in his capacity as HOD. The development of the school's leadership team is one of the aspects included in the investigated PD programme (which fell outside this study). Teacher MK felt empowered to be involved in the development of school policies:

…there are others who was coming here for management and like maybe how to develop some policies of the school and maybe safety policy and they came here and helped us (Interview with MK, 17 April 2013: 13).

Teacher NK

The programme assisted Teacher NK to improve her content knowledge of the "new" topics of the CAPS curriculum:

O, they helped us a lot. We were having difficulties in most of the aspects like in finance. These new topics, these new equations and then showed us how to derive the formulas and how they work and how to use them … (Interview with NK; 17 April 2013: 1).

Teacher RB

Teacher RB highlighted his development through the PD programme in terms of content knowledge:

But in short what I can say, JET has really cemented the content issue in terms of relating to the content, I don't have a problem … (Interview with RB, 17 April 2013: 1).

This teacher acknowledged that, previously, his content knowledge was problematic; but, now, it has increased.

The PD programme also enabled him to develop his computer skills so as to enhance his teaching in the classroom:

> If you want to cut another question paper, the way you want to add it you know, in terms of computer literacy, JET has enhances that. You know you can do something in a quality way (Interview with RB, 17 April 2013: 4).

The programme enabled Teacher RB to compile question papers of a better quality, more professionally. He was also able to do lesson presentations using the multi-media, since some of the resources were given to the participants in electronic format. He could then cut and paste sections, because he had learnt how to do it through the PD programme:

> . .. Ja, I have got electronic also. That is why you can add it; if you want like these files … PDF – If you need something from Science from the PDF because you cannot copy and paste from that, you can cut it nicely and here JET managed to help us do it – be comfortable; be computer literate (Interview with RB, 17 April 2013).

Teacher SB

Teacher SB expressed his eagerness to learn from this kind of programme:

> I mean like I said to you, we also want to be developed. Ja we were promised that people will come and help us, so we just wanted to learn more (Interview with SB, 7 May 2013: 4).

In professional development, the participants' eagerness can be an important factor in the success of its outcomes.

Teacher SB felt that he had developed in areas of the new CAPS topics:

> … even like this new CAPS topics you know. Ja she helped us a lot with regards to things like probabilities, we also reviewed circle geometry you know... Ja we had a look at them (Interview with SB, 7 May 2013: 4).

This teacher also felt that he benefitted from the workshops in terms of improving his content knowledge of the new CAPS topics, probabilities, and circle geometry.

Teacher SR

Teacher SR was awarded a laptop, a certificate, and R1 000 in cash by the provider of the PD programme. This is because he obtained the highest mark in three assessments written in both Mathematics and Physical Science. This laptop was given to him while the programme was still running. He used it extensively in his teaching endeavours and it helped him to be more professional:

… and this particular laptop really help me a lot. I prepare using this, I am having the material of JET inside here, I have everything inside here – even the question paper – the question paper and the previous question papers I set; they are here. So it is a matter of printing out. Even some times I am using this once more to teach in the classroom (Interview with SR, 15 April 2013: 9).

It must be noted that Teacher SR did not have a laptop before. Therefore, this gift allowed him to bring technology into his classroom, and assisted him in various ways in the classroom and during preparation. The award also boosted his confidence as a person. More than any other participant, he was passionate about the PD programme.

6.2.1.7 Possible recommendations on how the PD programme could be improved

At the end of the interviews, the participants were asked to make recommendations as to how the PD programme could be improved, if it was to be rolled out elsewhere. Their responses could also be regarded as possible weaknesses of the PD programme.

Teacher MK

Teacher MK felt very strongly about having the same person conducting the workshops and the class visits. This ensured consistency in that what was covered

in the workshops can be monitored and reinforced during class visits. This is signalled when Teacher MK asks:

But now the one who is coming in and then she didn't teach you at the workshop, but now she comes into your class … Why don't the (workshop) consultant get into our classes and see what they taught us is implemented correctly like they have taught us? (Interview with MK, 17 April 2013: 10).

Indeed, before 2012, the same person who conducted the workshops also did the mentoring. But thereafter another person was deployed to do the mentoring. This frustration might suggest that there was friction between Teacher MK and the new mentor. This teacher was not very happy with the new arrangement:

You know sometimes the (new mentor) would say: This is not right, this is not right. And then you feel …Ok, this mentor had to develop me, but now, the way she is tackling things, is just demotivating myself (Interview with MK, 17 April 2013: 11).

Teacher MK also felt that the increase in the mentor's visits in 2012 was too taxing on him. This is expressed in the following excerpt:

…she came on Monday doing that, and then on Thursday again. She will then say: Ok, I will be here again for a visit and one day I said to her: It seems as if it's too much for me – your visits – maybe … I need some rest of going to my class without anyone … (Interview with MK, 17 April 2013: 12).

Teacher MK claimed that the agreement between the participants and the programme staff was that they would be given transport money to enable them to attend the workshops. However, there was a time when this money was not paid. This caused unhappiness among the participants, until this issue was later resolved.

Teacher NK

Teacher NK indicated that more development was needed insofar as setting question papers in collaboration with other teachers:

Maybe if they can allow the educators to sit as a group and guide them how to set a question paper for the learners (Interview with NK, 17 April 2013: 8).

Another recommendation made by this teacher was that the lower grades' GET teachers be included in the PD programme to ensure consistency between the grades and their teachers:

… maybe again if they can allow the GET educators to set together with the FET and iron out the problems because these learners they come from middle school, they come empty. And there must be a progression from grade 9 to grade 10. So when they come here we start from the beginning when they come here empty. So I don't know what is it that the educators in GET are doing with the grades 8, 9 and 7… So maybe the project can, when they invite us for the workshop, they can take the FET and GET together, not separately. So they use to invite us separately. So maybe if we can sit together, we can iron the problems together (Interview with NK, 17 April 2013: 8).

Teacher NK also suggested an extension of the PD programme:

… and I would appreciate it if it (the programme) can come back … (Interview with NK, 17 April 2013: 8).

As a follow-up to her previous response, the researcher asked her what she would like the programme to still do. Her response was:

I would like them to still go on with what we were doing, like this was of developing investigations and rubrics. I am having a problem of developing a rubric … I think also the development of the file; … How to arrange the file … Maybe again if they can come again and help us about analysing the questions … When the learners have written the test or the assignment, then we are expected to analyse the learners' performance per question … If they can come and show us to analyse that learner's script, and to draw the graph, the graph from the learners' performance … So that I can know where does the problem lie, which aspect should I address (Interview with NK, 7 May 2013: 3).

One can gather that Teacher NK still has areas in which she needs development. These include developing a rubric for assessments, developing investigations as a form of assessments, identification of weakness after an assessment has been marked in order to plan further interventions geared towards supporting learners. These were areas that the PD programme did not focused on, but which Teacher NK thought were important to her professional development.

Teacher RB

Teacher RB recommended that mentors who have, until recently, taught in classrooms be used:

Someone who was not teaching for 2-3 years and come to be a mentor, there will be lot of mistakes in terms of doing things … He is not in class every day. Somewhere he will get stuck. You cannot expect

him to help you with everything because he is not in the class. What about the mentor. He is supposed to see every piece of my mistakes (Interview with RB, 17 April 2013: 8).

It transpires that the support given by the PD programme was good. However, its results will be limited if the teaching load of participants is not reduced:

… the results they're the same because of the amount of workload. Really, you could have done so well if the department manage to help the school with (more) teachers (Interview with RB, 17 April 2013: 12).

Teacher SB

Teacher SB was frustrated because, according to him, the programme did not stick to it initial plan. Indeed, the participants were originally told that they would write only 2 tests, namely, the pre- and post-tests. As the programme unfolded, more tests were scheduled, which this teacher refused to write:

… though initially they told us that you will write some tests. It's a pre-test and a post-test, but they ended up being multiples of tests instead of only 2 because we were told that there will be a pre-(before) test to check how far are. We then, after they help us, write a post- test just to check if there is any improvement, but we wrote lots and lots of tests to the extent that some of us ended up boycotting writing them anymore … (Interview with SB, 7 May 2013: 1).

As it becomes apparent, the PD programme added more pre- and post-tests in the workshops, in addition to the pre- and post-tests administered before its commencement. Teacher SB was unhappy about this and withdrew from the programme. This could have been avoided if more consultation had taken place.

His recommendation was that if this PD programme had to be rolled out again, the facilitators would have to stick to the initial plan. Indeed, the participants were initially consulted about the dates on which to run the workshops; but, as time progressed, only the subject advisor was consulted. The participants were merely informed of the finalised dates. This means that the finalisation of the dates was done without knowing if the participants were available on those dates (Interview with SB, 7 May 2013: 8). Furthermore, the initial arrangement was that the

programme would pay for the participants' travelling to workshops. However, this did not happen:

Then they also promised teachers that they will pay transport for them. The next thing they don't, you see. They must just keep to their words. – their original plans (Interview with SB, 7 May 2013: 8).

Another recommendation was that the programme use the same staff member as both mentor and workshop facilitator:

But the very same facilitator must be the mentors, not have somebody else to come and mentor us here (Interview with SB, 7 May 2013: 8).

It must be emphasised that this was not the first teacher who made this recommendation. The latter had also been articulated by Teacher MK. Thus, it should be perceived as a valid concern.

It became evident that the second mentor was not willing to present a lesson in class, or practically show what she meant when she recommended that the participants incorporate something in their classes (Interview with SB, 7 May 2013: 8). This distinguished her from the first mentor. The second mentor's unwillingness in the abovementioned regard was a problem to Teacher SB. Consequently, he recommended that such programmes employ staff who is willing to practically show participants how to incorporate what they recommend in class.

Teacher SR

Teacher SR had no recommendations for future improvements:

Hey I can't say anything to do things differently. Those things they have done here, they are correct. There is no way I can recommend another method or what. Everything was fine, in particular those facilitators. If they can start another project and take another district and then do something different, but leave the same facilitators. They know their work these people. Really, they know their work. They have skills in Maths, skills in Physical Science, how to teach educators. You see they acted like a subject advisor, more than subject advisors (Interview with SR, 15 April 2013: 8).

This teacher was passionate about what he gained through the PD programme. He commended the mentors of Mathematics and PS on their skills as professional development staff.

However, he mentioned the challenge constituted by the unbalance between a very big teaching load and the limited break time:

… we are having a lot of work; we have many learners, many classes. You see today I just start to teach from first period up till now (11h00). That is my time to rest now during break. After break I must go to another class. Seven period per day – it is too much. Ja that's my biggest challenge. I am the HOD, I need to moderate these books, I must moderate the books of the teachers in my department, so where am I going to get the time? You see look at these files … (Interview with SR, 15 April 2013: 10).

This big teaching load left Teacher SR with little time to research innovative approaches to assessment, or to thoroughly reflect on his practise. This is a serious challenge to his quest for excellence. A similar sentiment was expressed by Teacher RB earlier in this section.

The excerpt below captures Teacher SR's time constraint:

Ja if I have time. But I don't have time. If I can get one educator because he can take this and I can take the others … having the time to organize things (Interview with SR, 15 April 2013: 11).

6.2.2 Interview with first mentor

The researcher only had one interview with the first mentor (AK), since the second mentor passed on before the data were collected. The first mentor coached all the participants and conducted workshops for the FET Mathematics component in 2010 and 2011. She was a qualified Mathematics teacher who had given lectures for pre-service Mathematics teaching students at a university in South Africa for five to six years, and had also been a school principal. She had also done some work in the Mathematics section, for UMALUSI–the independent body that quality-assures the matric examinations in South Africa. However, it must be mentioned that she did not start when the programme was implemented. As a result, she was not involved in the

induction of the staff. The same headings used in analysing the interviews with the participants were applied to this interview. However, the headings for which no comments were made in the interview were left out. Nonetheless, the headings were not described in this section because that was already done in the previous sections.

6.2.2.1 Possible development in terms of preparing and conducting lessons

At the commencement of the PD programme the first mentor described the teaching strategies of the participants as:

> Mostly show and tell, you know. You just do it on the board, you know … (Interview with AK, 12 May 2014: 5).

This mentor felt that, generally, the teachers improved their teaching strategies and lesson planning, as the programme progressed:

> They did improve on the way they prepared, the questions they've asked (the learners) and how they tried to draw things out of the kids instead of just telling stuff. So I think there was an improvement but not dramatic, but I mean things like that don't improve dramatically over night. It takes time (Interview with AK, 12 May 2014: 6).

Mentor AK noticed an improvement in terms of the way written lesson preparation was done, the teachers' involvement of learners in the class, and how they challenge learners cognitively. However, the mentor indicated that she did not "see enough work for the kids to do" in their workbooks (Interview with AK, 12 May 2014: 10). This signals room for improvement.

During the class visits, teachers' written lesson plans were scrutinised by the mentor. The aim was to assess whether "what they had was enough to direct the lesson" (Interview with AK, 12 May 2014: 11). The researcher found it interesting that mentor AK did not mention that she expected the teachers to use the 3 headings of introduction, body, and conclusion:

> I am not saying that other people's way of preparation is not good, but I can't be bothered to write every time introduction, body and conclusion if I don't know if I will get to the end of the lesson (Interview with AK, 12 May 2014: 12).

This quotation explains the fact that the teachers only started writing their lesson plans with the 3 headings in 2012, after the first mentor had been replaced by the second mentor. It could thus be assumed that the second mentor had insisted that the teachers use those headings in their lesson plans.

Nevertheless, when asked a question about lesson plan, the first mentor indicated that:

> I think preparation is a very personal thing. What works for me might not work for you. You got to get something that works for you and what works for you is what makes you an effective teacher in the classroom (Interview with AK, 12 May 2014: 12).

When she was subsequently asked if the service provider had given any direction regarding lesson preparations, her response was “No. They didn’t have any …” (Interview with AK, 12 May 2014: 12).The above confirms that the first mentor did not view written lesson preparations in terms of following a particular pattern. Nonetheless, teachers who needed development in lesson preparation should have been guided on how to do it. A “do what works for you” approach is clearly contrarily to this.

6.2.2.2 Progress with the year work schedule

The first mentor summarised the teachers’ struggle to complete the year’s work schedule with “… so they never finish the syllabus” (Interview with AK, 12 May 2014: 5). When asked whether she checked this during class visits, she confessed that “that wasn’t something I really checked, I have to say” (Interview with AK, 12 May 2014: 10). It would seem that the mentor did not do much more than encouraging teachers to finish the year’s work schedule. However, her interventions in class also aimed to ensure that teachers spend less class time on marking the previous day’s homework. This could possibly assist teachers to complete the work schedule on time:

> I just tried to point out to the teachers … how much time you spend the next day on going over homework because a lot of teachers spend the whole lesson going over the previous day’s homework. So they never finish the syllabus (Interview with AK, 12 May 2014).

It becomes evident that the important aspect of finishing the year's work schedule was not given much priority in this PD programme.

6.2.2.3 Participants' development in terms of assessment

The first mentor did not mention much on whether she helped the participants to improve their skills in terms of setting assessments. However, she observed that teachers:

> … test what they taught. So there were stuff that they didn't teach and they didn't test (them) (Interview with AK, 12 May 2014: 6).

These areas that were neither taught nor assessed related to sections situated on a higher cognitive level (ibid). The mentor also observed that this scenario was not unique to the schools involved in the investigated PD programme, it was a general phenomenon.

On some occasions all the schools wrote common examinations which were set by one of the participants of the assessed PD programme. This was not common in the district before the launch of this initiative. However, the mentor noticed that these examinations were not of a high standard, as she identified errors in the papers. Some of the participants also referred to these errors. When the mentor mentioned this to the subject advisor who oversees the common paper, the latter became quite defensive about (Interview with AK, 12 May 2014: 7).

Later in the interview, the mentor was asked whether she had insisted that the teachers show her their assessments. She replied: "No, there wasn't time!" (Interview with AK, 12 May 2014: 14). It becomes clear that assessments were not checked by the mentor. This implies that the development of the participants in terms of setting assessments did not formally take place.

6.2.2.4 The role played by the workshops

The mentor defined her actual role in the programme in terms of making the participants competent in harder topics:

I think I tried to get them competent with the harder topics – the harder maths topics like finance, probability, you know things that they were weak on in the initial pre-test (Interview with AK, 12 May 2014: 3).

It must be emphasised that the workshops took place "over weekends" (Interview with AK, 12 May 2014: 3). The participants mostly worked in groups and, at times, in "a bit more informal" manner (ibid). She felt that the time allocated for the workshops was insufficient, as there was "never time" (ibid) to get through all the activities that had been prepared for a sessions. She hoped that the participants would do the remaining activities at home, but doubted that it would happen that way. When asked why she thought that the time would not to be enough to complete all the activities, she responded that she had prepared a lot of activities but had noticed that, sometimes, the participants progressed slowly:

So I probably had too much – you can never have too much you know… You can never have too much practice with stuff that you find hard. So I don't think that if I did it again, I would prepare fewer examples. I wouldn't (Interview with AK, 12 May 2014: 3-4).

The mentor felt that she had structured the workshops in a way that would allow the participants to think and reflect about the sections covered, afterwards:

… to try and make them think and not just to do an example and this is the way that you do it and now do six the same. You see I think this is the problem that we have in our maths. We don't teach … You got to be able to think. So I try and not tell my classes anything which I think they can figure out for themselves given the right stimulus. So that's what I think I try to do. (Interview with AK, 12 May 2014: 4).

It could be gathered that the mentor intended to stimulate the participants' critical thinking.

6.2.2.5 The role played by mentoring

At times, the mentor taught the class during school visits. This enabled the participant to observe her teaching. The mentor thought that it was a good strategy, as the observer could learn from watching a more experienced teacher. However, she did not insist that notes be taken by the teachers during these sessions, although it would have been more beneficial to the teachers. They could have discussed their notes afterwards, which could have been another learning experience:

But then the teacher need to take notes and say what he or she thought could have been improved where I missed the boat so to speak (Interview with AK, 12 May 2014: 18).

The mentor believed that more value would have been added to this experience, if there had been more maths teachers on the staff. They could have watched the lessons together, with the view to discussing them afterwards. Then exchanging different views of the lessons could have been a beneficial exercise for all parties involved. The mentor would have wanted to get the opportunity to observe the participants' lessons and afford them a chance to watch hers too:

> [It] should be a feeling of I watch you some times and you watch me sometimes … (Interview with AK, 12 May 2014: 18).

The mentor described the mentoring sessions as being too short and rushed at times:

We didn't have a lot of time to sit and talk to them – the teacher after (the lesson observation) (Interview with AK, 12 May 2014: 5).

She stressed that:

I think there should have been more time even if they (the teachers) had to miss a lesson. The right time to talk about a lesson was straight after it. And you need a full period not quickly before they go to the next period. You know it doesn't work. And just more time because you know they're quite far apart – the schools you know (Interview with AK, 12 May 2014: 15-16).

She acknowledged that the inclusion of mentoring in the PD programme was a good idea; but, she recommended that more time be allocated to it.

The mentor also had other projects that she was working on at the same time. Therefore, she only visited two or three schools per day, for mentoring (Interview with AK, 12 May 2014: 17). Her involvement in other projects resulted in her not being able to spend much time with the teachers after visiting their classrooms. This had a negative effect on the mentoring, as thorough feedback could not be given, given that it required time.

When the mentor visited the classrooms, she mostly commented on how the teachers could improve their lessons and choice of examples, and strove to establish whether learners' books were monitored by the teachers:

> So … I mean I just tried to point out to the teachers what would have made that lesson better ... choice of examples or activities that they are going to use to develop a concept …: I looked at what control they had over the children's books (Interview with AK, 12 May 2014: 5, 10).

This correlated with what the teachers said in the interviews regarding the choice of activities and examples, the controlling of learners' books, and letting the learners write more in class.

6.2.2.6 Challenges faced, from the perspective of the mentor

The teachers had heavy teaching loads because they had to teach different grades in more than one subject. This left the teachers with very little spare time:

> But they (participants) are busy. They teach different levels, different subjects. It's hard and they (learners) got a range of abilities, not big classes but a huge range you know of very clever kids to very ... So it's very hard (Interview with AK, 12 May 2013: 4).

As was mentioned earlier, two of the teachers also highlighted this challenge.

Another challenge faced by the mentor was related to the fact that the teachers' ineffective way of controlling the learners' books had not been corrected by officials from the Department of Education:

I looked at what control they had over the children's books and you know what they do and this I blame on the system … All they have to do is sign and date and doesn't matter if everything is wrong, you won't see them underlying an error or ... That's not what control is about. Controlling is not about signing and dating. And I mean that to me you might as well save yourself the energy because what's the good of a date and ... (Interview with AK, 12 May 2014: 10).

The mentor stressed that from:

… time to time yes they did need to take books in, but you can't mark it all, so check for completeness and then choose one or 2 examples to check in detail to see whether they've got it. And if not they have to remediate (Interview with AK, 12 May 2014: 10).

The mentor was also asked whether teacher reflection took place. Her response was:

Oh, I think that (teacher reflection) might be something that came in quite late in the project – and – not really – I mean which is a pity maybe. But you see again I think because of the pressures on teachers, they would have been quite superficial probably (Interview with AK, 12 May 2014: 14).

Although teacher reflection was one of the activities forming part of the PD programme, it did not occur. The mentor, who was supposed to have driven this process, was not very inclined to facilitating this reflection. This is because she felt that her own reflection happened "in the middle of the night" and she did not write it down. She added that "by writing it down would have been a pain in the bud" (Interview with AK, 12 May 2014: 14). These comments can be perceived as the expression of the mentor's reluctance to facilitate and promote reflection on the part of the participants.

6.2.2.7 Possible recommendations on how the PD programme could be improved

The mentor felt that, although the teachers were tested on their content knowledge, there were no consequences for the participants' lack of improvement on their pre-tests. Thus, she recommended that consequences be included. She also recommended that, in these cases, "they need to maybe get a full term of and go to a fulltime course or something" (Interview with AK, 12 May 2014: 13). She also

recommended that those who do well be awarded a certificate at the end of the programme (ibid).

6.2.3 Interview with the programme executive manager

The programme executive manager (PEM) oversaw all the teacher development programmes of the service provider. She was also part of the programme's project steering committee (PSC) which had termly meetings with the different stakeholders. She assured the researcher that it was one of her organisation's principles to engage all the stakeholders before and during the running of any project. The national and provincial Department of Education and the district in which the schools are located were consulted beforehand (Interview with PEM, 15 Oct 2013: 6). She indicated that the stakeholders included the District Director, the Chief Education Specialist (CES) for professional services, the CES for the curriculum, the South African Democratic Teachers' Union (SADTU), representatives of the service provider, the area office managers of the DoE, the subject advisor(s), and the teachers themselves. The PSC discussed the progress made and the challenges faced and tried to resolve issues relating to the programme. The PEM reiterated that the ultimate goal of the programme was to improve learners' performance through the teacher development. The same headings used in analysing the participants' interviews were applied here; as such, they do not need to be explained again. However, the headings where no comments were made in the interview were left out.

6.2.3.1 Possible development in terms of preparing and conducting lessons

The Mathematics subject advisor worked against the objective of the programme, when it came to lesson preparation. He allowed the teachers to write lesson plans made of two or three lines. In contrast, the programme advocated for detailed written lesson preparations with an introduction, a body, and a conclusion:

> … one of the problems that you might find interesting, is with the same advisor Maths, he wouldn't allow the teachers to do the detailed lesson plans. He wanted them to do just the CAPS one,

2-3 lines and we said: No! Teachers are not able to write such short lessons. They need to start from the beginning because we've found that they can't introduce a lesson. They don't know what to do with the body of the lesson. So they will just read out of the text book, you know, that kind of thing. And he was just adamant: They're not going to do it. Eventually they agreed, but the teachers now became aware of this and they often said when I went and interviewed them: The JET lesson plans are so long and so complicated, but then acknowledged at the end that if they did do it, they knew more about their lessons; they knew how to mediate that knowledge better than if they did that 3 lines (Interview with EPM, 15 Oct 2013: 10).

Given that the service provider regarded stakeholders' involvement as a key principle, the Mathematics subject advisor's differing view could have a negative influence on the programme's ability to reach its goals. Indeed, the Mathematics subject advisor is regarded by the participants as the face of the Department of Education. Thus, hearing from him that they did not have to adhere to comprehensive lesson preparations could cause them to become reluctant to do any planning. This might explain why some of the participants only started producing comprehensive written lesson plans towards the last year of the programme. Thus, the question would be whether these written lesson plans would be sustained after the PD programme. It must be emphasised that it is one of the subject advisor's key functions to check, during school visits, whether teachers' administrative duties – which include lesson preparation– are fulfilled. The EPM expressed her doubt on this issue:

The one thing that we hope is that the lesson plans would be sustained, but I doubt it because of the subject advisor's preference for the 3 lines. (Laugh) (Interview with EPM, 15 Oct 2013: 10).

6.2.3.2 The role played by the workshops

After analysing the results of the pre-test that the participants wrote in the beginning, the service provider became aware of most of the participants' lack of content knowledge. It was then decided that the workshop schedule should first focus on the content knowledge, in the first year (2010); then lesson preparation, in the second year (2011); and micro-teaching and consolidation, in the third and final year (2012):

… they (participants) will not know how to conduct the lesson and what to say if they don't know enough about the content? So the first year was really pushing to get subject content knowledge, the

second year was now starting to apply some of that subject content knowledge into lesson planning and for teachers to do now little bit of peer and micro teaching … And then the 3rd year was just to consolidate (Interview with EPM, 15 Oct 2013: 13).

The workshop schedules were thus directed by the needs analysis of the participants insofar as the content. However, the researcher is unsure if, at that stage, the service provider was aware of the need to develop the participants' lesson preparation. Nonetheless, working on the content knowledge before moving to lesson preparation was a good strategy. Indeed, to be able to devise a good lesson plan, a teacher needs solid content knowledge. Nevertheless, a scrutiny of the workshop content, in section 5.3, revealed that significant time was spent on content knowledge in 2011 and 2012. One could deduce that the lack of content knowledge was to the extent that one year was insufficient to close the identified content gap.

The workshops were initially scheduled for one and a half days per term. However, this was increased in 2012 to accelerate the development of the participants, since the service provider felt that the participants were not developing adequately. This was based on the analysis of the workshop test results. Although the number of workshops remained unchanged, the workshops' hours later increased. Indeed, these workshops then started on Thursday evening and ended on Sunday, before lunch time (Interview with EPM, 15 Oct 2013: 8).

The main challenges to the workshops were participants' family commitments, unsufficient time to work undisturbed, and the participants' unavailability on Friday evening. The participants' significant teaching loads played a role in their initial reluctance to agree to longer workshops (Interview with EPM, 15 Oct 2013: 8).

Although the duration of the workshop sessions had been increased, the EPM felt that not enough content was covered:

I don't think that we were able to teach as much as we hoped the entire curriculum in a short space of time that we had over the 3 years (Interview with EPM, 15 Oct 2013: 13).

This implies that one workshop per term was not enough to close the content gaps that the participants had.

The cluster meetings which were intended to complement the workshops did not take place:

> One of the things we failed in was the clusters. It didn't work … conceptually it would happen at schools after school once every forth night and teachers from different schools would come together. It did not work (Interview with EPM, 15 Oct 2013: 13).

No reason was given as to why they were not held. These meetings could have been another avenue for the development of the participants. The long distances that separate the involved schools as well as teachers' significant teaching loads might account for the fact that the cluster meetings did not take place. Indeed, the reality was that a significant number of teachers commuted to and from schools; they had to use lift clubs to get home. This could account for the fact that the cluster meetings did not take place as planned. The EPM also added the fact that "people want to leave school at 13:30" (Interview with EPM; 15 Oct 2013: 14).

6.2.3.3 The role played by mentoring

Mentoring was done for two years, 2011 and 2012, and a classroom observation schedule was used for lesson observations (Interview with EPM, 15 Oct 2013:3). Responding to the question on the impact of mentoring, the EPM remarked that "… it's difficult to quantify it" (Interview with EPM, 15 Oct 2013: 6), that is, it was difficult to establish if mentoring impacted the development of the teachers. Inferences can only be made based on the responses of the participants and the mentor.

Mentoring intensified in 2012, as the service provider realised that insufficient progress had been made with regard to the participants' development, based on the workshop test results of the teachers. Each participant was then mentored two or three times per term. This was only agreed upon after lengthy consultation with the teachers, when the initial resistance by some of the participants had been dissipated by means of explanation (Interview with EPM, 15 Oct 2013: 7). It took the service provider "the better part of the day of activities and motivation … for them to agree that they will do it" (Interview with EPM, 15 Oct 2013: 7). What was concerning to the

participants was that “they were not comfortable with people coming into their classrooms” (Interview with EPM, 15 Oct 2013: 8). Nonetheless, the stakeholders were kept informed, and agreements had to be reached first, before any changes could be made. It was also noted that “if the unions agrees to something being done, then teachers just follows” (Interview with EPM, 15 Oct 2013: 7). So the unions acted as gatekeepers for many of the agreements. However:

… initially we had a challenge with the SADTU member who we always thought was deliberately being controversial, but she (the representative) agreed to everything in the end and we really didn’t have as many challenges as what we had expected … So, if I must say, I was pleasantly surprised by the unions and the way they backed the project (Interview with EPM, 15 Oct 2013: 7).

When asked what she would recommend as the ideal frequency for mentoring, the EPM responded:

I think we should have people at school every day for at least a year. And that’s was what Trevor Manuel was talking about … that he was gonna give 6 000 mentors to go into certain schools. I did not hear about it happening actually, but if we could have had mentors devoted in the 5 schools, each that had a mentor that just travel around every single day with a proper time schedule and who was able to keep the data, I think that that would be ideal. For the first year at least; obviously you can’t continue. That would give you the most growth (Interview with EPM, 15 Oct 2013: 6).

Although this suggestion was not viable when one had financial constraints, it was certainly ideal for effective teacher development.

Besides the change in the frequency of the mentoring, the service provider also replaced the first mentor with another in 2012. This caused a lot of unhappiness on the teachers’ side, as could be gathered from the interviews with them. When asked about this change, the EPM indicated that:

It was financial. The people that did the workshops, they charged 4½ thousand rand a day. We could not afford 4½ thousand rand times 8 people being seeing 2 or 3 times a term. It was just gonna be too much! Also, we wanted people from the community. So Judith (the 2nd mentor) was fantastic. She was in the community, she had been in charge of Maths – she was an excellent Maths teacher. I mean we’ve did interviews, we shortlisted, we did interviews and she was amazing. Her results in Mathematics at some school of excellence … (Interview with EPM, 15 Oct 2013: 11).

So the change of mentor was prompted mostly by financial reasons. The choice of the second mentor was driven by the fact that the programme wanted to employ local person whose capabilities as Mathematics expert had been established. Her track record was an added reason for her being selected to do the job.

6.2.3.4 Possible recommendations on how the PD programme could be improved

The EPM felt that the workshop slots were too short. She recommended longer periods, in a residence format:

> And I wouldn't go for the one weekend per term workshop. I think teachers should go for a whole block, in the holidays, 5 days, one place, all live in residence and you can then work till late in the evening and so on. I don't think one and a half days will work. It is too short (Interview with EPM, 15 Oct 2013: 6).

It must be noted that this suggestion could have considerable financial implications on the PD programme budget.

The EPM acknowledged that the change of mentor was not an ideal situation. She indicated that it should only be done if it is inevitable. As a matter of fact, the abovementioned change of mentor caused unhappiness among the participants. According to the EPM, some of them could not "bond" with the new mentor, because they had become too attached to the initial mentor. The two mentors' "personalities and their relationships were quite different" (Interview with EPM, 15 Oct 2913: 4). This contributed to the fact that the participants preferred the first mentor. The participants who were already attached to the first mentor found it difficult to have the same relationship with the second mentor, that is, the "teachers loved the first one" (ibid). The EPM realised that "you have to be very, very careful about the kinds of mentors that you do have" (Interview with EPM, 15 Oct 2013: 4), as they can significantly influence the outcome of the programme. The second mentor "picked up the resistance (from the participants) a lot and she could not understand it" (Interview

with EPM, 15 Oct 2013: 11). The EPM felt that it was simply due to their attachment to the first mentor.

The EPM identified academic challenges and psychological barriers as some of the obstacles that teacher developers experience (Interview with EPM, 15 Oct 2013: 13). The academic challenges related to the poor performance of the participants in the pre-tests; whereas the psychological barriers were constituted by the participants' reluctance to be assisted. This is expressed through such statements as "I don't need to be (developed) … who are you to come and tell me that I don't know my job; that I should be doing this, that and the other …" (Interview with EPM, 15 Oct 2013: 13). The EPM suggested that the building of relationships of trust with the participants, from the beginning, was a possible way of overcoming such psychological barriers.

6.3 LESSON OBSERVATIONS DONE BY THE RESEARCHER

Lesson observations were conducted by the researcher to collect data about the participants' conduct in their classroom, after the PD programme interventions. These data were triangulated with those obtained from the lesson observations conducted by the mentor and mentor reports. These different data sources, namely, the lesson observations done by the researcher, the lesson observations conducted by the mentor, the workshop reports, and the interviews with both the participants and the mentor would provide insights into the participants' conduct as teacher, before, during and immediately after the interventions. The researcher used a self-compiled lesson observation schedule. A template of this lesson observation schedule is included as Appendix 5. This lesson observation schedule had the following headings: learner involvement, teacher facilitation, content knowledge, learners' living context, teachers' responses to learners' questions and written work, errors observed, and the teachers' written preparation.

Learner involvement was included in the lesson observation schedule because learning takes place when teachers and learners interact. Therefore should the quality of this interaction improve if the intention is to enhance learning (McKinsey & Company, 2007: 26). So learner involvement in the classroom should be carefully planned by the teacher, to ensure that learning would occur. This explains the inclusion of the learners' involvement in the classroom in this investigation. Teachers' content knowledge is important in three main ways: (1) it influences how teachers engage students with regard to the subject matter, (2) it influences how teachers evaluate and use instructional materials, and (3) it determines what students learn in the classroom (Kanyongo & Brown, 2013: 108). This explains the inclusion of content knowledge and teacher facilitation in the lesson observation schedule. It must be reiterated that lessons should link what is learnt in the classroom with the learners' real life context (Nel, 2009: 34), to give meaning to the learning. In other words, learners should be able to relate their learning to their real life context, for the former to be more meaningful. This might help the learners to realise the relevance of what is learnt and the significance of the learning to their understanding of the world (Killen, 2010: 29). This highlights the imperative to assess the inclusion of learners' living context in lessons. Teachers need to be able to anticipate common misconceptions and student errors (Bansilal, Brijlall & Mkhwnanzi, 2005: 37), to ensure that they can effectively facilitate learning. Hence the inclusion of the topic: "Teacher's responses to learners' questions and written work, and errors observed" in the lesson observation schedule. Killen (2010: 84) claims that one "cannot expect individual lessons to be successful if they have not been planned thoroughly and integrated carefully into medium and long term plans". Therefore, the teachers' written preparation should reflect their thorough planning of the outcomes, learners' activities, the content chosen, the resources used, the intended assessments. This explains the inclusion of the lesson preparation component in the schedule.

The following discussion would assess if there was a correlation between what was observed by the researcher and the information acquired through other sources. The discussion is structured according to the headings that were mentioned in the earlier sections.

6.3.1 TEACHER MK

Teacher MK was not observed. This is because he did not teach Mathematics classes at the time. Thus, the discussion that follows excludes any lesson observations conducted by the researcher.

Discussion

Teacher MK did not do written lesson preparations, according to the mentor reports, although he claimed, in the interview, that he was taught how to do it and was still doing lesson preparations in 2013. He realised the importance of finding the solutions to the classwork before giving it to learners. As HOD, he did not check whether the team he managed did lesson preparations. When some of his staff members submitted lesson preparations to him, he did not check their standard.

He felt that he now progressed faster through the work schedule due to the significant content knowledge he gained through the PD programme's workshops he attended. He felt the workshops covered the topics he struggled with, this allowed him to teach better. He also felt that the workshop topics, whether they were chosen by the workshop facilitator or by the participants, were relevant to his needs. Covering new CAPS topics like probability and financial mathematics added to his satisfaction with the selection of topics. The fact that those were the topics he struggled with in the past accounts for his perception that his content knowledge has increased. Afterwards, he found thosetopics more manageable. To him, the workshops also created a conducive environment to ask questions as a participant. He also experienced working in groups positively, since he felt that he had developed as a teacher by working with colleagues and sharing ideas with them. Teacher MK also felt that he had learnt through his exposure to higher order questions raised by the workshop facilitator.

Teacher MK felt that he had benefited from the first mentor's visits, but not from those of the second mentor. It seemed as if there were clashes between him and the second mentor. However, the first mentor mentioned that initially this teacher's work on the board was unstructured/a mess; but, through her intervention, he managed to improve the way he presented work on the board. It was difficult to triangulate all this information, given that the researcher did not observe his lessons in class. Nevertheless, Teacher MK's test results indicated that his content knowledge was the lowest. His pre- and post-test averages were 46.3% and 46%, respectively. These figures clearly indicate that his average dropped slightly in the post-test. It could be concluded that, although this teacher developed – in terms of how to prepare a written lesson plan, how to use the chalkboard better, and his understanding of the new CAPS topics – this was not reflected in his post-test. His involvement in the PD programme did not affect the grade 12 Mathematics results of his school.

6.3.2 TEACHER NK

One grade 10 and one grade 11 Mathematics class was observed by the researcher. In both classes, the learners' seats were arranged in groups of four or five, in such a way that they had to turn sideways to be able to see the board. In the grade 10 class, there was only one textbook available per group. This meant that four to five learners shared one textbook. Nonetheless, Teacher NK was in control of the class where discipline was concerned. The grade 10 and grade 11 classes had 29 and 33 learners, respectively, present at the time of the lesson observation. The grade 10 class was dealting with triangles (geometry) on 17 April 2013, whereas the grade 11 class was involved with circle geometry on 7 May 2013.

Learner involvement

Learner involvement consisted more of Teacher NK asking leading, close-ended questions and the learners providing a one-line answer. The same learners answered most of the questions, while the majority remained passive. This was

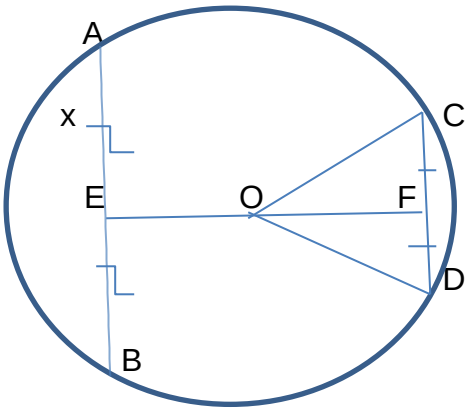
either because the latter regarded themselves as lesson observers or because they had not been paying attention at all. When classwork was given, all the learners had to engage with it. There were also opportunities for the learners to work on the board. An example was when a sum was put on the board and the teacher asked if a construction was needed to answer the questions. The learner who replied positively then showed what needed to be constructed, on the board.

Teacher's facilitation in class

The facilitation was dominated by the teacher asking leading, closed-ended questions to which individual learners responded. Below is an example where T represents what Teacher NK asked and L represents what the learner responded.

The question was to prove that AB ∥ CD.

Given:
AE = x units
CF = x-4
EO = 7 units
EF = 22 units
EOF is a straight line



T: So, if AE = x then what will x be?

L: EB.

T: If CF = x-4, then?

L: FD = x-4

T: What will be the length of OF?

L: 15

T: How do you get 15?

L: 22-7=15

T: So, how will you prove that AB ∥ CD? What are ∥ lines?

L: They will never meet.

When Teacher NK gave the learners a class exercise, she moved among the different groups. As a result, the learners were comfortable asking her questions.

Teacher's content knowledge

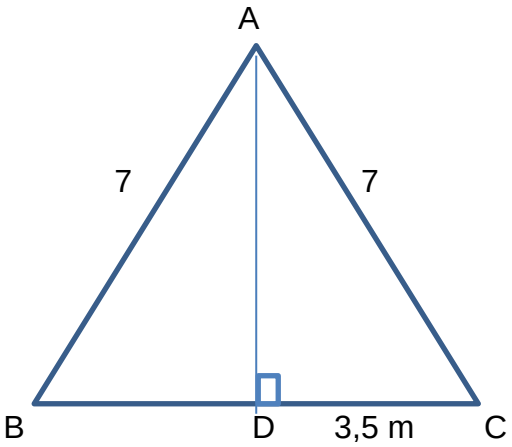
Teacher NK's content knowledge was flawless, based on the two lessons observed.

Whether learners' living context was taken into consideration

Teacher NK did not take the learners' living context into consideration during the lessons.

Teacher's responses to learners' questions, written work, and errors

Teacher NK responded adequately to the learners' errors. For example, in the grade 10 lesson of17 April 2013, a learner made an error to which the teacher responded as follows:



T: (After the Theorem of Pythagoras was revised) How will we find AD from the equation?

L: $AD^2 + 7^2$

T: Plus 7^2?

$AD^2 = 49 - 12{,}25$

L: $= 36{,}75$

T: The question said find AD. What will AD be?

L: $AD = \sqrt{36{,}75}$

T: Use the calculator and find $AD = \frac{7\sqrt{3}}{2}$

As it becomes evident, Teacher NK guided the learner quite well. However, in the last comment, she could have allowed the learner to figure out that he needed to use the calculator.

Teacher's written lesson preparation

Teacher NK had a written lesson preparation which was in line with what she said in the interview, that is, her having a written lesson preparation for every lesson. The lesson had the three headings agreed upon in the workshops.

Discussion

Before the PD programme was rolled out, Teacher NK was behind with the work schedule, and her content knowledge was not adequately developed. She did not plan her lessons correctly, and she marked homework for an entire period the following day. This contributed to her not finishing the work schedule on time. She also did not do written lesson preparations.

The workshops enabled her to do proper written lesson preparations, while mentoring helped her to conduct lessons that were more learner centred than teacher-centred, as was the case in the past. She also learnt to move around in

class to monitor what the learners were doing when they had been given class exercises. In this manner, Teacher NK talked less and afforded her learners the opportunity to engage in more guided writing in class. She also learnt to facilitate group work effectively. However, the lesson observation done by the researcher revealed that she often asked more close-ended questions which required one-word answers.

Although the pace at which she covered the work schedule increased, it was not enough to ensure that she finished the work schedule on time. Therefore, she used extra classes, on Saturdays and holidays, to finish the work schedule. Teacher NK's main reason for not finishing the work schedule in class time was that her learners did not grasp the concepts immediately. This challenge can be regarded as a time management issue.

The workshops also enabled her to set assignments and investigations, and to adapt questions from previous examination papers to create her own examination papers. She got significant assistance in the workshops on probability and trigonometry, to the extent that she felt that her competence in some topics had improved. Her content knowledge on the new CAPS topics also improved. The mentor's co-teaching contributed to her development as a teacher, as she allowed the mentor to correct her. It needs to be noted that the mentor availed herself to Teacher NK beyond the classroom, since the latter could phone or email the mentor anytime she needed assistance. She felt that she still needed support with the setting of question papers. A recommendation from her side was that the PD programmes include teachers – at the General Education and Training (GET) levels – not only to ensure that they also developed but also for the sake of continuity between primary and high schools.

Teacher NK's pre-test results were 51.3% and 56.6% for Paper 1 and Paper 2, respectively, whereas her post-test result for Paper 1 was 54.6%, which is an improvement of 3.3%. This was a fairly low improvement, considering that the programme lasted for three years. This teacher's Paper 2 post-test got lost in the post; therefore, her information was incomplete. Nonetheless, it could be determined

that Teacher NK's content knowledge did not improve significantly after the programme.

The grade 12 Mathematics results of the school she taught in did not change significantly in the period 2010-2012. This was an indication that her development did not translate into an improvement in her learners' performance. It could be concluded that Teacher NK did develop through the workshops and the mentoring, but more development was still needed in certain areas. These areas include content knowledge, assessment, and classroom management. It might be that the PD programme was not intense enough to ensure more development in those areas.

6.3.3 TEACHER RB

The researcher observed three of Teacher RB's lessons: two grade 8 lessons covering number patterns (17 April 2013) and volume (Geometry) (7 May 2013) and one grade 9 lesson on exponents (17 April 2013). The grade 8 and 9 classes had 6 and 8 learners respectively. Clearly, these classes were very small.

Learner involvement

Teacher RB asked learners several questions during the lessons. However, the researcher is not convinced that this was a common practice, because the learners hardly responded to these questions. It also seemed as if the learners were unable to perform at the level at which the lessons were pitched. An example was the grade 9 lesson of 17 April 2013 in which they dealt with solving exponential equations. During this lesson, the learners struggled to convert values into their exponential forms which were prerequisites to solving the given equations. One sum required learners to solve $9^x = 81$. Here, the learners struggled to convert $81 = 3^4$. On another occasion, they struggled to establish that $125 = 5^3$. This was one of the reasons for the unsuccessful learner involvement.

Yet another situation arose in the grade 8 lesson of 7 May 2013 on volume: the teacher gave the learners a word sum and expected them to use the relevant formula to find the height.

$V = A \times h$
$8 = 14{,}5 \times h$

The learners found it very difficult to divide by 14,5. Some added, whereas others subtracted 14,5. It became evident that the learners did not grasp the concept of dividing to find the value of h in this instance.

Teacher's facilitation in class

At times, Teacher RB's lessons were more of monologues. Indeed, although questions were posed to the learners, they hardly responded. This was the case even when the teacher prompted them. The researcher could not ascertain whether the lessons were pitched too high or whether the learners were just very weak. Below is an example from a grade 9 lesson dated 17 April 2013.

Teacher RB put the following on the board:

Solve $5.5^x = 25$

T: We are solving exponents. There is an equal sign in-between.

So we are making the exponents the same.

If you multiply…

L: … you can remove it by dividing.

T: (Called the learner to the board.)

$$\frac{5.5^x}{5} = \frac{25}{5}$$

L: $5^x = 5$

$x = 2$

T: (Substituted x = 2 in $5.5^x = 25$ and got 125 = 25)

What is wrong?

L: (Silence)

T: $5^x = 5$

$5^x = 5^1$

Since the bases are the same, x = 1.

So the teacher completed the last step as the learner did not answer him.

Learners were then given a class exercise and the teacher moved from desk to desk to check their work. However, the learners made little progress with the exercise. The researcher suspected that the questions in the classwork were at a more advanced level than the sums that were done in class. It included the following:

Solve for x:

1. $2^{-x} = 8$
2. $3^{x+1} = 81$
3. $2^{x+1} = 32$
4. $9^{x+1} = 81$

Looking at the first sum, the negative sign was not covered in the class, neither was the (x+1) in the exponents. This might be why they could not solve the abovementioned equations.

Teacher's content knowledge

The researcher could not find any problems with Teacher RB's content knowledge.

Whether learners' living context was taken into consideration

The learners' living context was not taken into consideration in the lessons.

Teacher's responses to learners' questions, written work, and errors

Teacher RB corrected the learners' written work, when they did class activities, on an individual basis. This was manageable because the learners were quite few in the class. The learners did not ask the teacher questions in the observed lessons, all the questions came from the teacher's side.

There were instances where the learners worked on the board and the teacher had to intervene to ensure that the lesson progressed. The following transpired in the grade 8 class on number patterns (17 April 2013):

T: (Wrote on the board): 1; 3; 5; … n^{th} term

(He then called a learner to the board to determine the n^{th} term.)

L: (Learner is standing still in front of the board.)

T: (Continues to prompt the learner, but the latter does not respond.)

(The teacher then called a second learner to the board to assist the first one.)

L_2: 1; 3; 5; …

$T_n = 2n - 1$

This scenario occurred again: one learner did not respond to the question posed to him by the teacher who then called upon another learner to answer the question. The researcher assumes that this was the pattern in this teacher's class because the first learner – in the previous instance – was left alone when he kept quiet. In other words the first learner – in the second instance – followed with the same behaviour because he knew that nothing would happen to him. This conduct of the teacher did not add to a conducive teaching and learning atmosphere because it did not challenge the learners to attempt the questions.

The teacher's written lesson preparation

Teacher RB had written lesson preparation plans which contained the three standard sections of a structured lesson as was discussed in the workshops. He also had

worksheets on the lesson on volume, for all his learners in the grade 8 class. Photocopies were made so that the learners could see the three-dimensional prisms that would help them to determine the volume thereof.

However, Teacher RB's choice of classwork was not appropriate in two of the observed lessons. In the grade 8 lesson of 17 April 2013, on number patterns, he first did linear number patterns; but, in the class exercise, he instructed the learners as shown below.

Find the n^{th} term of the sequence:

1. 5; 9; 13; 17; …
2. 2; 5; 8; 11; …
3. 1; 4; 9; 16; …
4. 1; 4; 7; 10; …

The third sum was not a linear but a quadratic function. Hence my above conclusion that the choice of the classwork was inappropriate. The learners got classwork on a topic other than the one covered in class. This also occurred in the grade 9 lesson of 17 April 2013, as described under the heading "teacher facilitation".

Discussion

Teacher RB was well versed in the content knowledge. As a matter of fact, the first mentor called him 'the financial mathematics specialist', which also enabled him to easily assist his colleagues with questions on financial mathematics. He himself felt that the programme had developed him in terms of content knowledge. This was reflected in his pre- and post-test results which showed that he had improved from an average of 56% to 74.6%. This was the highest improvement recorded.

The mentor indicated that she had not seen his lesson preparation, although he claimed that he did lesson preparation in the past. He indicated that his involvement in the programme had helped him change from using the "textbook" method to what he was taught by the mentor. He highlighted that the "textbook" method could direct him away from the work schedule, because textbooks were not necessarily written

according to the syllabus content. Thus, the PD programme assisted him in preparing lessons that were in line with the work schedule, and which evidenced a gradual progression in terms of difficulty levels. Teacher RB also indicated that he had learnt new ways of introducing a lesson and had also applied the computer skills that he had developed through the programme. He noted that with these new skills, he was now able to stimulate his learners. This was evident in the printed worksheets that he handed out in class, when he did geometric figures. His learners had computer-printed three-dimensional figures to work with, instead of hand-drawn ones which might not have been in scale.

He moved from a teacher-centred approach in the classroom to a more learner-centred approach. This, in effect, meant that he talked less and allowed the learners to be more involved in the lessons. The researcher noticed that he asked the learners more questions, allowed them to work on the board, and checked their classwork individually, to provide them with feedback where necessary. Teacher RB also indicated that he had learnt how to involve passive learners more in the class. However, the researcher's observation of his lesson suggested that he still needed development in the execution of what he learnt regarding his facilitation skills, since the learners held back when he asked them questions in class. Nevertheless, he learnt to give learners classwork after every lesson and to move around in the class. This enabled him to monitor what learners were doing and to control their books in order to correct any mistakes he might detect. He also learnt to be more patient both with the learners and with himself, when presenting the lessons. Indeed, in the past, he would move too fast, inconsiderate of where the learners were. He was now able to wait for learners' responses, even though he still needed more guidance in terms of what to do when he was waiting for the learners' responses. Although he gave homework and classwork regularly, he could still improve his selection of exercises, in addition to ensuring that he scaffolds these exercises and relating examples according to their level of difficulty.

Teacher RB experienced numerous challenges at the school where he taught. This resulted in some of his classes being disrupted due to circumstances beyond his control. This negatively affected his productivity in class. However, the grade 9

Mathematics results of his learners, for the period 2012-2013, showed significant improvements – considering that the significance level was 0.001. Although there was evidence of a significant change, it was of a small scale when considering the significance level's magnitude. Furthermore, the smallness of the school cohorts could also have had a negative impact on the test.

It can thus be concluded that Teacher RB developed in terms of his lesson preparation, classroom practice, and content knowledge, as a result of the mentoring and workshops he was involved in. however, there were areas where he could still develop, namely, his facilitation skills and probing, especially when learners do not come up with the correct answers.

6.3.4 TEACHER SB

Due to the fact that Teacher SB had to fulfil his duties as FET Mathematics teacher and acting principal, the researcher only managed to observe one of his lessons. It was a grade 12 lesson on factorising 3rd degree polynomials; it was conducted on 7 May 2013. There were 10 learners in the class; they were organised into two groups of five learners each. The general atmosphere in the class was characterised by discipline, dedication, and a sense that the learners knew what the teacher expected from them. Because these learners were few, Teacher SB knew all of them well.

Learner involvement

Learners were involved in answering questions, and the teacher constantly asked them to assist on the board. This is evidenced by the example below.

T: What is a polynomial?

L: Expression with more than 4 terms.

T: What is a monomial?

L: Expression with 1 term.

The learners were also given class activities which they attempted to do individually.

Teacher's facilitation in class

Teacher SB showed confidence in facilitating teaching and learning. He tried to involve more learners in answering questions that he posed to the class. In the different intervals, he continually asked questions and kept the learners' attention on the board. The following is another excerpt from one of the observed lessons:

T: $\frac{9}{2} = 4 \, and \, remainder \, of \, 1.$

What do we call ?

L: Quotient.

T: Divide $\frac{a(x)}{b(x)}$ to find the quotient where $a(x) = 2x^3 - x^2 - 3x + 1$ and $b(x) = x - 1$.

T: (Teacher and learners did the long division together.)

T:
$$\begin{array}{r} 2x^2 + 3x - 2 \\ x-1 \overline{)\, 2x^3 + x^2 - 3x + 1} \\ \underline{2x^3 - 2x^2} \\ 3x^2 - 3x \\ \underline{3x^2 - 3x} \\ 1 \end{array}$$

T: What is the quotient?

L: $2x^2 + 3x - 2$

T: And the remainder?

L: 1.

However, the learners had limited opportunity to work on the board. The questions asked by Teacher SB were mostly close-ended and were not of a higher order.

Teacher's content knowledge

The researcher did not detect any flaws in Teacher SB's content knowledge.

Whether learners' living context was taken into consideration

The learners' living context was not taken into consideration in the lesson. This is mainly because the lesson did not lend itself to it.

Teacher's responses to learners' questions, written work, and errors

Teacher SB prepared the learners well at the start of the lesson to ensure that they would be able to understand the concepts covered. Indeed, he used $\frac{9}{2} = 4 \, and \, remainder \, of \, 1.$ as an introduction to long division of algebraic expressions. When learners made mistakes, he referred them back to this simple example and emphasised that another way of writing the equation will be 9 = 4.2 + 1.

Teacher SB was patient when he revised sections for clarity because a learner had made the following mistake:

$$
\begin{array}{r}
x-5 \\
x+3\overline{)\,x^2-2x+2} \\
x^2+3x \\
\hline
-5x+2 \\
-5x-15 \\
\hline
17
\end{array}
$$

L: (Concluded that) $(x^2-2x+2)=(x-5)(17)$

T: (The teacher went back to 9 = 4.2 + 1 and, in the process, made the learner understand that $(x^2-2x+2)=(x+3)(x-5)+17$.

Clearly, the teacher was supportive towards the learners and assisted them in correcting errors.

Teacher's written lesson preparation

Teacher SB went to class with only his textbook and chalk. There was no evidence of written lesson preparation. However, the observed lesson displayed an introduction, a body, and a conclusion. The chosen class exercises were also appropriate as a follow-up to the lesson and were on par with the cognitive level of the learners.

Discussion

Teacher SB was perceived as a passionate Mathematics teacher with well-developed content knowledge. The mentor mentioned that he was well versed in the content knowledge and it also reflected in his pre-test results – since he did not write the post test. His pre-test results' average was 82%, 22% higher than that of the person with the second highest marks. This revealed that he had stronger content knowledge, compared to the other participants. This was further reflected in the confidence with which he covered the application of higher order questions with his learners. However, he felt that he understood the new CAPS topics better only due to his involvement in the PD programme.

Teacher SB was aware that his content knowledge was better than that of the other participants. Indeed, in the interview, he mentioned that:

Probably you might find that some concepts I have easier ways of explaining – passing it onto the learners which I can share with other colleagues (Interview with SB, 7 May 2013: 2).

However, he was not boastful about it and was willing to assist the others by sharing what he knew. Nonetheless, he had a positive attitude in that he still wanted to learn more and develop more.

Teacher SB did not do lesson preparation at the onset of the programme, but this changed in term one of 2012, according to the mentor reports. The latter noted a significant improvement in his lesson plans. The areas where he could still develop, as identified by the mentor, were the detailed worked-out solutions for the classwork and the homework. The mentor report indicated that Teacher SB gave learners

individual attention and tried to involve the passive learners. This is confirmed by the observations made by the researcher. However, he could still improve his cognitive challenging of the learners in class.

Teacher SB indicated that the area where he also developed through mentoring was concluding a lesson, instead of just stopping at any point. Concluding a lesson implied giving learners work, correcting it the same day, and giving the learners homework. He felt that this helped the learners to grasp the concepts better. This showed that adequate content knowledge alone does not make a competent teacher, there is more to an effective teacher than just content knowledge.

The grade 12 Mathematics results of Teacher SB's learners did not reveal significant change in the period 2010-2012.

6.3.5 TEACHER SR

The researcher observed four lessons conducted by Teacher SR, two in his grade 11 class and two in his grade 12 class. There were 22 learners in the grade 11 group and 18 learners in the grade 12 group. The grade 11 lessons were on Analytical Geometry (15 April 2013) and Trigonometry (6 May 2013), whereas the grade 12 lessons were on Functions and Relations (15 April 2013) and Differentiation (6 May 2013). In general, these classes were very well disciplined, and it was evident that the learners knew what the teacher expected from them.

Learner involvement

Learners were involved in substituting values into the formulas and simplifying answers, leaving them in surd form. Class exercises were also given. An example of these is: Find the distance, length, gradient, and midpoint, using A (3; 0) and B (-6; 3). Clearly, direct application was given during the lesson and homework was given to learners afterwards. This was in line with what the Teacher SR said in the interview (see Section 5.6), notably that he no longer talked for the entire period: he

allowed learners to also do work in class. Another confirmation of what was said in the interview with this teacher was the homework he gave learners as practice (see Section 5.6). However, there were still more opportunities for increased learner involvement.

In the grade 12 lesson of 6 May 2013, there was a time when the teacher was called to the principal's office while he was working on the board. As he left the class, a learner spontaneously went to the board and completed the sum. An atmosphere of coherence prevailed among the class members who felt free to explain their solutions to the rest of the class until Teacher SR returned. This was evidence of both independent work ethics on the part of the learners and the fact that ground rules were in place to ensure that time was not wasted. These learners have had this teacher now for three years. It was obvious that a mechanism had been devised for the class to continue even in Teacher SR's absence.

Teacher's facilitation in class

Most of the questions asked by Teacher SR were closed-ended. This teacher was well-prepared and had selected appropriate exercises for class activities. He wrote down the different sections of the broader topic on the board and told the learners which ones they would cover for the day. Below is the list of the different sections:

Find: 1. Distance between two points

2. Midpoint

3. Gradient

4. Inclination

5. Parallel lines

6. Perpendicular lines

7. Equation of the straight line

Teacher SR then informed the class that they would cover the first 3 sections, which he did manage to complete. This confirmed what he said in the interview that the mentor had advised him to link sections in order to finish the work schedule on time. So he linked distance, midpoint and gradient; he answered questions using the same Cartesian plane and, in the process, made learners aware that these sections interlink.

The Cartesian plane was used to ensure that learners linked the algebra with the diagram. The formulas were revised and written on the board. Learners were asked to substitute values in the formulas. Some of the learners encountered some difficulties with signs:

With A (1; -4) and B (-2; -7):

Distance $_{AB}$ $= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

$= \sqrt{(-2-1)^2 + (-7-4)^2}$

Incorrect signs when substituting (-4)

Teacher SR corrected the sign without clarifying why the negative sign was incorrect. Here, he missed an opportunity to facilitate learning even more. Another missed opportunity was in the grade 12 lesson of 15 April 2013 where the teacher covered linear functions and their inverses. Before he gave the learners exercises to do, he told them that they should know where the straight lines and their inverses intersect. However, he did not elaborate as to why the intersection is important, that is, its significance. This again could be viewed as a missed opportunity for the teacher to connect concepts.

Another interesting moment was when, at the end of the period, Teacher SR informed the class that the section covered was part of Paper 1, since the subject was divided into two papers. This was a good way of indicating to the learners where the particular section fits.

In the grade 12 lesson of 6 May 2013, this teacher did differentiation with the learners, focusing on differentiation where exponents were involved. He first

expected the learners to change the sum's format into exponential form and then differentiate using the rules. For example:

$$y = -\frac{2}{x^2} = -2x^{-2}$$

$$\frac{dy}{dx} = 4x^{-3}$$

He did more examples on this type and continued to $y = \frac{x^3}{3} + \frac{x^2}{2} + \frac{x}{4}$. His learners were reminded that this was different from the previous example, in the sense that the unknown was now in the numerator. The researcher felt that making the learners aware of this shift was central to ensuring that they could distinguish between these different types of differentiation. He also frequently asked his learners to assist with the answers and asked them to explain how they got to the answers. This gave the learners the opportunity to verbalise their answers and help their peers to understand how the answers were obtained.

At regular intervals, Teacher SR made the learners aware of the marks allocated to these sections in the final examination. Although this could be construed as preparing learners for the final examination, it could also be regarded as promoting the examination instead of teaching and learning.

Later in the lesson, the learners were given classwork, and Teacher SR controlled their books as he walked from desk to desk. This, once again, confirmed this teacher's affirmation – in the interview – that he had learnt from the programme.

Teacher's content knowledge

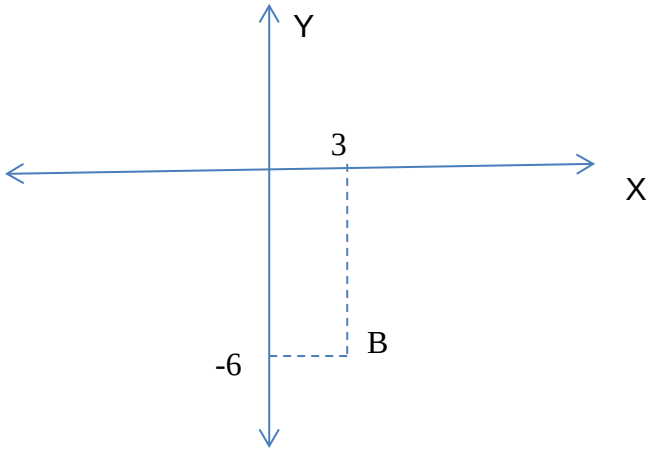
Teacher SR's content knowledge was flawless. This was confirmed by the positive comments contained in the mentor reports, as quoted in section 5.2.

Whether learners' living context was taken into consideration

The learners' living context was not taken into consideration in the lesson, since the covered sections did not really lend themselves to it.

Teacher's responses to learners' questions, written work, and errors

During the grade 11 lesson on Analytical Geometry (15 April 2013), some of the learners struggled to draw the points A (3; 0) and B (-6; 3) on a Cartesian plane that they had to draw themselves. When the teacher went around to check the learners' books, he was sometimes irritated by their responses. An example of one learner's incorrect plotting of point B on the Cartesian plane was:



There were instances where individual learners were asked to respond to questions and those where the learners answered a question as a collective.

Teacher's written lesson preparation

Teacher SR had a written lesson preparation plan for each of the observed lessons. The examples he had chosen were appropriate for the scaffolding of the levels of difficulty. Homework and classwork were prepared and given to the learners.

Discussion

Teacher SR rated all aspects of this PD programme positively. Consequently, he did not have any suggestions on how to improve similar PD programmes in future,

besides keeping the same staff. He was a hardworking teacher and, although he was the oldest participant in Mathematics, he was still eager to learn more. This resulted in his being awarded a laptop and R1000 by the programme.

Teacher SR's content knowledge was fairly good; he had an average of 60% in the pre-test and 64% in the post-test. This could still be improved. He felt that his lesson preparation had improved due to the improvement in his content knowledge. In the past, he did not do written lesson preparations. But, through his involvement in the PD programme, he realised the importance of lesson preparations. He felt that that lesson plans would help him to complete the work schedules faster. Furthermore, he followed the workshop facilitator's advice and linked small sections of the work and focused on them in a lesson. He gave learners exercises to determine if they were coping with the covered sections.

The area in which he developed most was his teaching strategy. Indeed, in the past, he taught (one can also say talked) for 50 minutes, without involving the learners. This has now changed as a result of what he learnt through mentoring and workshops. He involved learners more, talked less, allowed for time to incorporate classwork and marked it in class, and gave homework thereafter. While the learners did the classwork, he moved around to check what they were doing and gave them individual attention while controlling their books. That his lessons were now more learner-centred was evident when the researcher did her lesson observations with him.

Teacher SR felt that he had benefitted from the workshops. The latter gave him opportunities to present both lesson plans and lessons to his peers, learn to use apparatuses in lessons, learn to formulate questions in workshops, and how to relate to his learners better. He found that the topics covered in the workshops were relevant to his needs.

The mentoring session in which the mentor co-taught with him gave him the opportunity to learn from a more knowledgeable person, which fostered his development as a professional. However, there were instances where the researcher

observed that Teacher SR could have been more patient with the learners when he was correcting the mistakes they had made.

His learners showed that they could work independently when he was assisting the principal. However, the number of classes he taught was detrimental to the application of what he learnt, as he hardly had time to prepare better or to work on more innovative strategies.

In conclusion, the participants in the investigated PD programme developed in different areas and at varying paces. This was confirmed by the fact that only the results of one of the five schools involved in the programme revealed a significant change. Interestingly enough, this change only occurred in the school whose grade 9 results were used. Teachers benefitted from the workshops and mentor interventions. This was evident in their own accounts as well as in the workshop and mentor reports. However, their pre- and post-test results did not yield significantly differences.

The next chapter discusses the findings and conclusions of the study. The findings regarding the effect of the workshops on the teachers' competence and performance were discussed before the impact of mentoring. These discussions were followed by the analysis of the interviews with the participants and both the mentor and the programme executive manager. Subsequently, the results of the participants' pre- and post-tests were discussed. The findings of these discussions contributed to answering research questions one and two. Lastly, the findings of the learners' results were discussed in an attempt to answer research question three.

CHAPTER 7

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

7.1 FINDINGS

The data analysis was done in chapters 5 and 6. Various key findings and conclusions emerged from this analysis. Different data sources were used, and the analyses of the data were triangulated. The findings were discussed using the themes represented by the different headings: competence in content knowledge, possible development in terms of preparing and conducting lessons, progress with the year work schedule, development in terms of the setting of assessments, the role played by the workshops, the role played by the mentor, the pre- and post-test results of the participants, the learners' results in the period 2010-2014, and other findings.

7.1.1 Competence in content knowledge

The participants' competence in the content knowledge emerged from the analysis of the mentor reports, mentor lesson observations, workshops reports, the pre- and post-tests of the participants, the researcher's interviews and lesson observations with participants (see Chapter 5, Sections 5.2.2, 5.3.6, 5.5; and Chapter 6, Sections 6.2 and 6.3). In the analysis of the content of these mentor reports and the researcher's lesson observations, the researcher could not ascertain whether the participants' content knowledge had improved or not. This is because the only time when the content knowledge could be assessed was when the participants made mistakes pertaining to this aspect. Given that most of the lessons were not pitched at a high complexity level, with regards to Bloom's taxonomy, mistakes in this respect were minimal.

In turn, the lesson observations showed that Teacher NK needed to further develop her content knowledge competence, whereas Teacher RB was well versed in terms of his content knowledge. Indeed, he could select appropriate examples to be used in his lessons to facilitate learning; he built on the previously-covered sections, and displayed more than one approach to solving mathematical problems. The content knowledge competence of Teachers SB and SR was adequate in that it enabled Teacher SB to facilitate challenging sections in trigonometry and allowed Teacher SR to highlight possible common errors to his learners.

The workshop reports, the different individual interviews, and the pre- and post-tests assisted in assessing the participants' content knowledge. The interview with the programme executive manager (PEM) shed light on the content knowledge issue. The latter indicated that the service provider had become aware that most of the participants lacked content knowledge, after analysing their pre-test results. A decision was then made to first work on the participants' content knowledge in the workshops in the first year (2010), to focus on their lesson preparation and micro-teaching in the second year (2011), and to consolidate all these aspects in the third year (2012). The rationale for this course of action was the assumption that the teachers would not know how to conduct lessons, if they lacked content knowledge. This was perceived by the researcher as a logical way of developing the participating teachers. However, in 2011 and 2012, the workshops were still mostly devoted to addressing the participants' content knowledge gaps.

The workshop reports revealed that financial mathematics, circle geometry, probability, application in calculus, algebraic inequalities, trigonometry, and contextualised quadratic number patterns were topics that the participants struggled with. The participants claimed that circle geometry, financial mathematics, and probability were not part of the syllabus when they were school learners, which explained their lack of background knowledge in these topics. The topic of Financial mathematics was addressed in several workshops. As such, it was not surprising that it was the only topic in which the participants had improved significantly in the post-test, compared to the pre-test, as it had a significance level of 0.0317, which

was still less than 0.05 (see Chapter 5, Section 5.5). Other topics which were addressed more than once in the workshops were probability and geometry. This might have been because these topics were dealt with in a fragmented way, or because not enough planning went into the structuring of the workshops. Another reason could have been that the participants were just very weak in these topics.

The mentor/ workshop facilitator saw her actual role in the programme as assisting in increasing the participants' competence with regards to more challenging topics like financial mathematics and probability. This might be why these two topics were covered more than once in the workshops. However, the mentor also mentioned that the participants' pre-test performance in these topics were the poorest. A challenge faced by the mentor/ workshop facilitator related to the fact that the participants struggled to complete the tasks that she set out in the workshops, while the remaining tasks were never completed by the participants at home. The facilitator also tried to structure the workshops in a way that would develop the participants' critical thinking so that they could figure things out independently.

The participants themselves revealed, in the interviews, that the topics they were struggling to understand were dealt with in the workshops. These topics were put forward by the participants, or were identified by the workshop coordinator after the pre-test analysis. The general view of the participants was that the topics were relevant to their needs. They were equipped with different ways of solving certain mathematical problems. The participants were challenged with exercises which were pitched at different cognitive levels and, in the process, trained them to deal with the more demanding application of the content knowledge. This also gave the participants the confidence to attempt the same exercises in their own classes, so that their learners could also be challenged on a higher cognitive level.

A community of practice formed among the programme participants where they learnt from each other and received support in a safe space. This created a conducive environment where the participants could rely on each other for

assistance. They perceived working in pairs, on exercises and other workshop-related activities, as positive. This is because they learnt from each other, especially if the partner used another method of solving the same problem. Furthermore, the opportunity to use their mother tongue – which was different from that of the workshop coordinator – also helped them better understand the content, since language barriers did exist.

Although the analysis of the test showed that the participants' competence had only increased significantly in Financial mathematics (see Chapter 5, Section 5.5), the participants also mentioned probability and trigonometry as topics in which they had gained more content knowledge. Teacher NK specifically mentioned that she had gained confidence in presenting the topics covered in the workshops. In other words, her competence in the content had improved, due to her involvement in the workshops. Teacher RB described his experience of the workshops as "fascinating", because he learnt a lot in terms of the new topics in the syllabus. He specifically highlighted financial mathematics and working in groups, to tackle exercises, as aspects which he valued. He said that he had been struggling with financial mathematics. Interestingly, the mentor later called him the group's financial mathematics expert because he excelled in the content knowledge thereof to an extent that he was able to assist the other participants with any question on this section. This revealed his growth in and mastering of the content knowledge in this topic. Teacher SB appreciated their forming a community of practice, as it broke the isolation he had been working in as a teacher in a rural school. Teacher SB also benefitted from the new CAPS topics covered in the workshops. Modiba (2011) emphasised that the inclusion of content knowledge in South African PD programmes would enable Mathematics teachers to successfully implement new curriculum policies (see Chapter 2, Section 2.5). Teacher SB has appreciated the inclusion of the participants in the planning of the workshops through the selection of some of the content. The participants' test results revealed that they were at different levels of competence in terms of their content knowledge. This was highlighted by the tests results (see Chapter 5, Section 5.5).

Eight of the ten topics included in the pre-test had zero as the lowest score. This indicated that at least one participant got zero in eight of the ten topics. This flagged a serious lack of content knowledge on the part of at least one participant. In three topics, namely, logarithms and exponents, application of calculus, and compound angles equations, the lowest score in the post-tests was also zero. This meant that no development occurred in these topics for at least one participant. Only financial mathematics revealed a significant change in the post-test. Teacher MK had the lowest pre-test average while Teacher NK had the second lowest average. Teacher MK's post-test average was lower than his pre-test average, after three years of involvement in the PD programme. Teacher SR's average increased by 4% while Teacher RB's grew by 18.6% (see Chapter 5, Section 5.5). Teacher SB had the highest pre-test average; however, he did not write the post-test. Nonetheless, it could be anticipated that he would still have had the best score of the group.

In Chapter 2, Section 2.3, reference was made to Killion (2005: 5) who proposed that interventions be "over an ample time period". However, the gap in the participants' content knowledge was such that one year (or even two years) would not have been enough to close it. While the hours spent per workshop were increased, the number of workshops remained unchanged. It would seem that one workshop per term was insufficient to close the participants' content knowledge gap. However, there could be other reasons than time for this PD programme not improving the teachers' content knowledge as much as would have been hoped for.

7.1.2 Possible development in terms of preparing and conducting lessons

The interview with the EPM revealed that the programme's focus in the second year, turned to the participants' lesson preparation and micro-teaching. The programme had already attended to the participants' content knowledge in the first year. However, controversy arose as a result of the conduct and belief of the Mathematics subject advisor that three lines were sufficient for a lesson plan (Chapter 6, Section 6.2.3.1). He also did not check the participating teachers' lesson plans regularly,

when he visited the schools. It was established that he visited these schools predominantly for moderation purposes.

It was stated earlier that lesson preparation was important for the planning of the lesson and to ensure that the work schedules were covered in the stipulated timeframes (Chapter 5, Section 5.2.3). One participant indicated that, because he did not prepare lessons correctly in the past, he used to follow the textbook when conducting his lessons. This approach took him away from what he was actually expected to cover as per the syllabus. The mentor constantly encouraged the participants to do lesson preparations. Her reports indicated that the participants did written lesson preparations at varying degrees. The workshops also assisted the participants on how to do a lesson plan and gave them the opportunity to do practical exercises on it. However, when the participants were asked to showcase their plan to their peers, no one was willing to do so. It might have been that they were not comfortable with sharing their lesson plan, due to a lack of confidence in how they approached the task, or because of a lack of experience. It was also evident that the lack of thorough lesson preparation resulted in some participants not completing the syllabus within the prescribed timeframes. This was compounded by the fact that they did not have specific time allocated to marking the homework of the previous day.

It was regrettable that it was only in the last year of the programme, after the subject advisor had outlined the DoE's requirements, that the teachers were expected to have lesson plans for every lesson that they conduct. It is at this moment that the participants realised the importance of a written lesson preparation. They then agreed on a specific lesson preparation template in the workshops and, still according to their respective levels of competence, prepared their lessons. This was reflected in the mentor reports, the mentor's lesson observations, and in both the researcher's lesson observations and interviews. This, combined with the strategy consisting in grouping topics in the same lesson, enabled the participants to better manage their time in class. It also helped them to increase the pace at which they progressed with the work schedule. All these observations serve as evidence of the

participants' improved competence and performance. However, as the fact that the participants realised the importance of written lesson plans so late in the programme left them with very little time to not only refine their lesson planning skills, but also to establish whether the written lesson plans were sustained (see Killion's claims on duration in Chapter 2, Section 2.3).

Another regrettable fact is that one of the participants – who was also a HOD – did not check his team's lesson preparations, although this formed part of his responsibilities. The question then arose as to whether the written lesson plans would be sustained if neither the HOD, nor the subject advisor monitored them.

In workshops, the participants were given the opportunity to do micro-teaching (see Remesh & Teaching Support Services in Chapter 2, Section 2.3) where their peers critiqued their performance and provided them with feedback on how to improve their lesson facilitation skills. The mentor described the participants' conduct in the classroom, at the onset of the programme, as "show and tell" (Chapter 6, Section 6.2.2.1). This was confirmed in the interviews with some of the teachers who confessed that, before their involvement in the PD programme, they talked a lot – even right through the lesson– and did not involve their learners (Chapter 6, Section 6.2.1.1). It became apparent that these teachers taught the way they were taught (Thomas & Pederson, 2003: 319). Furthermore, due to the apartheid regime, most of the involved teachers received their education in under-resourced schools with overcrowded classes. Consequently, their teaching strategies were mainly of the kind that enabled them to cope with the situation, at best. As such, PD programmes need to change this around, since these outdated teaching strategies and the teachers' lack of content knowledge have resulted in poor learner performances. The presence of the mentor in their classes made the participants aware of conducts that were not conducive to effective teaching. The mentor encouraged the participants to involve their learners more, to select examples that would enable scaffolding, give learners homework, and check their written work. Before the intervention, the teachers used to give learners examples or exercises which were all on the same cognitive level of difficulty. Co-teaching with the mentor was done to demonstrate to

the participants how to improve whatever the mentor felt could be enhanced (see Badiali & Titus, 2010, in Chapter 2, Section 2.4).

The participants incorporated other teaching styles and strategies in their lessons, like facilitating group work, using more visual means of introducing a lesson, and trying to involve passive learners. Teacher NK was a typical example of the extent to which the participants had changed. She changed from talking for most of the period to facilitating more as she moved around in the classroom to check what the learners were doing, when given tasks. From both the interviews and lesson observations done by the researcher, it became apparent that her classroom practice had changed as a result of her involvement in the PD programme. Moving around in the classroom enabled the participants to detect learners' errors and possible misconceptions and correct them. Although this evidence that some the participants had developed, others still needed more support to increase and improve their use of these "new" strategies.

7.1.3 Progress with the year work schedule

It was difficult to determine whether the participants completed the syllabus, since three of the participants' teaching files did not indicate which topics they had already covered (Chapter 5, Section 5.2.1). Teacher NK was behind with the work schedule at one point, whereas Teacher SR was ahead of the work schedule at some point. Based solely on the reports, the researcher could not establish if all of Teacher NK's grades were behind, nor was it possible to determine whether Teacher SR's grades were all ahead of the work schedule.

The interview with Teacher MK revealed that the pace at which he completed the syllabus increased as a result of his improved content knowledge. Before his involvement in the PD programme, he experienced difficulties in completing the syllabus; but, after receiving support from the programme, he completed the grade 12 syllabus before the June examinations. In her interview with the researcher,

Teacher NK acknowledged that completing the syllabus had been a challenge before her involvement in the programme. However, although her pace increased, it was still not on par with the work schedule. She claimed that it was because the learners took long to comprehend certain topics. To make up for this, she had holiday and Saturday classes. On his part, Teacher RB stressed that circumstances beyond his control had led to the suspension of classes. This delayed him and prevented him from adhering to the prescribed work schedule progression. This forced him to rush through certain sections, in an effort to make up for lost time. He confessed that, at some point, he panicked and became "harsh" on the learners, a behaviour that was unconducive to effective teaching and learning. Teacher SB was the only participant who did not have any problem to complete the work schedule in time. When he missed classes, because he had to attend workshops or assume his responsibilities as acting principal, he would catch up by asking the learners to come for Saturday classes. In his interview with the researcher, Teacher SR mentioned that he used Saturday classes to stay abreast with the work schedule. However, he acknowledged that the PD programme had equipped him with approaches that allowed him to complete the syllabus faster. For instance, he had learnt to group relatable sections of a topic so as to cover them in one lesson. This process of linking different sections could foster effective teaching and learning. His Saturday classes were also used to not only revise grade 11 topics with the grade 12 learners, but also to allow FET learners to write tests which he did not have time for in the regular class period.

In her interview with the researcher, the mentor indicated that she did not check whether the teachers completed their syllabi; but, she noted that they never finished them (Chapter 6, Section 6.2.2.2). This was very contradictory and prompted one to wonder how she knew that the teachers did not complete their respective syllabi. However, she mentioned that she pointed out to teachers – probably during lesson observations – when they spent too much time on the previous day's homework. This accounted partly for their delayed completion of the syllabi.

Nonetheless, it must be noted that the participants were at different levels in terms of their progress with the syllabus. Furthermore, it should be emphasised that the

teachers' levels of professional development were proportional to their ability to complete the syllabus. The participants did not develop adequately in terms of keeping their administrative tasks up–to-date, as they neglected to tick off and sign the work schedule topics that they had already covered, even near the end of the PD programme. However, progress was made in terms of accelerating some participants' completion of the syllabus. The participants' heavy teaching loads contributed to their flaws in the administrative tasks and their failure to complete the syllabus timeously (see Fraser-Thomas & Beaudoin (2002) and Darmody & Smyth (2011), in Chapter 2, Section 2.3).

7.1.4 Development in terms of the setting of assessments

The development of the participants in terms of assessments was limited; it seemed that it was not the focus of the PD programme's interventions. However, the programme helped the participants with the drafting of investigations and their own assessments. This prevented them from cutting and pasting assessments from other documents, as they did in the past. One participant highlighted the development of his assessment skills in the process of compiling common assessments in the PD programme. He learnt to be cognisant of the imperative to balance the questions in terms of the different cognitive levels. The test items that were collectively compiled and collated in book form were also used as a resource, especially when the participants had to conduct test later on. Through the PD programme, the participants also obtained additional assessment-related resources to be used in their classrooms. It can be concluded that the participants' assessment skills were developed through the PD programme.

7.1.5 The role played by the workshops

As mentioned earlier (Chapter 7, Section 7.1), the workshops played a significant role in the development of the participants' content knowledge (of both the old and new curricula), their lesson preparation, and their conduct of lessons. Workshops also gave the participants the opportunity to be part of a community of practice. This was a new development since they were from rural schools where they mostly

worked in isolation. The workshops were also opportunities where participants could receive valuable resources from the service provider and the subject advisor.

The participants learnt different strategies that would help them to solve mathematical problems, besides those that they have been using. They also discussed the different cognitive levels to include in class exercises to ensure that the learners were exposed to higher order questions. This would prepare learners to answer more demanding questions and enhance their problem-solving skills. The participants themselves were also exposed to higher order questions in an attempt to develop their competence as well. Indeed, as teachers, they needed to be capable of dealing with higher order questions, before the same could be expected from their learners (Chapter 6, Section 6.2.1.4). In other words, teachers would be more confident to give higher order questions to their learners if they themselves mastered them (Chapter 6, Section 6.2.1.4). The possible reason learners' grade 12 results in Schools B, C and D, and the grade 9 results in School A (Chapter 5, Section 5.6) did not improve could be that the participants did not expose their learners to higher order questions. The fact that the learners' intellectual growth was not fostered contributed to their poor scholastic performance (see Moodley (2013) in Chapter 2, Section 2.3). Another reason might be that the participants did not yet master the skills of incorporating other teaching strategies that they tried out in class (see Luneta (2012) in Chapter 2, Section 2.3).

The workshop coordinator/mentor also used the workshops as an opportunity to address the challenges she observed when conducting lesson observations, in her capacity as mentor. In this way, the gaps in the content knowledge and teaching skills of the participants could be addressed in a manner that would have a direct impact in the classroom.

In several interviews, the participants indicated that they enjoyed and developed through working in groups in the workshops. Although these opportunities were new to them, they added value in that they enabled the participants to learn from one another, given that they were exposed to other methods of solving mathematical

problems and other ways of presenting lessons. Group work also made the participants aware that they were not in the only ones experiencing challenges in their schools and classrooms. The workshop coordinator also created a conducive environment where the participants felt free to ask questions, express their views, and raise their concerns (see Ambrosetti & Dekkers in Chapter 2, Section 2.4). This added a dimension of openness to the workshops.

All of the above contributed to the participants' increased competence (content knowledge, lesson preparations, assessment, and so forth), and performance (new teaching strategies, more involvement of learners in the class, completion of syllabi, and so on).

However, the marginal difference between the results of the pre-test and those of the post-test questioned the effectiveness of the development of the participants in terms of their content knowledge. The repetition of the same topics in different workshops might be due to insufficient planning and scaffolding of concepts in the workshops, but it might also highlight the significant gap in the participants' content knowledge. However, in their respective interviews, the participants emphasised that they had benefitted from the workshops in terms of learning from one another and had grown in terms of content knowledge, lesson preparation, and conduct of lessons.

7.1.6 The role played by the mentor

The mentor was the "third" party in the classroom; she advised the teachers on where and how they could improve their teaching in order to be more effective in class. From the interviews (Chapter 6, Section 6.2.2.5), it seems that the first mentor was well-received by the participants, unlike the second mentor.

The mentoring interventions, together with the workshops, motivated the participants to do written lesson preparations, to a large extent. The mentor also helped the participants to refine their lesson preparations and, in the process, their planning. However, it must be stressed that the second mentor, who took over in 2012, was instrumental to the development of the teachers with regard to their lessons. Indeed,

it was only in 2012 that the participants started to take lesson plans seriously. Moreover, the first mentor admitted, in her interview with the researcher, that she did not really check the teachers' lesson plans.

The mentoring also enabled the participants to change their classroom practice in that they became more learner-centered. This means that they allowed the learners to do more classroom activities, and gave them homework. The teachers also spent less time to mark their learners' homework in class the following day, compared to the time they spent before the intervention. The participants were successfully encouraged, by the mentor, to check the learners' books in class. In so doing, they could identify errors that the learners had made and helped the latter to correct these errors.

The teachers were supported in conducting lessons through co-teaching or co-facilitation with the mentor who showcased other ways of teaching the section being covered in class. The other function of this co-teaching was to demonstrate to the participants how to teach certain topics that they found difficult or problematic. The participants were also encouraged to use other teaching strategies like group work, and were taught better ways of conducting investigations.

The participants were also supported in rectifying the neglect of their administrative work, notably, the ticking off of the work schedules and the timeous marking of assessments (Chapter 5, Section 5.2.5). These aspects were important in terms of the holistic development of the participants as professionals.

One of the advantages of this programme was that the participants were much more willing to allow the mentor in their classes. This was uncommon in the South African context, due to the reluctance of the biggest teachers' union to allow "others" into the classroom.

The challenges relating to mentoring in this PD programme included the minimal mentoring time, limited time to discuss the lessons after the mentor had done the lesson observations, the significant distances that separated the different schools involved in the programme, the mentor being involved in other work outside this PD programme, and the heavy teaching loads of the participants (Chapter 6, Section 6.2.2). The mentor could have impacted the competence and performance of the participants more if mentoring time had been higher from the beginning. From the interviews, it was gathered that the participants felt that they were not visited enough by the mentor during the three years of the PD programme. They believed that more mentoring opportunities would enable them to refine the teaching and assessment strategies they had learnt in the programme. Consequently, the dosage was increased in 2012, but it was not done timeously and significantly (Chapter 6, Section 6.2.3.3). Mentoring requires the mentor and mentee to discuss the lesson observed by the mentor so that meaningful inputs could be given from both sides, to facilitate learning. However, at times, these discussions did not happen, raising the question of the significance of these lesson observations. The distances between the different schools, and the fact that the mentor had other duties outside the investigated PD programme also added to the lack of time to have discussions after the lesson observations. Rhodes et al. (2004: 24) warned that time constraints could lead to the ineffectiveness of the mentoring process. The participants' heavy teaching loads also contributed to this situation (Chapter 6, Section 6.2.1.7).

The mentor's specific views on educational issues could also be perceived as challenges to the effective running of the mentoring interventions. The mentor indicated that she did not have conventional views on reflective practices which she regarded as very personal and hard to control. Furthermore, her view on lesson preparations was not fully in line with that of the DoE. This might have contributed to her not checking the lesson plans of the participants, despite the fact that the programme foregrounded them as one of its outcomes. The mentor also did not undergo a proper induction from the service provider. This could account for her

differing perception of the aims and objectives of the programme as well as her eccentric approach to the different interventions.

7.1.7 Pre- and post-test results of participants

The pre- and post-tests were not set on exactly the same content, since the programme included topics from the new CAPS document in the workshop interventions, the pre-test was based on the "old" NCS topics and the post-test was based on both syllabi. This explains the inclusion of topics which were not part of the pre-tests. Although this could be used as a basis for not comparing these tests with each other, comparing was done, since significant workshop time was spent on the NCS topics. It must be stressed that the tests only showed significant improvement in the content knowledge of participants on financial mathematics, given that a lot of time was spent in different workshops on this topic. The fact that one participant's post-test average was lower than that of his pre-test was a cause for concern. However, this was only the case with one participant, even though two other participants did not have post-test results. If their results had to be taken into consideration, it could be argued that the programme did not succeed in improving the participants' content knowledge in the FET Mathematics. It might have been that the gap in content knowledge was to the extent that one year (or even three years) was not enough to close it. As claimed in Section 7.1.1, the content knowledge gained was not of a high-level scientific nature, as proposed by Modiba (2011) in Chapter 2, Section 2.5.

7.1.8 Learners' results

The analysis of the learners' results indicated that there were no significant improvements in the grade 12 learners' performance of Schools B, C and D. The grade 9 learners' performance of School A was only significant in the period 2012-2013. What is more, this improvement was on a small scale, this meant it was not necessarily significant. In the periods 2011-2012 and 2011-2013, there was no significant change in School A's grade 9 learners' performance. It can therefore be concluded that the performance of the learners at the schools where the programme

was rolled out did not improve in the period 2010-2013. The effects of the development of teachers in terms of their content knowledge and teaching practices might have been delayed (Guskey, 2000: 254; Joyce & Calhoun, 2010: 17) and might reflect on their learners' results in subsequent years. Loucks-Horseley, Stiles, Mundry, Love and Hewson (2010: 77) remark that "it can take 3-5 years for teachers to fully implement a new practice or programme, and therefore expecting learners' achievement to change in a short period of time is unrealistic". In the light of the above, the investigated period might have been too short to be able to appreciate the effect of teachers' development on their learners' results, the teachers' content knowledge might still be insufficient, their teaching strategies might not have improved sufficiently; or, a combination of the different scenarios mentioned is responsible for the lack of improvement in the learners' performance.

7.1.9 Other findings

The participants were given the opportunity to partake in decisions pertaining to the programme, notably the selection of topics to cover in the workshops. This ensured that the participants accepted ownership of the programme and might account for their positive attitude towards the workshops (see Kgalema, Luneta & Lee, Chapter 2, Section 2.3). All the participants felt that the topics covered in the workshops were speaking to their needs, whether the topics were from the NCS or the new CAPS syllabus.

The deliberate inclusion of all the stakeholders in the inception of the programme and in its regular steering committee meetings allowed all the stakeholders to be directly involved in the making of decisions and to immediately address any burning issues. This might be why tests could be conducted with the participants. Indeed, in certain instances, teachers' unions refuse these kinds of requests.

The participants preferred that the person facilitating the workshops also be in charge of their mentoring. This allowed for the smooth transition from showing ways of doing in the workshops to their application in the classroom. When the mentor and workshop coordinator were different people, the participants were reluctant to

cooperate. This is mainly because different ways of doing became confusing and frustrating to them.

7.1.10 Summary of findings on the effectiveness of the PD programme under Investigation

In chapter 2, different components on which to base the evaluation of the PD programme were highlighted. Below are the conclusions drawn at the end of the investigation.

PD programmes are more effective if their activities are conceived as reforms (see Desimore in Chapter 2, Section 2.3) which include group study, teacher network, mentoring relationship, committee or task force, internship, and so on. This is in contrast to the traditional workshops, courses and conferences. The investigated PD programme can thus be classified organised as reform type, because mentoring was included where a relationship was formed between the first mentor and the mentees. Furthermore, in the workshops, the participants formed active pairs or groups, and teacher networking was fostered. Indeed, the involved teachers critiqued each other's lessons, and shared the different approaches that they used to solve certain mathematical problems.

With regards to the duration of the activities (see Cohen &Hill & Lee Chapter 2, Section 2.3), it can be concluded that the workshops and mentoring took place over three years. However, although the duration was long enough, the dosages of the workshops and mentoring were insufficient throughout the span of the three years, as mentioned earlier in this chapter. Careful consideration should be given to the participants' needs analysis so as to adjust the dosage of the activities to ensure that the PD programme is effective.

Active learning (see Darling-Hammond in Chapter 1, Section 1.2.3) was foregrounded in this PD programme, as participants were given the opportunity to be actively involved in workshops, for example. They were given activities to do,

individually and in pairs, and were expected to justify the methods they used in solving certain mathematical problems. They also critiqued each other's lesson plans and the actual conducting of these lessons, which were further examples of active learning. In the mentoring sessions, advice was given; whereas in co-teaching with the mentor, they could pick up new ways of doing things in their own classrooms. In trying out the techniques they had learnt in workshops or mentoring sessions the mentor helped the participants to adapt the application of these new methods to their own specific situations. This was another means of fostering active learning among the participants.

Collective participation (see Wenger in Chapter 1, Section 1.2.2) -– in groups – of teachers from the same school, department or grade level, as opposed to the individual participation of teachers from many schools was another component of an effective PD programme. This programme, due to the fact that there was only one teacher who taught their school's FET Mathematics learners, mostly focused on the participation of individual teachers from the different schools. Indeed, because of the unique situations of these rural schools, collective participation was not possible. However, there were certain things that the participants had learnt that could be shared with colleagues in the same school who taught lower grades; but, this was beyond the scope of this study.

Collaboration among the participants (see Rogers et al in Chapter 2, Section 2.3) was identified as another component of an effective PD programme which was foregrounded in this study. Numerous aspects or examples of this were already mentioned.

Another component of an effective PD programme is the involvement of the participants in the planning of the programme (see Kgalema, Luneta & Lee in Chapter 2, Section 2.3). There was no evidence of the involvement of the participants in the initial planning of the programme; but, the participants were part of

the planning of the content of the workshops. This added to the programme's ability to address their needs at the time.

The success of the scaffolding of activities in the programme (see Desimore et al. in Chapter 2, Section 2.6) was mitigated. This is because some topics were repeated in more than one workshop, which created doubt as to whether successful scaffolding occurred within certain topics. The fact that the participants' test results also did not show significant improvement reinforces the abovementioned doubt.

Therefore, it can be concluded that this programme showed signs of effectiveness to a limited degree, based on the components discussed above.

7.2 CONCLUSION

It could be concluded, due to the triangulation of different data sources, that a more accurate picture of the evaluated PD programme and its effect could be ascertained. It could be claimed that the participants developed in specific areas, due to their involvement in the workshops and the mentoring sessions. The participants gained better content knowledge of both the NCS and the CAPS syllabi topics in the FET phase. The content covered in the workshops was jointly proposed by the workshop facilitator, the participants, and the subject advisor. This gave the participants a sense of ownership of the programme. It was, therefore, not surprising that all the participants also expressed their satisfaction with the topics covered in the workshops, as these addressed their needs at the time.

The participants also developed with regards to both their lesson preparations and the actual conducting of lessons. Lesson preparation was dealt with in both the workshops and the mentoring sessions. The participants were able to apply a wider variety of teaching styles and involved their learners more in the classroom. This was achieved by giving learners exercises where the chosen examples allowed for the scaffolding of concepts. The teachers also gave their learners homework on a regular basis and ensured that it was marked timeously and in less time than before

the intervention. The mentor conducted co-teaching with the participants in order to show them how certain sections could be taught or to assist the participants who experienced difficulties. The participants also did lesson demonstrations in workshops where they critiqued each other's lessons. This not only assisted in their development in terms of conducting lessons, but it also increased the cohesion of the community of practice.

The workshops and mentoring sessions also enabled the participants to complete the syllabi within the stipulated time by combining sections relating to the same topic in a lesson. In that way, they could cover the topics faster and be able to link relatable sections. Although some of the participants still needed Saturday and holiday classes to complete their syllabi, they were able to cover the topics faster. The programme also assisted the participants with regard to the setting of such assessments as investigations and assignments. This helped the participants to be less reliant on assessments set by other teachers, as they developed their abilities to customise or adapt existing models to their own contexts. So the workshops and mentoring sessions contributed to the participants' improved competence and performance as professionals.

However, evidence suggested that the participants still needed support in the implementation of certain teaching strategies that they had learnt as a result of their involvement in the workshops and mentoring sessions (Chapter 6, Section 6.2.1.1). Teacher NK, for instance, made specific reference to her need to be developed in terms of analysing the learners' results to assist her in directing further support to learners. The participants themselves expressed the need to continue with the programme, because they also knew about these areas where they still needed support. Although the programme lasted for three years, which could be perceived as a significant duration for a PD programme, the dosage of both the workshops and mentoring could have been increased from the start to enhance the effectiveness of the programme (see Chapter 7, Section 7.6). Looking at the results of the pre-tests, it was evident that the participants had a huge content knowledge gap. As content knowledge is a very important element of an effective teacher, a bigger dosage of workshops will be essential to addressing this issue. The mentoring dosage was only

increased in the last year of the programme. If it had been done earlier and the mentor was solely assigned to this programme, the teachers could have developed more.

The pre- and post-tests written by the participants included a number of topics, but significant improvement was only evident in financial mathematics. By analysing the individual teachers' results, it was evident that they started and finished the programme with varied levels of content knowledge competence. Fortunately, the interviews with both the participants and the mentor revealed that the participants gained a better understanding of the content, especially that of the "new" CAPS topics. Most of the participants did not teach some of the "new" CAPS topics before, nor were these topics part of the syllabus when these teachers were still pupils in school. Therefore, these topics were dealt with in workshops, starting from a very basic level. It seemed that there was not enough time to bring the participants up to par with the new curriculum. However, the participants' content knowledge improved, though the test results did not indicate so. The involvement of different stakeholders added to the working relationship between the service provider, the DoE, and the teachers' unions. This concluded the first and second research questions.

The learners' performance of the schools participating in the programme did not improve significantly, except that of School A in the period 2012-2013. Adler and Reed (2002: 137) claimed that "improvement in student learning is a function of teachers' knowledge of their subject matter, which is, in turn, a function of subject-focused pre- and in-service Teacher Education". The fact that the participating teachers' content knowledge did not show significant improvement in the post-test results might explain the lack of improvement in learners' results. Given that the "new" CAPS topics covered in the programme had to start with the basics as teachers were mostly exposed to these topics for the first time, the programme – most probably – did not manage to develop the participating teachers' content knowledge to an advanced level.

7.3 RECOMMENDATIONS

PD programmes need to ensure that the dosage of their interventions and the time allocated for these will be sufficient to address the content and skills gaps of the participants, after a thorough needs analysis (see Luneta, Joyce & Showers in Chapter 1, Section 1.2.2).

Site-based mentoring is an effective avenue for developing teachers, as the mentor can identify individual teachers' challenges and strengths in the classroom. However, the mentor needs to be carefully selected and adequately trained in relation to the specific intentions of the programme. In the selection process, caution should be taken as to the interpersonal skills of the mentor to ensure a good working relationship with the participants. Indeed, the mentor's interpersonal skills can contribute to the success or failure of mentoring as an intervention. Where possible, the same mentor should be employed for the duration of the intervention, provided that the mentor adheres to the ethos of the PD programme. There should also be coherence between what is promoted in the workshops and the mentoring so that the teachers are not given contradictory information (see Desimore, Kgalema & Guskey in Chapter 2, Section 2.3).

The inclusion of micro-teaching in PD programmes can add to bridging the gap between what is done in off-site workshops and how what is learnt is implemented in the classroom. In this way participants can also be exposed and supported in the use of different teaching styles and to build confidence in new ways of teaching.

The assistance of participants in the preparation of lessons should be included in PD programmes where needed. This will assist the participants in completing the syllabus within the allocated timeframes. This assistance should be done from the onset of the programme to allow for sufficient time for participants to refine their skill of lesson preparation.

PD programmes need to flexible, even while they are implemented, to the ever changing needs of the participants but also to the changing educational context. In the investigated programme the curriculum changed and by adapting the covered content topics to that of the new curriculum, the participants benefited significantly.

There need to be close collaboration between the PD programme implementers and the subject advisors to ensure that they share the same aims, objectives and specific ways of doing pertaining to the development of the teachers. If this is not ensured, confusion can arise amongst teachers and the purpose of the PD can be defeated by this.

The close monitoring of teachers by the subject advisors to a manageable number of schools is of the essence to ensure effective teaching and learning. Where possible the manpower of subject advisors needs to be increased so that more focused support can be guaranteed. It is also of pertinent importance that the function of subject advisors is not limited to moderation, but that they also focus on the development of the teachers residing under their jurisdiction.

Incentives are an important way to motivate teachers to participate optimally in a PD programme. It must be stressed that the participant who received an incentive for being the most-improved person in the group, while the programme was still running, was very motivated and committed.

However, it is very difficult for the participants to fully participate in interventions and implement new ways of doing, if they have heavy teaching loads. Therefore, Teacher Education should strive to alleviate the heavy teaching loads of the participants, to ensure the success of teacher PD programmes.

Teachers in rural schools mostly work in isolation. Therefore, their inclusion in a community of practice is not only a possible way of enabling them to overcome this isolation, but also a means of stimulating mutual learning among teachers. Therefore, PD programmes need to consider the benefits of consciously creating communities of practice that would function as platforms for the stimulation of learning.

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APPENDICES

Appendix 1

Letter of consent by North West Department of Education to conduct the research

education and training
Lefapha la Thuto le Katiso
Departement van Onderwys en Opleiding
Department of Education and Training
NORTH WEST PROVINCE

cnr Kock and Heystek Stree
Rustenburg 029
Private Bag X8211
Rustenburg 030
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OFFICE OF THE CHIEF DIRECTOR: BOJANALA DISTRICT

Enquiries: Ms M.E. Mogotlhane 014 565 9601/ 0837621090

To: Ms Benita Nel
Senior Coordinator: Mathematics
Academic Development Centre

From: Ms M.P. Mokhutle
Director: Professional Support Services

Date: 03 December 2012

Subject: Permission to do Research on the Bojanala INSET teacher development program

The District Management grants your company permission to access our schools for the above mentioned purpose.

It would, however, be prudent to ensure that during the execution of this noble task, teaching time remains unaffected.

Furthermore, it is expected of your company to submit your schedule of activities to the Area Office/s well in advance, for purposes of proper planning.

I trust that you will find the above in order.

Thanking you

Ms M.P. Mokhutle
Director: Professional Support Services

DEPARTMENT OF EDUCATION
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"STAND UP, TEAM UP AND REACH OUT"
"A PORTRAIT OF EXCELLENCE"

Appendix 2

Letter to teachers seeking permission from participants to partake in research

Dear Educator

I, Mrs Benita Nel, am currently studying my PhD degree in Mathematics Education at UNISA. My research topic is to investigate the effectiveness of the (**PD Programme's name**). I would like to request your participation in this research project. However, this participation is voluntary and you may withdraw from this intent at any time without negative or undesirable consequences. You will be required to participate in an interview and lesson observations. All the data collected will be used for the project evaluation and not a teacher evaluation. The information collected will be used anonymously and no names will be used in any reports. None of what you say will be used against you or affect your employment in any way. All the information gathered will be used to contribute to Mathematics Education research and for the development of Mathematics Education.
If you are happy to participate in this research, please complete the consent slip below?

If you require further details, please do not hesitate to contact me on 011 559 6586 or email bnel@uj.ac.za.

Thank you for your participation. Your time and effort is appreciated and will be of value to this research.

Yours truly,
Benita Nel

Storage and security of data
All the data gathered for the study will be stored under lock and kept in the School of Education (ISTE) at the UNISA, and destroyed 5 years after the completion of the analysis and reporting.

……..

I have read all of the above and consent to my participation:

Name (participant): …….

Signature: …….

Date: …….

Appendix 3

Ethical clearance letter from UNISA

UNISA university of south africa

Ref: 2013/ISTE/30

08 July, 2013

Mrs. Nel Benita
(47293314)
ISTE
UNISA.

Dear Mrs. Nel Benita,

REQUEST FOR ETHICAL CLEARANCE:

Title of Study: "An Evaluation of the Bonanala Systemic School Improvement Project (BSSIP): the case of Mathematics Teacher Development INSET programme in the North West Province of South Africa."

Your application for ethical clearance of the above study was considered by the ISTE sub-committee in the College of Graduate Studies on behalf of the Unisa Research Ethics Review Committee on 16 May, 2013.

After careful consideration of the details and implications of the study, your application was **approved** and hence you can continue with the study at this stage.

Congratulations.

C E OCHONOGOR
CHAIR: ISTE SUB-COMMITTEE

CC. PROF L. LABUSCHAGNE
EXECUTIVE DIRECTOR: RESEARCH

PROF M N SLABBERT
CHAIR- UREC.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Appendix 4

Consent form for Mentor & Programme Executive Manager

Dear Mentor/Programme Executive Manager

I, Mrs Benita Nel, am currently studying my PhD degree in Mathematics Education at UNISA. My research topic is to investigate the effectiveness of the (**PD Programme mentioned**). I would like to request your participation in this research project. However, this participation is voluntary and you may withdraw from this intent at any time without negative or undesirable consequences. You will be required to participate in an interview and allow me to observe at least one mentoring session with one teacher per school that you will conduct. All the data collected will be used for the project evaluation and not a teacher evaluation. The information collected will be used anonymously and no names will be used in any reports. None of what you say will be used against you or affect your employment in any way. All the information gathered will be used to contribute to Mathematics Education research and for the development of Mathematics Education.
If you are happy to participate in this research, please complete the consent slip below?

If you require further details, please do not hesitate to contact me on 011 559 6586 or email bnel@uj.ac.za.

Thank you for your participation. Your time and effort is appreciated and will be of value to this research.

Yours truly,
Benita Nel

Storage and security of data
All the data gathered for the study will be stored under lock and kept in the School of Education (ISTE) at the UNISA, and destroyed 5 years after the completion of the analysis and reporting.

……..

I have read all of the above and consent to my participation:

Name (participant): …….

Signature: ……..

Date: ……..

Appendix 5

Interview schedule with the Teachers

The following questions will be asked and other prompts will following depending on answers given:

1. Briefly share your experiences in the PD programme.
2. What in the lesson you just presented would you say was done differently from how you did it before your involvement in the programme?
3. Did you manage to stick to the work plan during the year? Explain how/why not.
4. Did your assessment assess what was presented in the lesson? Motivate your answer.
5. Did the presentations in the workshops assist you in your development as teacher? Explain.
6. Would you say that the mentoring by the facilitator contributed to your development as teacher? Explain your answer.
7. Are there other developments that took place in you as a teacher due to your involvement in the PD programme?
8. Can you recommend ways in which the programme can be improved in order to assist you better as a teacher?

Appendix 6

Lesson observation schedule

Component 1: Learners involved in active learning tasks while teacher facilitates the process.			
4. Learners have several opportunities to be actively engaged in learning tasks while the teacher moves around the class to facilitate what learners do and assist, support and encourage learners where needed.	3. More opportunity to be actively engaged in learning tasks as individuals or in groups than just one classwork activity. More than half of class is not mere observers. Teacher occasionally interacts with individuals or small groups.	2. Learners are only engaged in learning tasks when they copy work from board or doing an exercise in class. For most of the lesson learners are observers and teacher does most of the talking.	1. Learners are not engaged in active learning tasks. Teacher does all the talking and writing on the board.
Description:			
Component 2: How teacher facilitate learning by connecting ideas or investigate the thinking in the class and ask open-ended questions.			
4. Teacher asks open-ended higher-cognitive level questions frequently and makes more than one connection with ideas. Probing also takes place to investigate the learners' thinking.	3. Teacher asks few questions at a higher-cognitive level and limited evidence of connecting ideas was observed. More of the questions asked by teacher are closed-ended than open-ended.	2. Teacher asks lower-cognitive level questions and do not connect ideas to enhance conceptual understanding. Teacher mostly asks closed-ended questions while learners respond with at most a sentence. No evidence of connections between ideas evident.	1. Teacher seldom asks questions and learners seldom are given opportunity to respond to questions.
Description:			

Component 3: Teacher's content knowledge reflecting in class			
4. Teacher does not display any mistake in terms of content knowledge. Teacher uses unplanned opportunities that arise in the lesson to show more than one way of presenting ideas. Task selection shows the scaffolding of concepts as tasks were carefully selected.	3. Teacher displays no mistakes in terms of content knowledge and shows occasionally more than one way of presenting ideas. Task selection shows evidence of scaffolding concepts.	2. Teacher displays a few mistakes in terms of content knowledge and the selection of tasks shows gaps in scaffolding concepts.	1. Teacher display numerous mistakes in terms of content knowledge and the selection of tasks are bound to sequence in textbook.
Description:			
Component 4: Does teacher draw on learners' living context in lesson.			
4. Teacher draws on more than 2 occasions on learners' context.	3. Teacher draws only on learners' living context 1 or 2 times.	2. Teacher connects section covered with context, but the context is not that of the learners.	1. Teacher does not draw on learners' living context.
Description:			

Component 5: Teacher's responses to learners' questions, errors made or responses to their written work.			
4. Teacher's response to learners' work was in the form of probing their thinking to further enhance learning. The focus was not on correct responses, but more on the learners' thinking process to enhance the conceptual process. Open-ended question accompanied this process where the teacher spoke less and the learner more.	3. Teacher's feedback was in the form of facilitating the learners thinking as to assist him/her to devise the validity of the response him/herself.	2. Teacher's feedback is in the form of just giving the student the correct answer or informs the student the response is incorrect.	1. Teacher seldom gives feedback.
Description:			
Component 6: Application of theory in the lesson.			
4. Application of theory was done and suitable connection was made between them, and all of them added to the progression of the concept(s).	3. Application of theory was done and suitable connection was made between them, but not all were suitable for progression.	2. Application of theory was attempted but was not suitable connection was made between them.	1. No application of the theory was visible.
Description:			

Component 7: Homework was given to learners to do at home.			
4. Homework was given on conceptual levels 1-4 and there was an increase in difficulty and application of the theory.	3. Homework was given on conceptual levels 1-3 and there was an increase in difficulty.	2. Homework of less than 10 minutes was given.	1. No homework was given to learners.
Description:			
Component 8: Teachers' lesson preparation done and used.			
4. Teacher has a written lesson plan which follows the given structure of introduction, body and conclusion. These sections flow to fit as a unit. In the execution of the lesson the different aspects of the lesson follow each other smoothly. The objective of the lesson was clear and achieved and both the content and the learners were kept in mind when the lesson plan was drawn up. Prior knowledge is used as a stepping stone to link to the section that is dealt with in class.	3. Teacher has a written lesson plan and there is a flow between the different component of introduction, body and conclusion. However it does not fit as a unit. The objective of the lesson is clear and more emphasis is put on the content of the lesson and to a limited extent the learners were kept in mind when the lesson plan was designed. Some prior knowledge is linked to the section being dealt with.	2. Teacher has a lesson structure but not written out. There isn't a flow between the different component of introduction, body and conclusion so that it fit as a unit. The objective to the lesson is also not clear. The teacher was only mindful of the content of the lesson, but not the learners. Prior knowledge is not linked to the section being dealt with.	1. Teacher does not have a lesson plan and there is no structure to the lesson.

Description:

Appendix 7

Turn-it-in Report

29 January 2015

Supervisors report: Turn it in - PhD thesis

Candidate: Benita Nel

Title: An Evaluation of a Mathematics Professional Teacher Development Programme

Information from the turn it in report:

Originality

Similarity Index:	7%
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I have checked the full Turn it in report and there is not substantive copying without attribution. In this report it shows a 7% similarity.

Yours sincerely

DR. Kakoma Luneta
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University of Johannesburg
PO BO 524
Johannesburg
South Africa
Tell: +27 11 559 2563/5246 : Cell 082 6356257:

Appendix 8

Language Editor Letter

30 January 2015

To whom it may concern

Re: Editor's declaration

I, Herve Mitoumba-Tindy, hereby declare that I have performed language editing on Benita Portia Nel's PhD thesis entitled "**An Evaluation of a Mathematics Professional Teacher Development Programme**".

I further declare that, having worked under extreme time constraints, I have done the necessary language corrections to ensure that the final product is of an improved standard, compared to the original that I received. A track-changes electronic copy of each chapter was sent to the author (Benita Portia Nel) as evidence that editing was done and that all the chapters were covered.

Yours sincerely,

Nel, Benita
Qualification: MA English
Position: Writing Centre Coordinator at a South African university
Cell: 082 489 8108
Email: mitoumba2000@hotmail.com